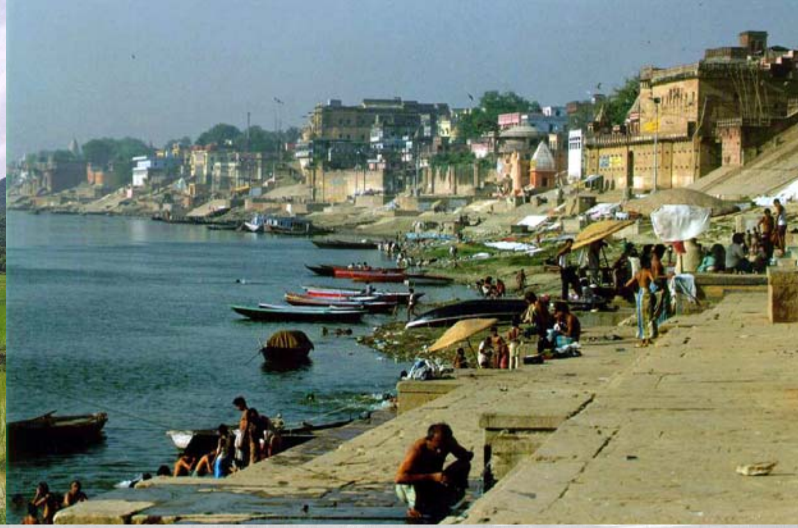

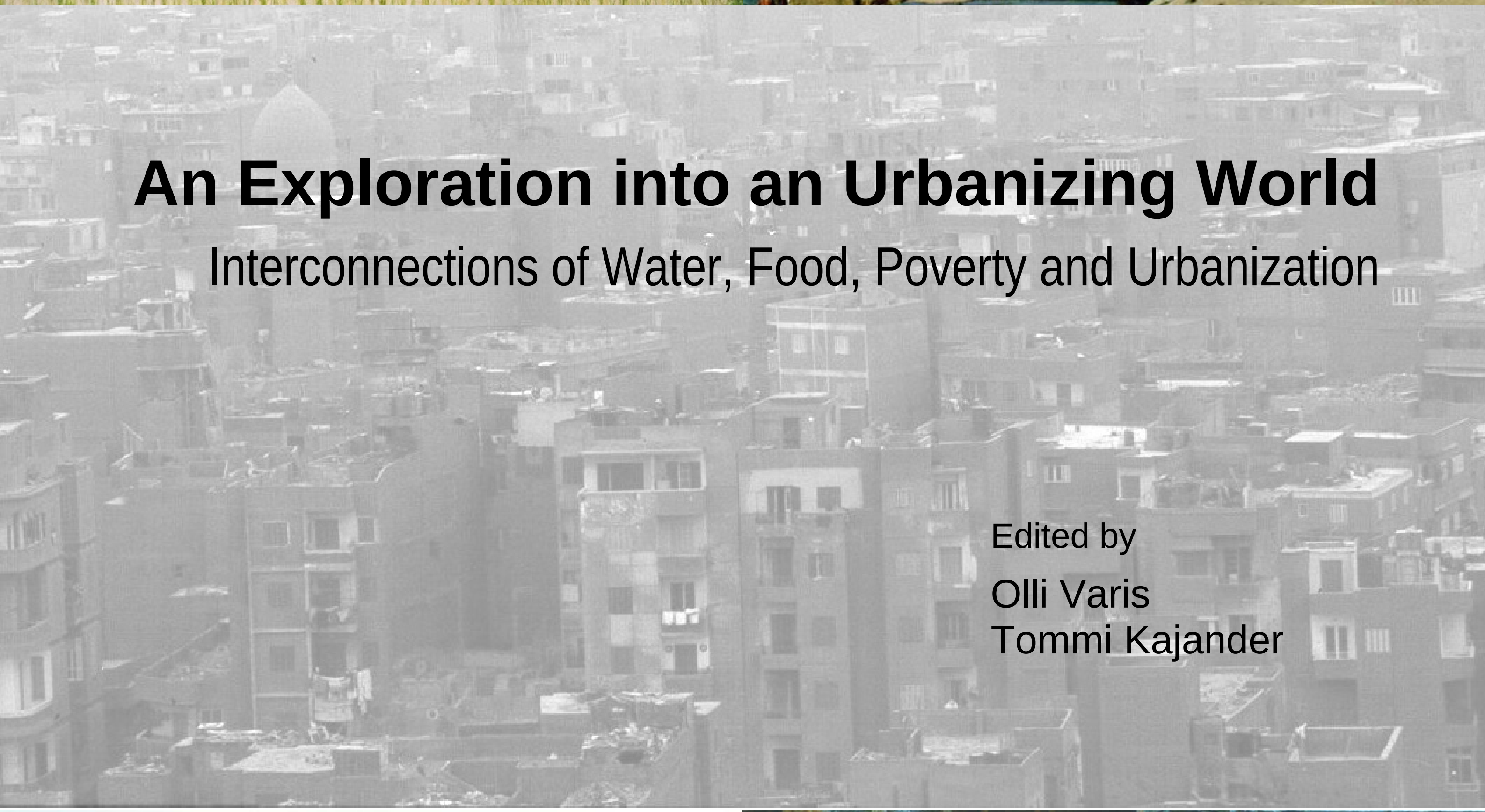

An Exploration into an Urbanizing World

Interconnections of Water, Food, Poverty and Urbanization

Edited by
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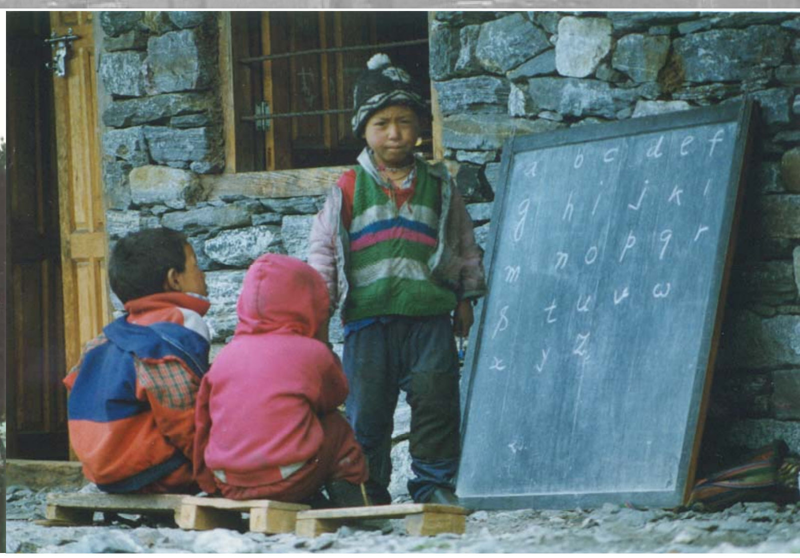

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1. Introduction

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Water must be one of the simplest things one can imagine. But at the same time it is interwoven in the various functions of the nature and the human society in countless ways which makes water one of the most complicated challenges of the mankind today. These challenges call for seeing water in a broad development framework, pressed by a mix of demographic, social, environmental and economic drivers.

Dilemma of the water "sector"

It was until the Renaissance, that the Europeans believed Terra to be at the center of the Universe. It needed some science, confrontation, political devotion, and humble attitude to change this view, but the worldview changed and the people now appreciate the Terra as a component of a highly complicated and sophisticated planetary system.

It might appear a bit rudimentary to draw an analogy of the water community of today and the pre-renaissance Europeans, but the comparison might not be totally wrong. All water agendas stipulate perennially that water should be managed in a basin-wide context, all stakeholders on water management should be brought at one single table and so forth and so on.

One important caveat is due to the fact that whereas water professionals commonly see water as a consolidated sector, many other sectors consider water to belong to their own sectors. Take for instance the energy sector, forestry sector, agricultural sector, or the health sector, not to talk about water's cultural, political and sacral dimensions. All these sectors and dimensions have their own claims within their own modus operandi, and water is a part of such claims.

The water sector itself is a many-dimensional mosaic of activities, with no clear disciplinary boundaries (cf. Mohile 2005). Water has a very varied, crosscutting function that goes across, and links many different sectors. Clearly, water resources management should be integrated, but the drivers, needs, investments, policies and solutions come often outside of the water sector proper.

Water belongs usually under up to ten ministries and only the core water profession considers for instance the river basin as an appropriate unit for water management, others go along jurisdictional borders, technical access, ownership of the resource, economic region or some other criteria in defining their geographic dimension for planning and management.

Water: the blood of the planet

What comes to the role of water for the nature of this planet, the prominent Swedish hydrologist Malin Falkenmark (1997) calls water as the blood of the planet; as the whole biosphere's metabolism is governed by water circulation, water is extremely difficult to manage in a sustainable way. If either the quantity or the quality of water is being disturbed too much, the consequences may be serious and unexpected.

Human activities have disturbed the hydrologic cycle in massive ways in the past, but never as much as today. Where we are now is, however, just an overture to what will come in coming decades. Many of the mighty rivers such as the yellow river or the Nile do not bring much water to the seas any more. Groundwater aquifers are being overdrawn with alarming rates. The water quality problems of surface and groundwater are growing increasingly severe. Land use changes and climate factors cause the increase of floods, storms and droughts. With increasing urbanization and congestion of people to very small land areas, the above problems as how they are created and felt by humans are notably amplified.

Water as a strategic resource

Water is one of the most strategic natural resources. It is intertwined in the everyday life of human beings in countless ways. The importance of water as a driver for health, food security, and quality of life and as a pillar for economic development is unique.

As water affects human lives, the mankind also effects the hydrological cycle of this planet, in all dimensions from the very local to the global scale. The production of one kg of grain consumes 1,000-4,000 liters of water. Food production—although not being enough for all—already accounts for 90% of water use in developing countries.

Hydropower production by damming rivers evokes grand emotions, yet sustainable energy production is among cornerstones of economic development. The damage caused by floods and droughts is escalating. After the IFRC (2002) 700 million people were affected by natural disasters during the 1970s. In the 1990s the figure had stepped up close to two billions. The figure keeps growing. The share of floods of these disasters is reasonable—two thirds. The property damage has been growing even more rapidly.

Water kills far more people than "terror" or all conflicts together. It kills more than AIDS or other great diseases that we see on headlines daily. Every 10 seconds somebody dies due to poor quality water.

The human impact on ecosystems is catastrophic in immeasurable ways. Water is largely a political good since a bulk of the mankind lives in river basins shared by two or more nations.

Water, poverty and development

Water is a backbone of economy in very many countries of the world. Water resources management provides the foundation of the agricultural sector, much of the energy sector, an important part of urban infrastructure, health care and many other functions of the society.

Economic growth is desperately needed in poverty reduction, but growth alone is not sufficient. The well-being must reach the poor; otherwise the growth only polarizes the economies. Water's role is very important in this complex interplay.

Besides being an important fundament to many economic sectors, water is also a key in meeting many of the basic needs that are in turn instrumental in poverty reduction.

- *Water:* The more important economically the poorer the nation is.

- *Environmental threats:* By far the most detrimental environmental catastrophes are floods and droughts. Water is the main carrier of environmental pollutants. It is also the major agent in the global erosion, desertification, biodiversity decline and climate change problems.

- *Traditional societies and the traditional sector:* Their economy is tied with nature and very closely to the water cycle.

- *Informal sector:* Water is a key constraint to a decent livelihood in the rapidly growing informal sector. Particularly in urban conditions the challenges are soaring.

- *Agriculture:* Accounts for 70% of all water use by humankind. In most developing countries the share is over 90%. Water nature, infrastructure, technology, etc. are the backbone of the economy.

- *Industry:* In large part of the world (in terms of population: China, Southeast Asia, South Asia…) industry is developing more rapidly than ever before. Many industrial sectors rely on water. Pollution challenge is enormous.

- *Energy:* The Johannesburg Plan of Implementation defined the increase in the share of renewable energy sources as the primary goal of the energy sector. It is fundamental to understand that 96% of renewable energy production comes from either biomass or hydropower. These both rely completely on water resources management.

- *Services:* For many service industries such as tourism—which is the fastest growing industry sector of the world—water is elementary.

Economic growth is necessary to poverty alleviation, but does not guarantee poverty alleviation. Distribution of wealth is necessary. In economic terms, care must be taken also of not very profitable sectors such as (capital intensive) food production

Water, food and urbanization

The new millennium starts with urbanization. Whereas the population growth rate on the Earth is around 70 million in a decade, it has been estimated that this will be almost entirely urban growth. While the global food production has shown stagnation since 1990, the pressure to feed the human population is rapidly escalating.

The dominating factor underlying the difficulty to increase food production is water. The growth of irrigated area has dropped drastically during the past ten years. This is due to a number of reasons, but in short, it becomes more and more demanding and expensive to take new arable land under intensive irrigation. At the same time, due to unsustainable practices, a bulk of irrigated land has become unproductive. Roughly one third of the total irrigated area has already become unsuitable to agricultural use, chiefly by salinization. Moreover, the public opinion towards construction of reservoirs has become very negative in many parts of the world. The vulnerability of the global water and food system to hydrologic extremes and political instabilities is in rapid growth.

Agriculture already contributes more than four fifths of all consumptive use of water. How the rural areas will feed the 1.2 billion urban dwellers more than today plus themselves is a big question. Many examples show that the urban areas have given a priority in water allocation over agriculture due to faster capital recovery. Apparently, the expectable rise in food prices will balance out this situation to some extent, but this development will unfortunately have the most drastic impact on the poor. With the liberalization of world trade, privatization, and other such global trends, those who have no cash become increasingly vulnerable. Accordingly, the water crisis will by and large be a severe developing country issue.

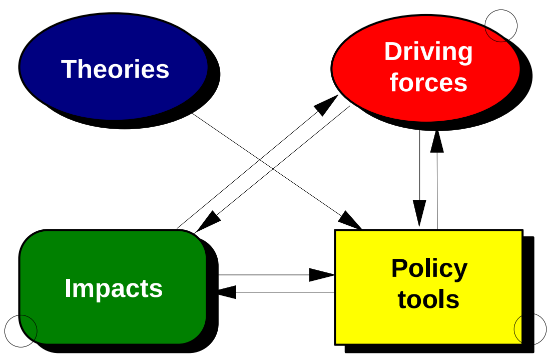
Water related issues are among the most important figures in the equation of managing both the urbanization and the human nutrition questions in the coming few decades.

Interconnections

The complexity of water, food, poverty and urbanization is governed by a high number of driving forces, impacts, and policy tools. They constitute a complicated network of interconnections and interdependencies. The present mainstream methodology to the analysis of large-scale phenomena such as global changes and processes is dominated by deterministic approaches, which typically allow discipline-specific, mechanistic studies with limited appreciation to the vast uncertainties and complex, interdisciplinary interconnections between nature, technology, and society.

The mankind must, however, face and deal with such issues. For planners and policy-makers, it is indispensable to address questions such as what is known, uncertain and unknown, what would be the value of new information on the myriad of different details of the entity, how things are interconnected in a large perspective—in space, time, and over disciplines—and where the key points, risks, and policy handles really lie. The quest for integrative approaches that help make scientists and policy-makers to communicate better has been here for a while, but the development work lies far behind the needs.

Figure 1a
The four clusters of variables
The major interconnections between the four variable groups.



This study elaborates and analyzes the poverty, water and food issue as a global phenomenon, in light of the urbanization process. Forty-five variables—including development theories (11), driving forces (5), socio-economic impacts (5), environmental impacts (5), and policy tools (17)—were selected to allow an itemized analysis of interdisciplinary connections (Figure 1a).

Driving forces for change

When considering the major driving forces that determine the development of the mankind and its environment, we have to fix first the time scale that we want to study. To put the analysis in the framework of sustainable development, the minimum appropriate scale would be one generation backward and one ahead. This scale is typically used in global assessments. In this frame, we include the following issues as major driving forces:

- Population growth,
- urbanization and other patterns of migration,
- changes in climate, environment, and nature,
- economy, and
- human capital, technology, and industrialization.

The various impacts of those issues, as well as those issues per se, are under varying levels of control by the societies. Crucial questions to development are:

- To what extent the factors are controllable?
- How they can be controlled?

Today almost one billion people live in industrialized countries, most of them in urban areas. Population growth in these countries has been slow during the last few decades whereas economic growth has been fast. Most of the world's population, 5.5 billion people, live in developing countries where population growth is fast—2 billion people over the past 25 years (two-thirds more within one generation)—and economic potential is very restricted.

Population growth is expected to take place almost exclusively in developing countries. Around the year 2000 the boundary of 6 billion people on earth was passed and in 20 years the population will be almost 8 billions. Economic inequality is predicted to increase.

Urbanization will be rapid; today the share of the rural population of world total is about one-half and is predicted to decrease to almost one-third by the year 2025. In very simple terms, the major demographic change will be the extensive growth of Asian and

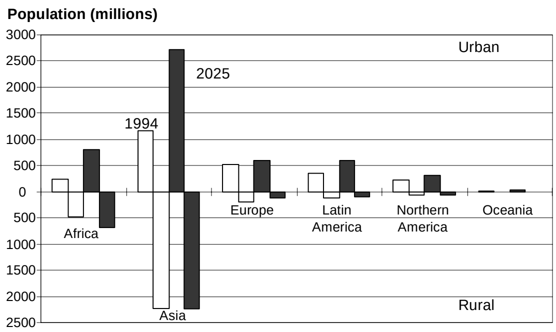
African cities. Other changes are expected to be far smaller (Figure 1b).

Within one generation, a rural person will have to feed two city dwellers instead of one. Agriculture accounts for already now two-thirds of all water withdrawals. Water will increasingly become a source of conflicts between rural and urban areas, as well as in the international scene.

Figure 1b

Population grows mainly in Asia and Africa

Around 50% of humans live now in urban areas. In 2025, there will be almost as many urban dwellers as the total population is at the moment. Urbanization will be fastest in Asia and Africa. Source: UN (2002).



Climatic changes and variations do not make this task easier, at least what comes to forecasts and their quality. In many contexts (such as IPCC's assessments), the forecasting of the climate and weather patterns of the tropical zone has been mentioned to be extremely difficult, even without any climatic changes. Global circulation models that are used as the starting point of scenario analyses in climatic change research, are very imprecise in the tropical zone. However, the countries within that zone are most vulnerable to changes in water resources, given the five driving factors that were listed above.

Impacts

With the escalating pressure for water and land resources, examples of unsustainable water resources management are getting more and more frequent. Among many, the two most drastic examples include overexploitation of groundwater and salinization of irrigated land. Already one third of all irrigated land has been spoiled by salinization. While 40% of all agricultural production is from irrigated fields, the extent of this problem is enormous.

Transport and transfer of food and water to congested areas that are apart from food production on one hand, and do not allow natural ecosystems to process the wastes on the other hand, make the recycling of resources such as nutrients and organic matter increasingly difficult. This yields the loss of productive capacity and biodiversity of ecosystems at one end, and in gigantic waste and pollution problems at the other. The global risks and effects of severe droughts or other hydrologic extremes are expected to grow rapidly.

Also many social and economic impacts follow. The global maps of food security, poverty, inequality, health and even political instability and conflicts are changing all the time due to the major drivers that shape our planet and the living conditions of its inhabitants.

Policy tools

Where are then the policy handles to all this problematique? How the development at the global level could be driven to the direction we want, to make the world as good as possible after a few decades. The answers are definitely not only in the water policies but in many other areas as well.

We must also recall how politicians, and in fact many other people are enthusiastic in some ideologies in some times and on other ones in some other times. Therefore, we must consider some policy tools and associated theoretical frames that would make our exercise a more active and attractive one.

In the quest of sustainable development, there has been a clear shift from considering sustainability primarily as an environmental concept as was the case still in the Rio Earth Summit in 1992. In Johannesburg World Summit on Sustainable Development, the concept was broadened to include a balance between environmental, social and economic issues, under good governance and public participation. This is a major shift indeed.

The institutional and the human dimensions are particularly important as the backbone of any policies and governance systems. Therefore, this book pays special attention into those aspects, within the context of environmentally, socially and economically viable water resources development.

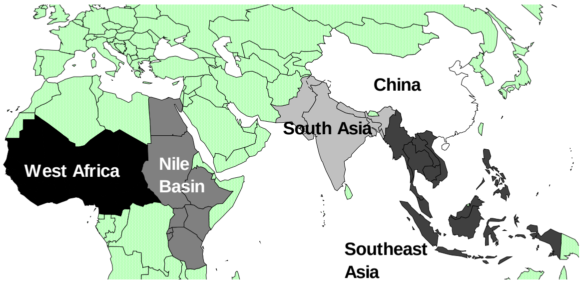
Focal geographic areas

This book concentrates on five geographic areas defined in Figure 1c. Those critical regions accommodate 60% of world's population, and 80% of all rural dwellers. These regions coincide rather well with the tropical zone, which is totally dependent on monsoon rains, and is densely populated.

Their share of undernourished children and people in absolute poverty is dominating in the global level. One generation ago, their proportion of global GNP was 11%, but now it has gone down to 7%. Their CO_2

emissions have, however, increased from 8% to 20%. These trends are alarming. These regions will be forced to increase their food import drastically during this and the next decade (see Section 2).

Figure 1c
The five study regions



The following questions summarize the starting point of this book:

- How each one of these changes will take place in different parts of the globe?
- Will economy grow faster than population?
- Will human, technological, and industrial development make the world better or worse?
- Will cities be dynamos of wealth and prosperity, or will they be sinks for poor people without no hope? Certainly both, but in which proportion?
- Will climatic factors constitute ever-increasing risks and uncertainties to the development of societies and nature?

Questions are tough. Selected examples of the enormous insecurities faced are revealed in the book; the various water and food availability projections differ drastically from one another, and so do the climate change projections. The style of the organizations publishing such studies is to avoid comparison of their results and approaches with those of their rivals.

Perhaps the only certainty that remains when comparing such studies is that it will be more and more difficult and demanding to meet the growing demand from deteriorating supply of water. Decisions and attitudes concerning solutions on capacity such as human development, institutional set-up, water constructions and other technological issues, given the economic and social constraints constitute a challenging entity with no simple answers.

The study includes an array of entities that cover most important development theories, global changes, environmental and social impacts, and policy alternatives. These alternatives have been clustered in four groups: the human dimension, institutions, the rural dimension, and water.

The regions defined in Figure 1c are studied as political-economic entities, as well as in a country level. Countries and regions excluded from the major consideration are also included, but merely on comparative basis. The time horizon is from 1970 to present, and from the present to 2025. This horizon gives a framework for the analysis of sustainable development and its policy implications, one generation in retrospect and another one to the future.

The methodological approach builds up from the following elements: The vast amount of literature that has emerged mainly from the 1990s onwards on global issues is under review. Consultation and cooperation with experts in respective regions and issues is used. The databases of numerous multilateral and national organizations are analyzed.

Structure of this book

Section 2 presents the key regions that were chosen to a scrutiny for this work. Thereafter, the basic concepts of the problem outlined above—*primarily from the rural standpoint*—including food and water scarcity, etc. are presented.

Section 3 summarizes first the major trends in freshwater management. A survey on global development theories follows. The theories are also related to the global water situation.

The five most important driving forces that largely determine the frames for the evolution of the problems outlined in this book are summarized in Section 4. They are population growth, urbanization, climate change, economy and globalization, and human development.

Sections 5 and 6 survey the impacts of the projected development into socioeconomy and the environment. The socioeconomic impacts included are security and vulnerability issues related to water and food scarcity, political vulnerability and the societies' resistance and robustness against risks, gender development, poverty reduction, and public health. The latter ones include impacts on arable land, groundwater, surface water, other ecosystems, biodiversity, and material cycles.

An array of policy tools on the human dimension and on institutions is presented in Sections 7 and 8. The next two sections summarize policy tools related to rural development and water resources development.

The major conclusions are drawn and discussed in Section 11. As the book started from the rural direction, it ends to a chapter which draws some conclusions from the urban viewpoint.

References to Chapter 1

Falkenmark, M. 1997. Society's interaction with the water cycle: a conceptual framework for a more holistic approach. *Hydrological Sciences Journal/Journal des Sciences Hydrologique* 42(4): 451-466.

IFRC 2002. *World Disasters Report 2002.* International Federation of Red Cross and Red Crescent Societies (IFRC), Geneva. www.ifrc.org/publicat/wdr2002 (13.6.2006).

Mohile, A.D. 2005. Integration in bits and parts: a case study of India. In: Biswas, A.K., Varis, O. & Tortajada, C. (Eds.): *Integrated Water Resources Management in South and Southeast Asia.* Oxford University Press, New Delhi. pp. 39-66.

UN 2002. *World Urbanization Prospects: the 2001 Revision.* United Nations, New York. www.un.org/esa/population/publications/wup2001/wup2001dh.pdf (13.6.2006).

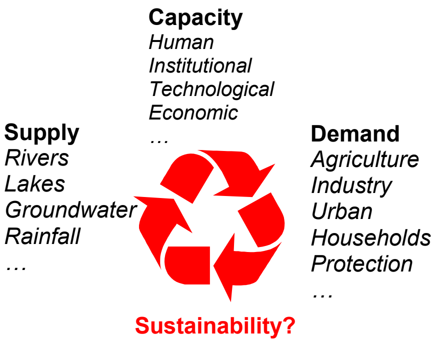
2 THE REGIONS, THEIR WATER AND LAND

Dry desert is in many ways the most critical environment in terms of water. Therefore, many water-related studies concentrate on dry areas such as Middle East, Northern Africa, Central Asia. Needless to say that such studies are well justified.

However, there are many other issues that cause water problems than the absolute availability of the resource. Such issues include demand factors such as the structure of the economy, population density and so forth as well as the economic, social, human and institutional capacity to cope with water problems (Figure 2).

This study targets at five macroregions, which are the most critical ones in terms of water, food, poverty and urbanization. These regions are China, Southeast Asia, South Asia, the Nile Basin countries and West Africa. First, an overview of these regions is presented. Thereafter world's water situation is summarized and the study regions are related in the global picture. An analysis of water availability and demand follows, with a particular focus on agricultural production since agriculture is the dominating water user in the five critical macroregions.

Figure 2
Supply, demand, capacity, and sustainability
The challenges to meet the water demand are tough enough even without the unavoidable quest for sustainability.



2.1 Key regions

Olli Varis and Pertti Vakkilainen

Some regions of the globe are more vulnerable and are impacted in a more profound manner by the global water, food, poverty, and urbanization development. Six criteria were used to detect the regions to be taken under a profound scrutiny. There are five regions that completely or nearly fulfil these criteria: China, South Asia, Southeast Asia, the Nile basin, and West Africa.

Criteria

This book aims to present a global view of water in an urbanizing world. However, due to practical constraints, it is possible to consider only a limited number of cases in detail. The following six criteria were chosen in order to focus the analysis to the most critical regions of the earth:

1) The available water resources are already utilized to a great extent, and the situation is rapidly becoming worse,

2) A major part of the world's population lives in these areas,

3) Population is growing substantially,

4) Urbanization, especially the growth of megacities, is considerable,

5) The level of income is low,

6) Net imports of crops and/or undernourishment are already present, and increasing.

Table 2.1a shows how the macro regions in the world meet these criteria. On these grounds, five regions were chosen for closer studies. They are presented in Figure 2.1a, so as to relate their development until now and possibly in the future to the total global situation.

The critical regions with respect to all criteria are the Nile Basin and the W Africa regions, China and S Asia. Furthermore SE Asia was also chosen for study, despite the fact that there are states like Singapore, Malaysia and Thailand, which are rapidly becoming affluent. Population growth in the area, urbanization and shortage of water resources (e.g. in Indonesia and the Philippines) is, yet, massive even considering the global situation as a whole. Also the economical and political stability has not been strong over the last decades.

Figure 2.1a
The study regions

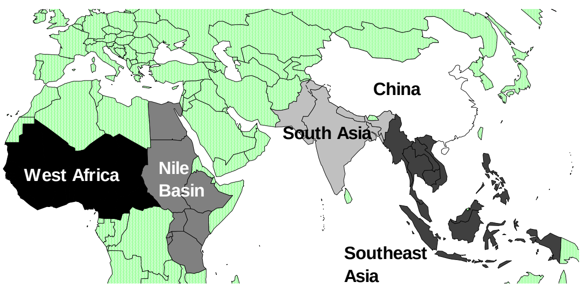


Table 2.1a
The world's regions vs. the six critical factors
— = does not fulfill, no mark = some risk, + = fulfills the criterion.

Region	*1*	*2*	*3*	*4*	*5*	*6*
N Europe	—	—	—	—	—	
C & W Europe	+	+	—	—	—	
E Europe			—	—		
Ex-USSR/European	—		—	—		+
N America		+			—	—
C America	+		+	+		
S America	—	+	+			
N Africa, Egypt excl.	+	—	+			+
Nile Basin countries	+	+	+	+	+	+
W Africa	+	+	+	+	+	+
C Africa	—		+	+	+	+
S Africa	+		+	+		
N Asia	—	—				
C Asia, Kazakhstan	+	—	+			+
China	+	+	+	+	+	+
Near East	+	+	+			+
S Asia	+	+	+	+	+	+
SE Asia	+	+	+	+		+
Japan	+		—	—	—	
Australia & NZ		—		—	—	—
Oceania	—	—		—	—	

The Near East, from Turkey to Afghanistan, would have been our next choice as an area needing to be studied according to our estimates. Also the vulnerability of the area as far as constant conflicts are concerned would support a more careful analysis. On the other hand, its urbanization rate and income level are higher than in the areas chosen for study.

Table 2.1b lists the countries included in the study regions, and some of their key descriptors. These regions account for the global level of some major indicators as follows: population 60%; rural population 77%; urbanization 60%; GNI (Gross National Income) 8%; arable land 38%; cereal production 47%; irrigation 58%; fertilizer use 49%. They are thus in a key role when considering the global food, water, poverty, and urbanization nexus. They cover 33,330 km^2, which is 25.6% of the total land area of the globe. In Figure 2.1b, some important development indicators are shown for these regions.

Table 2.1b

Basic country information on study regions

Source: World Bank (2004).

	Population Millions	Area Km^2	GNI US$ per capita
China			
China	1,280	9,598	960
S Asia			
Bangladesh	136	144	380
India	1,049	3,287	470
Nepal	24	147	230
Pakistan	145	796	420
SE Asia			
Cambodia	12	181	300
Indonesia	212	1,905	710
Lao PDR	6	237	310
Malaysia	24	330	3,540
Myanmar	49	677	..
Philippines	80	300	1,030
Singapore	4	1	20,690
Thailand	62	513	2,000
Vietnam	80	332	430
Nile			
Burundi	7	28	100
Egypt	66	1,001	1,470
Eritrea	4	118	190
Ethiopia	67	1,001	100
Kenya	31	580	360
Rwanda	8	26	230
Sudan	33	2,506	370
Tanzania	35	945	290
Uganda	25	241	240
W Africa			
Benin	7	113	380
Burkina Faso	12	274	250
Cameroon	16	475	550
CAR*	4	623	250
Chad	8	1,284	210
Côte d'Ivoire	17	322	620
The Gambia	1.4	11	270
Ghana	20	239	270
Guinea	8	246	410
Guinea-Bissau	1.4	36	130
Liberia	3.3	111	140
Mali	11	1,240	240
Mauritania	2.8	1,026	280
Niger	11	1,267	180
Nigeria	133	924	300
Senegal	10	197	470
Sierra Leone	5	72	140
Togo	5	57	270

*Central African Republic

China

China’s population exceeds 1.3 billion. In spite of a strict birth control, the population growth continues and could reach 1.6 billion (UN 2005) by the year 2050. Estimates of the present urban population vary between 230 and 370 million. During the next thirty years, the urban population is estimated to increase by 600 million to around one billion. The Chinese economy is growing fast but the country is still classified in the low-income category with its GNI per capita approaching US$ 1000.

The arable land area of about 96 million ha is decreasing, while the population grows. About half of the arable land is irrigated. The changing structure of the economy, i.e., industrialization and urbanization, creates situations where land is the focus of intense competition. Prime agricultural land is under pressure of being used for building or road construction. Arable land will be cleared in areas worse than at present where soil is of poorer quality and irrigation water more difficult to get.

China's renewable water resources are estimated to be about 2,800 km^3 per annum. Water consumption is around 500 km^3 per year or 18% of the quantity of usable water. The share of irrigation is almost 90%. Zhang and Zhang (1995) estimate that roughly half of approachable water is in use already. Agriculture and food security in China are fully linked with water. 87% of all water withdrawals go to agriculture, while the industrial use contributes to 7% and domestic to 6% of all withdrawals.

Recently China has invested significantly in water resources development. There are about 85,000 reservoirs, with a total gross storage volume of around 17% of the annual runoff. The most important water project at present is the Three Gorges Dam, which is under construction on the Yangtze. It will increase the river’s storage capacity from 10% to 13% of annual runoff. With its 18 GW hydropower production, it will add China’s power generation capacity by 7% by 2007.

In spite of such massive projects not enough water is available. In the 1980s one half of the cities suffered from water shortage. In every tenth city the situation can be described as critical. China's particular prob-

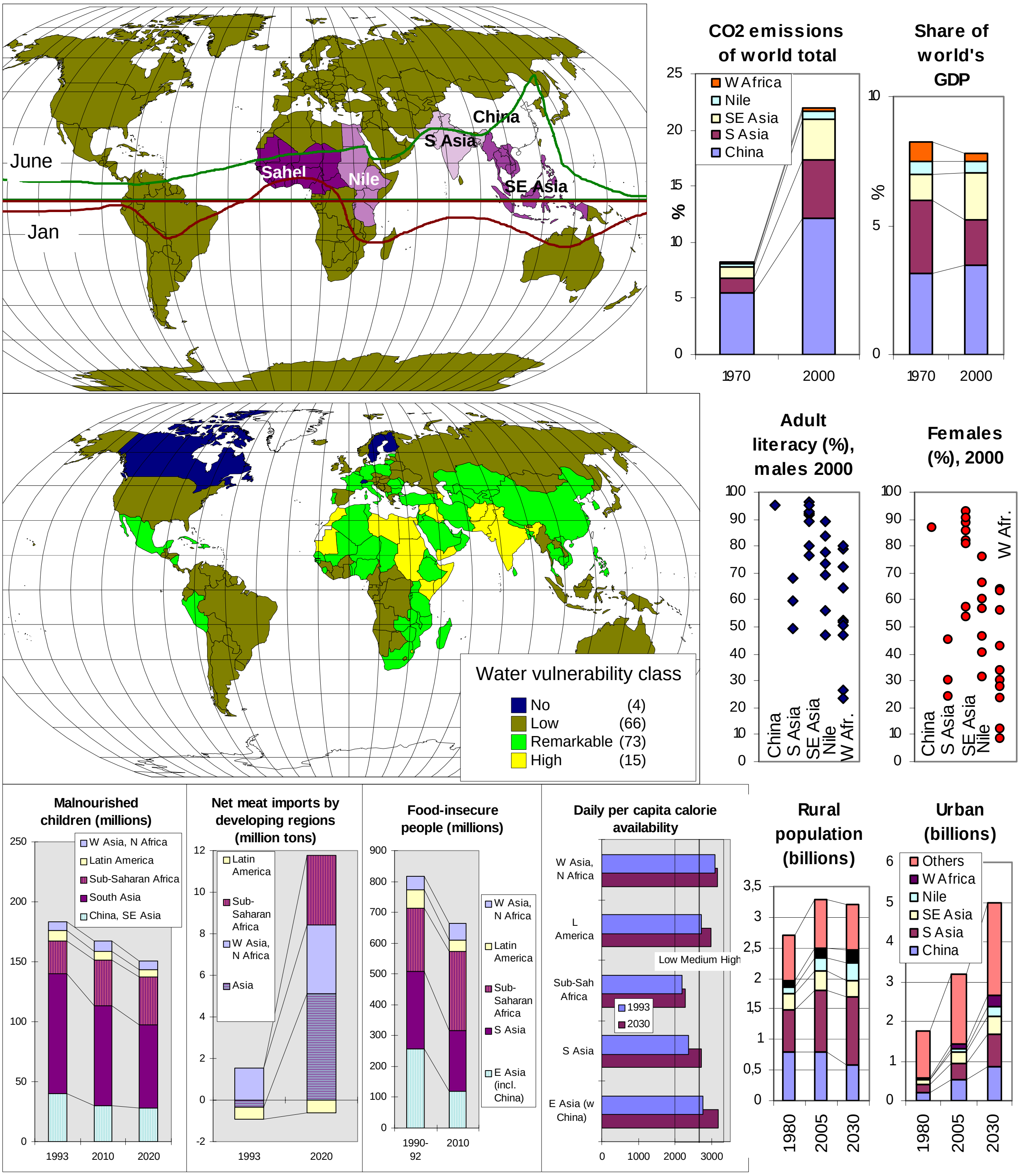
Figure 2.1b

Overview to the regions

Up: *The map shows the tropical, monsoon zone (intertropical convergence zone, see Chapter 4.3, particularly vulnerable to climate change and variation) in January and in June. As compared with the world total situation, the economic capacity of the regions (except SE Asia and China) has dropped within the past three decades, but the CO_2 emissions have nearly tripled (source: World Bank 2004).*

Middle: *Water vulnerability index (WRVI-I; SEI 1997, see Chapter 2.4) combining water resources reliability, use-to-resource, and coping capacity. The regions still suffer from a wide gender gap, and the literacy rates are low, particularly in S Asia and African regions (source: World Bank 2004).*

Low: *The regions' share of the world's rural population remains high, around 4/5, but the urban population share grows dramatically (source: UN 2005). Malnourishment and meat import data (IFPRI 1997) are based on an optimistic economic scenario allowing food import food and consequent reduction of malnutrition, although the history of economic development has not been very promising.*



lem is that 81% of its water resources are in the country's southern part but the largest part of arable land, 64%, is in the north, where the nation's political and economic center is located. 126 million people live in North China on an area of only 426,000 km^2 where renewable water quantity is only 52 km^3 per annum. Water use of northern rivers now exceeds 60% of the annual rate of flow (Zhang and Zhang, 1995). In 1987 the quantity of available water was only 44.5 km^3 per year and consumption rose to 87.3% of this quantity (Zhang et al., 1992). Huang He's (Yellow River's) water has been used so extensively that no water flowed to the sea for 227 days in 1997 (Chen et al. 2001). Prior to 1991, the maximum annual number of days with a similar situation was 40 days. This situation has, however, improved since, due to heavy and obviously efficient water saving policies in the watershed.

Groundwater in N China is used at a rate much higher than that with which the aquifers are filled. This has caused the level of groundwater to drop, in some places as much as 70 m. In Beijing, the drop has been 40 m and the city has subsided by over 0.5 m (Zhang and Zhang, 1995). A plan has been made of diverting water from the Yangtze to the north to improve the water situation. For this purpose a water transfer system of 53 to 71 km^3 of annual capacity is being planned, and some parts have already been constructed.

Besides water availability, the quality of water is also a problem for the Chinese. For instance, only one fifth of industrial waste water is treated to some extent before being discharged in a waterway.

Water availability is a major constraint in China's attempt to raise its standard of living. With a rising standard of living and urbanization, water consumption will increase. Market price determination for water, increasingly adopted in China, will seriously threaten irrigation water accessibility. In order to secure food production into the future, considerably more irrigated arable land is needed. Acquisition of enough water for this purpose is difficult.

China is undergoing a rapid and profound transition to a market-oriented economy. The traditional, strongly centralized political system is moving towards a more decentralized system. The lack of a unified water administration and management has been acknowledged. The gap between planning and decision-making is serious. Finally, the inadequacy of financial resources is an important constraint in addressing the water resources challenges (ADB 2000). These constitute the starting point for the consideration of the country's institutional possibilities to face the challenges to its water resources.

An important question, which concerns the whole world, is how much grain import China will need in the future. The United States Ministry of Agriculture foresees the need for import to be 32 million tons in 2005. The Chinese Academy of Science's estimation for import is 35 million tons in 2010 and 45 million tons in 2020 (Crook and Colby 1996). According to Brown (1995) the need for import is as much as 207-369 million tons in 2030. The importance of these figures becomes evident when we find out that the net amount of grain bought by developing countries at the turn of the decade was about 80 million tons in all (Alexandratos 1995).

China has changed its political system to a new direction almost every decade during this century. The possibilities for development from now on are innumerable. An extreme case is the destiny of the former USSR: a political system opens out but loses the control over the country. In the case of China this could also lead to regional separatism and the breakdown of economy. On the other hand the country could develop and industrialize rapidly.

Evidently strong Chinese nationalism will, however, be put to a severe test when the country opens up and to stress the importance of patriotism. For instance, the Three Gorges Dam is regarded as an important national symbol. What kind of symbols will the Chinese look up to in coming few decades?

South Asia

The combined population of India, Nepal, Pakistan and Bangladesh approaches 1.4 billion. The population is now bigger and it is growing much faster than in China. In 2025 the population is predicted to approach 1.9 billion. The GNI per capita in the area is low; US$ 420 per annum in Pakistan, US$ 470 in India, US$ 230 in Nepal and US$ 380 in Bangladesh (World Bank 2004).

Over half of India's land area is used by agriculture. Arable land counts for 188 million hectares. It is difficult to increase this area. To provide enough food for the increasing population agriculture has to be made more effective. This demands even more intensified measures in for example irrigation. The irrigated land area is now about 38% of all arable land. It is possible to improve irrigation but new projects are economically demanding and more difficult to implement than before. The use of fertilizers per arable hectare has grown sevenfold during the last 25 years.

The total amount of India's renewable water resources according to SASTAC (2000) is 1,869 km^3 per annum but the amount of utilizable water is only approximately 1,690 km^3. Water consumption for the year 2000 is estimated to be 750 km^3, of which irrigation takes 92%. The annual need for water in 2025 will, according to the prognosis, be 1,050 km^3 i.e. roughly equal to the total amount of usable water and over 50% of the total amount of renewable water resources.

Water distribution in the region is unequal. In the east there is plenty of water and in the west it is scarce. This situation has led to the idea of connecting the rivers running in the east-west direction via canals to form a network, which could get its water from India's biggest river, the Ganges. In this water transfer project we can see Bangladesh's water problems in the lower reaches of the Ganges. The river's runoffs have already decreased during the dry season over 25%. In addition to water shortage salty sea water from the Bay of Bengal is penetrating deeper into the Ganges-Brahmaputra delta affecting all water use (Rabbi and Ahmad 1997). In order to store water, India has built many reservoirs, among which the project of the Narmada River has raised objections worldwide (Box 2.1).

Box 2.1

Narmada

The dilemma of food, poverty, the environment, and human rights (Vakkilainen and Varis 1999).

The Narmada river flows through some of the poorest areas of India. There are 40 million inhabitants within its sphere of influence and population growth is fast. The situation as far as water and electricity are concerned is poor and worsening all the time. Solutions to improve the situation and prevent massive migration to towns have been searched for a long time, resulting to a general plan that suggests the construction of 30 big and 130 smaller dams directed towards the needs of settlement, industry, irrigation and hydropower production. India's central government and the states through which the river Narmada is running, have accepted the project. Its construction is expected to take 50 years.

The project’s dimension is enormous; the lowest reservoir, Sardor Sadovar, will provide irrigation water for 1.9 million hectares and supply 450 MW of electricity. Another immense reservoir, Narmada Sagar, planned to be constructed in the middle reaches, would supply enough water to irrigate at least 141,000 hectares and allow irrigation of vast areas in the lower reaches. It would also produce 1,000 MW of electricity. The water stored in the reservoirs would secure agricultural work for about 5 million people. 70,000 people would have to be moved from the area needed for the reservoir in Sardor Sadovar and 80,000 from Narmada Sagar.

Narmada’s construction has met with strong resistance. The opponents propose that the official resettlement figures are severely underestimated, that the reservoir would increase income disparity, spread diseases, and damage the environment. The World Bank, who had already in 1985 made a decision concerning the financing of Sardor Sadovar and Narmada Sagar, withdrew the promised financing in 1993 because of strong protests by human rights organizations. The Indian government decided, none the less, to continue with the project.

The project supporters consider their opponents' views as classical examples of shortsightedness. They stress that if Narmada is not constructed the area will become very poor and environment cannot be managed. If the means of livelihood is lost in the area, millions of people would have to migrate. The migration would then be huge in comparison with the immediate resettlement volumes due to the construction of Sardor Sadovar and Narmada Sagar (Dixon et al. 1989, Frederiksen 1996).

It has to be recalled, however, that India has already built enormous irrigation systems which, if made more effective, could double yields in vast areas without additional water use (Pike 1995).

The source of life in Pakistan is the river Indus. Most of the country's arable land is located in its valley. The total arable area is 22 million hectares of which 74% is irrigated. As in India, most of the potential agricultural land is already under cultivation. To feed the increasing population more effective measures must be used in agriculture. The Irrigated area has been increased by 1/4 since 1975 and the use of fertilizers has risen sevenfold. One of the biggest problems is that 1/5 of the irrigated area has become saline and 1/6 waterlogged. Extensive remedy projects are under way, yet the problems are huge.

The renewable water resources in Pakistan are 298 km^3 per year and water consumption was estimated to be 153 km^3 per year in 1990, of which irrigation contributes to 98% (Frederiksen et al. 1993). The right of Pakistan to the water resources of the Indus has been secured by a treaty with India in 1960. Bangladesh is situated in the delta area of the Ganges and Brahmaputra, in the Bengali Lowland. The population density of the country is high: it has just passed 1,000 persons per km^2. Agricultural land is 7.4 million hectares. It is fertile and climatic conditions allow even three harvests per year.

As the population increases, there will be a shortage of arable land. The irrigated area has become threefold since 1970 and is now about 30%. The use of fertilizers has risen sevenfold as in India and Pakistan.

The amount of renewable water resources in Bangladesh is, on average, 1387 km^3 per year and their use only 22.5 km^3. These figures, do not, however, give a real picture of the country's water problems. Floods in summer and drought in winter plague the inhabitants. Loggings in the Himalayas have aggravated the runoffs of the rivers flowing through the country. People have had to become accustomed to the fact that both floods and drought destroy crops. During the years 1973-87 floods destroyed 1.7 million tons of grain on average whereas damage caused by drought was 1.5 million tons (Hasan and Mulamoottel 1994).

In all these countries it is the quality of water that has become more problematic. Community waste waters are not properly treated. The same is true for industrial waste water which contains heavy metals and poisonous compounds that constitute a serious hazard (Frederiksen et al. 1993).

The problem with Indian and with almost all S Asian agriculture has been its ineffectiveness. According to Pike (1995) yields from India's irrigated areas are only about 50% of the respective yields per hectare in other parts of Asia. The great challenge of the region is to improve the efficiency of soil and water use by emphasizing training, technology and irrigation systems management (ICID 1995).

Another regional challenge is the lack of cooperation between states. Without adapting the measures taken in Nepal and Tibet to the needs of countries in the lower reaches water resources management will not achieve the best possible results (Upreti 1993, Ahmad et al. 1994).

India, Pakistan and Bangladesh have not been very peaceful during over half a century of independence and Nepal, under pressure from its powerful neighbors, is not in an enviable position. International cooperation has been and will be hard and internal stability has not been favorable in any of the countries of the region; perhaps least of all in Pakistan.

Stockholm Environment Institute (SEI 1997) classified Pakistan and India as high-stress countries with respect to water. Bangladesh and Nepal were classified as medium stress countries.

Southeast Asia

SE Asia is perhaps the most geographically inhomogeneous region among those under examination. It consists of the countries of Indochina (Myanmar (formerly Burma), Thailand, Lao PDR, Cambodia, Vietnam, Malaysia and Singapore) and the Philippines and Indonesia. The region is 4.3 million km^2 (3.3% of world total) and the population 527 million (8.3%). Indonesia has 217, Vietnam 80, the Philippines 80 and Thailand 62 million inhabitants. The population is predicted to grow to 700 million by the year 2025. Practically the whole area is pluvial, very fertile and fruitful. In spite of the fact that the region contains some important areas for global grain production and export such as Thailand’s Central Plain, the region is a net grain importer.

The average GNI per capita was around US$1,200 per year in 2002 (2.3% of world total). It is very unevenly divided. For instance, the GNI of Singapore's 3 million inhabitants is the equivalent of 14% of the region’s total GNI and is more than 50-fold compared with the GNI of Lao PDR with 5 million people. Differences within countries are also very noticeable (Drakakis-Smith 1987). The GNI per capita for Djakarta, Bangkok and Manila is one order of magnitude greater than the corresponding figure for the rural population. In some respects it explains why the metropolises of the region grow so rapidly.

Two important international rivers, the Mekong and the Salween, run through the region. Both have their source in Tibet. The Mekong flows through China (the Yunnan Province) as a border river between Myanmar and Lao and then through Thailand and Lao. It continues to flow through Cambodia and runs from the Vietnam area into the South China Sea.

The Salween river runs through the region of China and Myanmar, and is a border river both between China and Myanmar and between Thailand and Myanmar. As far as the Mekong is concerned, since 1957 there has been the Mekong River Commission supported by the United Nations and other international organizations. It has attempted to solve the regional water controversies with varying success. Its functioning has been made especially difficult by China's absence, and by several national and international conflicts and wars in Vietnam, Cambodia and Lao (Jacobs 1995).

Among these countries Myanmar has experienced continuous internal disquiet and Indonesia has been volatile all the time. However, over the last few decades the situation has become more peaceful, but shows signs of underlying instability as the economy or the politics suffer from even modest crises. The biggest concentration of the population is on the island of Java in Indonesia. Its area is 127,000 km^2 and the population 130 million. Its population density is 1000 persons per km^2.

The region has 62 million hectares of arable land (4.6% of world total), of which 17% is irrigated and 49 million hectares grain production (7.1%). The irrigated arable land is divided so that Thailand has 37%, Indonesia 23%, Vietnam 14% and Myanmar 11%. In Malaysia and Cambodia, on the other hand, agriculture is largely dependent on direct exploitation of natural rainfall.

The Nile basin countries

The Nile will definitely be one of the globe's most critical river basins in the coming decades in several respects. This basin of magnificent, ancient civilizations is facing enormous challenges in relation to the region's capacity to tackle the problems of its own development (e.g. Elhance 1999). It is illustrative to compare the basin's problems to some other critical regions of the world, in order to understand better their magnitude, urgency and complexity.

The Nile basin of 3 million km^2 covers about 10% of Africa, and 2.3% of the world’s land surface area. Characteristic of its hydrology and climate is that its water sources are in pluvial regions in E Africa. Its mighty tributaries are united in the Sudan and flow through a virtually rainless desert a few thousand kilometers to the Mediterranean.

In the basin there are ten states. However, the Democratic Republic of Congo is only to a lesser extent within the basin. Therefore, it is excluded from this analysis. In the other nine countries (Burundi, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, the Sudan, Tanzania and Uganda) the population is currently about 277 million and is expected to grow to 360 million by 2025. About 70% of them live in the Nile basin. The total area of these countries is 5.1 million km^2. The GNI per capita is US$ 340.

Arable land makes up 40 million hectares of the region (the nine countries mentioned), of which irrigated arable land is 13%, divided between Egypt (57%) and the Sudan (36%). Egypt has 25% of the region's population. Its share of the GNI approaches 60%.

Due to climatic conditions, agriculture in the White Nile countries—except parts of Tanzania and Kenya—is based on the use of natural rain and there is no large-scale irrigation. In Egypt and the Sudan irrigation is of major importance. The most significant evidence for this is the tradition of several millennia of irrigation systems, which has a unique cultural value.

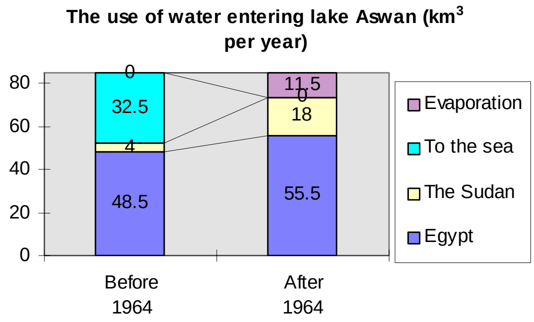
Over the past hundred years several significant dams and barrages have been built on the Nile in the Sudan and Egypt. The most massive of the dams, the Aswan High Dam, was closed in 1964, and completed in 1968. This dam provides an enormous live storage of over 130 km^3, which allows multi-year storage of the Nile water. It has also an indisputable significance to Egypt's national identity and political stability. With the help of the dam it is possible to collect the Nile's floodwaters of which, before the construction of the dam, 32.5 km^3 per annum were not exploited (Shahin 1985).

At present virtually no Nile water is flowing into the Mediterranean. Solely 0.4 km^3 are released annually to the sea through the Rosetta, Damietta, and other major branches, and some more water is pumped up into the coastal lagoons and lakes which drain to the sea. Almost all the rest, 94 km^3 per annum which flow to Lake Aswan evaporate either from arable land, Lake Aswan (11 km^3), or in the form of different losses.

Egypt's share of the Nile water increased by 7 km^3, and the Sudan's by 14 km^3 per year (Figure 2.1c). Egypt has—partly to its own inconvenience—built a giant dam, which has had ill-effects for the country and the Nile river valley, of which Egypt admits responsibility (Biswas 1995). Its share of the water from the dam amounts to only 8% of the water entering Aswan and 13% of the total use of Egypt´s water.

International treaties on the use of the Nile waters have existed for decades. The best known Nile Water Treaty originates from 1920 and it has been strengthened and amended several times. Its present form dates from November 4, 1959. It has proved to be functional, especially in the issue of dividing

Figure 2.1c
Aswan water balance
The Aswan High Dam changed the water use and availability in the lower Nile basin markedly. Since 1964, Egypt and the Sudan share all the usable water entering lake Aswan (Source: Biswas 1995).



the river's water between Egypt and the Sudan. The treaty is under great pressure from the directions of the other riparian nations, particularly from Ethiopia, as they will want to enhance irrigation and hydropower production (e.g. Magloff 1999). In addition, at least six other major agreements exist regarding the utilization of the Nile's waters in the past few decades. None of them has included more than three nations (Ilomäki 2000, TDFF 2005). Obviously, such a fractured approach does not serve the goals of basin-wide management strategy, nor it serves to promote the interests of all riparian nations in an equitable way.

A historical burden is due to the former colonial approach of bilateral treaties: Between 1891 and 1952, at least ten treaties or agreements were signed. In each of them, Britain was one of the two partners (TDFF 2005). The other partners included Italy, Belgium, Congo, Ethiopia and Egypt. The present needs for an integrated, basin-wide management would require a completely different approach. All riparian nations should be involved, and should have a feeling of ownership of a common resource.

As an economic and military power Egypt is superior to the other region's nations. It objects projects, which attempt to reduce the runoff in Aswan. Among the countries of the region the Sudan, Ethiopia, Uganda, Burundi and Rwanda have suffered from serious internal crises. Tanzania on the brink of famine, and Kenya in a continually volatile state, are also politically unstable. Egypt has had a more stable recent history, which, however, has not been fully completely free of conflicts and violence. In conclusion political instability and the uncertainties it brings along are noticeable in the region.

More details about the White Nile, the Blue Nile, and Egypt's ambitions with the Nile waters is provided in Box 10.4.

West Africa

In the region of W Africa, we have included the following states: Benin, Burkina Faso, Cameroon, Central African Republic (CAR), Chad, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone and Togo. In 2002, these countries had a population of 275 million people. Nearly half of these lived in Nigeria. The population has doubled during the last 25 years and is growing rapidly. In 2025 the region will, according to UN (2005) prognosis, have about 414 million people.

The region is poor. In terms of GNI per capita, Côte d'Ivoire is the wealthiest, with its US$ 620, while Guinea-Bissau is the poorest with US$ 130. None of the states is self-sufficient in grain production and only Nigeria, Niger, Chad and Burkina Faso reach a self-sufficiency of 90%. The long-lasting drought explains the low level of agricultural production to a great extent but attention has to be paid also to underdevelopment of irrigation. The most striking feature in Africa which differentiates it from other low-income areas in the world is that the extent of the irrigated arable land is very small, usually only a few percent or a fraction of a percent of the total arable land area (See Chapter 9.1).

The Sahara is extending to the south all the time. Previously nomads moved back and forth in the region but since the construction of drill wells they have been able to settle down. The result is overgrazing which removes the modest vegetation covering the soil leaving it open to erosion. An exceptionally long dry period has destroyed the vegetation and made afforestation projects futile, which have tried to prevent the advance of desertification. These problems affect mostly the states from Senegal and Mauritania to Chad. On the other hand, in the coastal states of the Guinea Bay the annually renewable water resources can be considered abundant. Mauritania consumes the highest proportion of its renewable water, yet only 10% (Gleick 1993).

Annual averages do not tell the whole truth as variations in river runoff are normally large. Over the last few decades droughts have worsened the situation. However, there is enough water to make the region's food supply secure, if flood water could be stored for irrigation. The lack of funds is evident. It is estimated that the costs for extensive irrigation projects in W Africa vary from US$ 2,000 to 6,500 per hectare (World Food Summit 1996). In the project for the river Senegal the costs are estimated to rise to US$ 10,000 per hectare (LeMarquand 1990).

Because of the fragmentation of the area one of the characteristics of rapid urbanization will be migration across the state borders, especially from the dry desertified states to the coastal metropolises like Dakar, Abidjan, Accra, and Lagos. The migration will be facilitated by the extensive use of common colonial languages, ethnic plurality, which does not fit the state borders, and a common monetary system in most countries of the region.

There have not been any recent major conflicts between the states in this region, in spite of political instability in many countries, e.g., Sierra Leone, Liberia, Chad, Côte d'Ivoire and Nigeria. Without political stability this region cannot control its population growth or develop its economy.

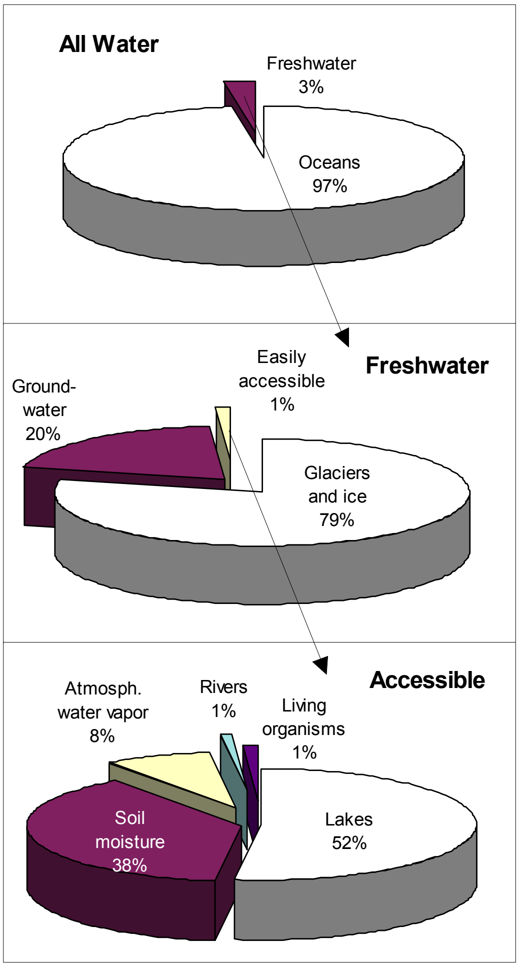
2.2 World's water balance

Olli Varis and Pertti Vakkilainen

Water is a finite resource; the proportion of available water used by humans is high and growing. The use of all water that evaporates to the atmosphere without reaching groundwater, rivers, or lakes is over ¼, and of freshwater in aquifers, lakes, and rivers, which is geographically and temporally accessible to humans is over ½. Till 2025, the accessible runoff is estimated to grow only with 10% whereas the population will grow with 40%.

It is crucial to see that water is a resource that is finite and growingly scarce. The share of accessible freshwater used by humans is already considerable, and the population growth continues to increase this share. At the same time, increasing watershed degradation, pollution, and climatic changes reduce, impair, and insecure the supply of water to human use.

Figure 2.2a
Where the water is?
Percentages of water in the phases of the hydrologic cycle. Source: FAO (1995).



Freshwater resources form less than 3% of the total water on the globe (Figure 2.2a). Of that freshwater, only 1% have been estimated to be easily accessible to human consumption. There are a number of global-scale assessments of the volumes stored in the different phases of the hydrologic cycle. Table 2.2 shows two of them. Note that although most of the major components show matching values, there are huge discrepancies in some of them. This might be due to inconsistent terminologies used, but clearly, the assessment task itself is difficult and prone to various sources of meagerness.

Table 2.2
Water quantities
Two estimates of water volumes in different phases of the hydrologic cycle (cf. Figure 2.2a).

Water quantity (1000 km^3/year)	FAO (1995)	UNESCO (1978)
Water total	1,400,000	1,385,984
Oceans	1,365,000	1,338,000
Freshwater	35,000	35,029
Glaciers and ice	27,650	24,374
Groundwater	7,000	23,400
Saline		10,530
Fresh		12,870
Easily accessible	350	
Lakes	182	182
fresh		91
saline		85.4
Soil moisture	133	165
Atmospheric water vapor	28	12.9
Marshes		11.4
Rivers	3.5	2.12
Living organisms	3.5	1.12

Figure 2.2b presents a general balance of the global freshwater situation, showing that stable river runoff (portion of freshwater that can be made available for human use) is approximately 25% of the water discharged by the rivers. It does not reveal more complex problems like spatial and temporal variability and quality issues, which make the problem more complicated and difficult.

Figure 2.2b
Global freshwater balance
In 1000 km^3 per year (source: Golubev 1993).

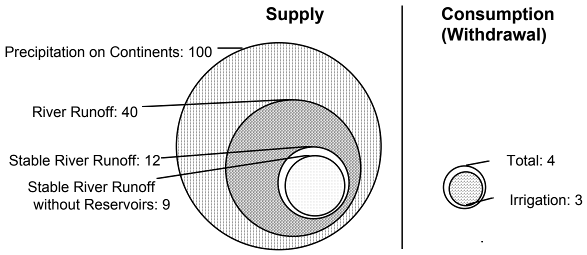


Figure 2.2c summarizes the water accessibility and use on the global level. Of the total amount of water precipitated over the continents, 2/3 evaporates back to the atmosphere before reaching groundwater aquifers, lakes, or rivers. 26% of that amount is appropriate to human uses such as agriculture and forestry (Figure 2.2d). The share of human-occupied areas such as lawns, parks, and sport facilities is minor, about 0.5% of the total appropriated volume.

The rest 1/3 of the total terrestrial renewable fresh water supply forms the runoff to the oceans. The estimates of this volume range from 33,500 to 47,000 km^3 per year, the average estimation being 40,700 km^3 (Gleick 1993, Postel et al. 1996).

If this mass of water were distributed evenly in time and regionally according to the size of population there would not be any problems regarding water sufficiency on the earth. In reality the uneven geographical distribution and seasonal changes create a situation of water insufficiency.

An even more significant problem is the fact that water from flooding cannot be used when human settlement, industry and agriculture need it. Postel et al. (1996) estimate that the amount of constantly accessible stable runoff is only 9,000 km^3 per year. As reservoirs can store, in addition to this, approximately 3,500 km^3 of accessible water it amounts to 12,500 km^3 per year. When evenly distributed among people now living on earth it amounts to 6 m^3 per 24 hours.

When comparing the populations on different continents, and their share of the global river runoff, Figure 2.2e reveals two continents that are in average much worse off than the others; Asia and Europe. They both are very crowded in comparison to their water availability. This scale of consideration is, naturally, very rough. All continents contain areas that are water rich, and others that are water scarce. Chapters 2.3 and 2.4 summarize some of the many recent studies in water use vs. availability, which have been made using a higher resolution. Yet, the key message of Figure 2.2e is the exceptionally high overall pressure to water resources in Asia, and increasingly in the future, because it has a rapid population growth, and it has already put into use much of its water resources by reservoirs, irrigation systems, and so on (Chapter 10.1).

Part of the world's water resources are inaccessible and cannot be used. In the Amazon basin, for instance, roughly 1/6 of the total global runoff flows into the sea but only 0.4% of the world population lives there. This kind of water comprises 19% of the total runoff (Figure 2.2f). The world's major rivers are shown in Figure 2.2g.

Figure 2.2c
Human appropriation of renewable fresh water supply
Unit is 1000 km^3 per year. Data from Postel et al. (1996).

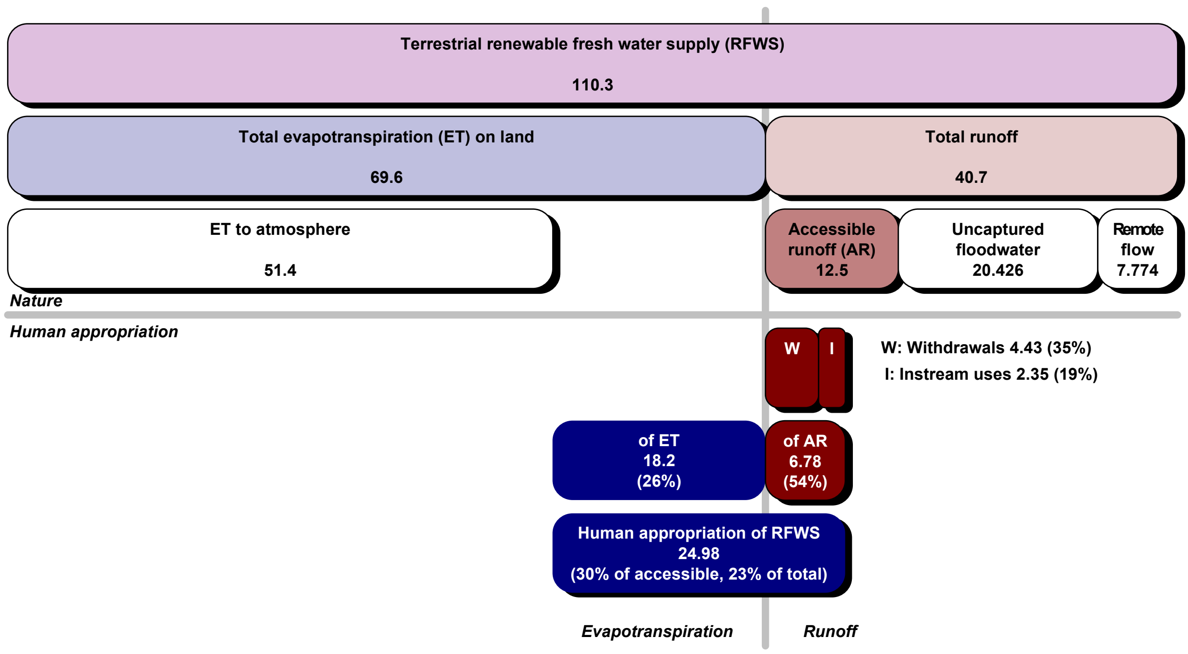


Figure 2.2d
The three big primary producers
Estimates of evapotranspiration appropriated for human-dominated land uses. The total proportion of terrestrial evapotranspiration appropriated is 26.2% (source: Postel et al. 1996).

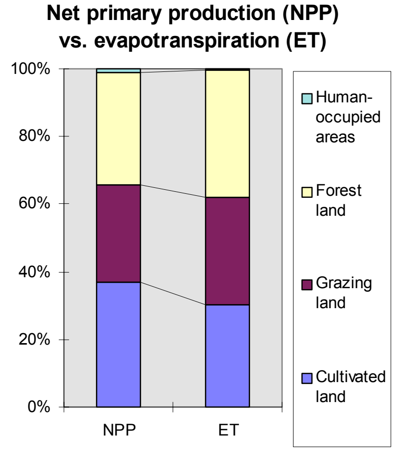


Figure 2.2e
Asia and Europe are water scarce
Share of global runoff and population by continent. The unit for runoff in data labels is km^3 per year (source: Postel et al. 1996).

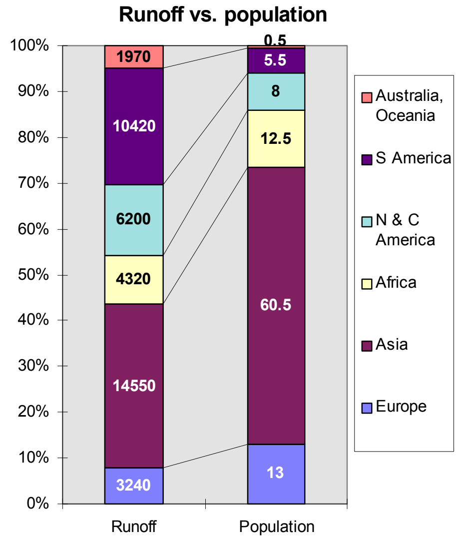


Figure 2.2f
The remote, inaccessible river flows
The major inaccessible rivers of the world are the Amazon, the Zaïre-Congo, and fifty-five remote, undammed northern rivers in North America and Eurasia ("Others"). Their total inaccessible runoff is 7774 km^3 per year (source: Postel et al. 1996).

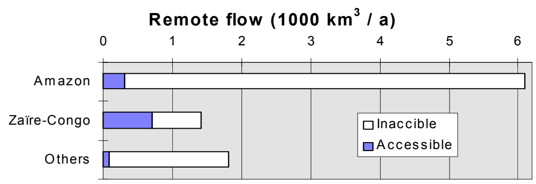
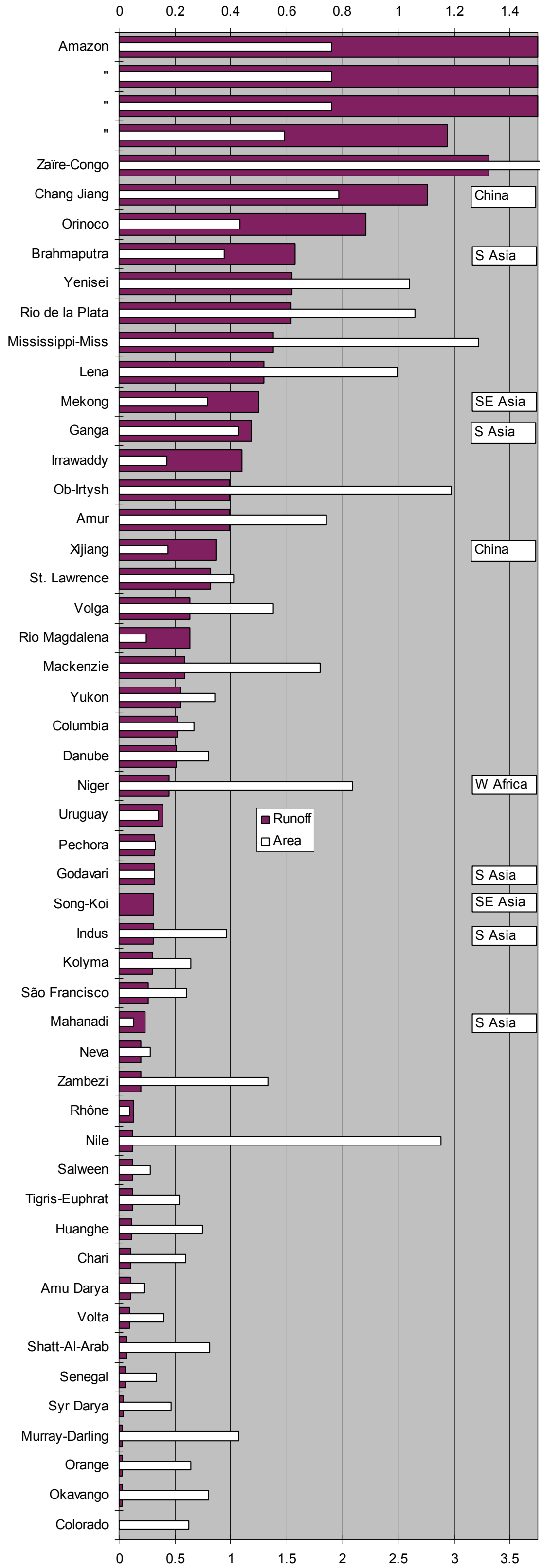


Figure 2.2g
Major rivers of the world
Runoffs (1000 km^3 per year; upper scale) and drainage areas (10^6 km^2, lower scale) of selected major rivers. The four first columns are for the Amazon River (sources: Czaya 1981, Szestay 1982 and Meybeck 1988).



The Nile region is by far most water scarce of the study regions (see Ch 2.1). SE Asia has the best situation with respect to available water resources as related to its population. On average, it lies one order of magnitude above the scarcity limit of 1,000 m^3 per year per person (Figure 2.2h). Asia and Europe on average have only 1/3 of SE Asia's amount per person, S Asia 1/4, China 1/5, and the Nile basin in total 1/9 of that amount. Given the population projections till 2050, the Nile basin would have only 1/15 of the water per capita in that time, in comparison of SE Asia, and only 1/27 of SE Asia's present level (see also Figure 2.2j).

Averages are the more misleading the larger and more heterogeneous the unit under concern is. One must only recall, that the Island of Java in Indonesia has 110 million people in a fairly small area. The Javanese have around 1,200 m^3 water per capita per year, making the area equally water scarce as the Nile basin.

A more dramatic pressure to water resources is, however, imposed in N China, particularly in the basins of Hai He, Luan He, Huang He, and Huai He rivers (Figure 2.2i). In those basins, the total annual, renewable water availability is 212 km^3. This accounts for 7.5% of China's total water resources. These basins are the home of 425 million people, which is 34% of China's total population. This population has 38.5% of nation's cultivated land. This implies, that these basins have less than half of the water per capita in relation to Egypt or the Island of Java, Indonesia, which are recognized of extremely water-scarce regions. The most severe is the situation of the 120 million people who dwell in the basins of Hai He and Luan He basins, which provide only 1/5 of water per capita, as compared to the scarcity limit.

Figure 2.2h

Runoff per person by continent in 1995, and by region in 1995, 2025, and 2050

According to Falkenmark and Lindh (1993), 1,000 m^3 water per capita per year is a critical water quantity, below which a serious water shortage is faced. Unit of the vertical axis is thousands of m^3 water per capita per year (sources: Postel et al. 1996 and SEI 1997).

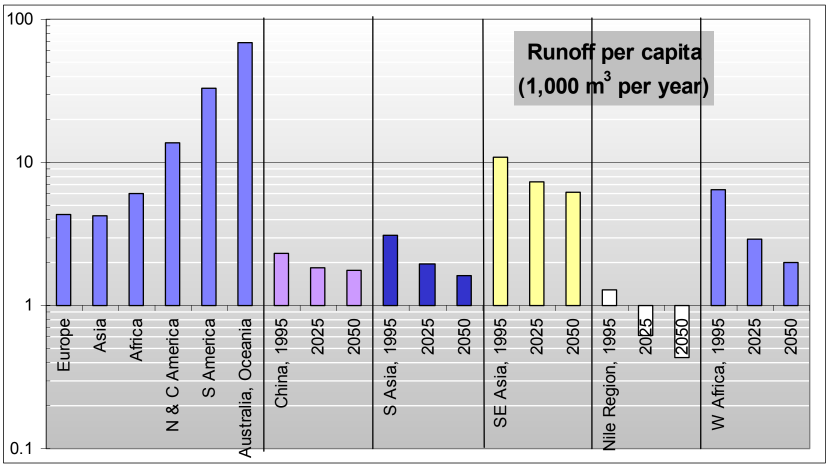


Figure 2.2i

China's Northern Plain is extremely water scarce, whereas the south is rich in water

Water resources availability per capita (m^3 per year, 1995) in different parts of China (after Heilig 1999).

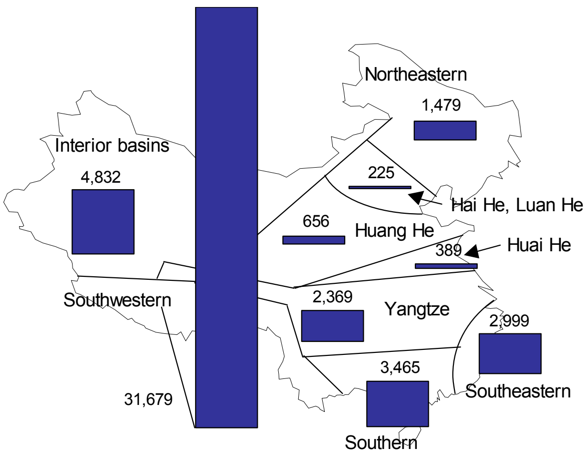
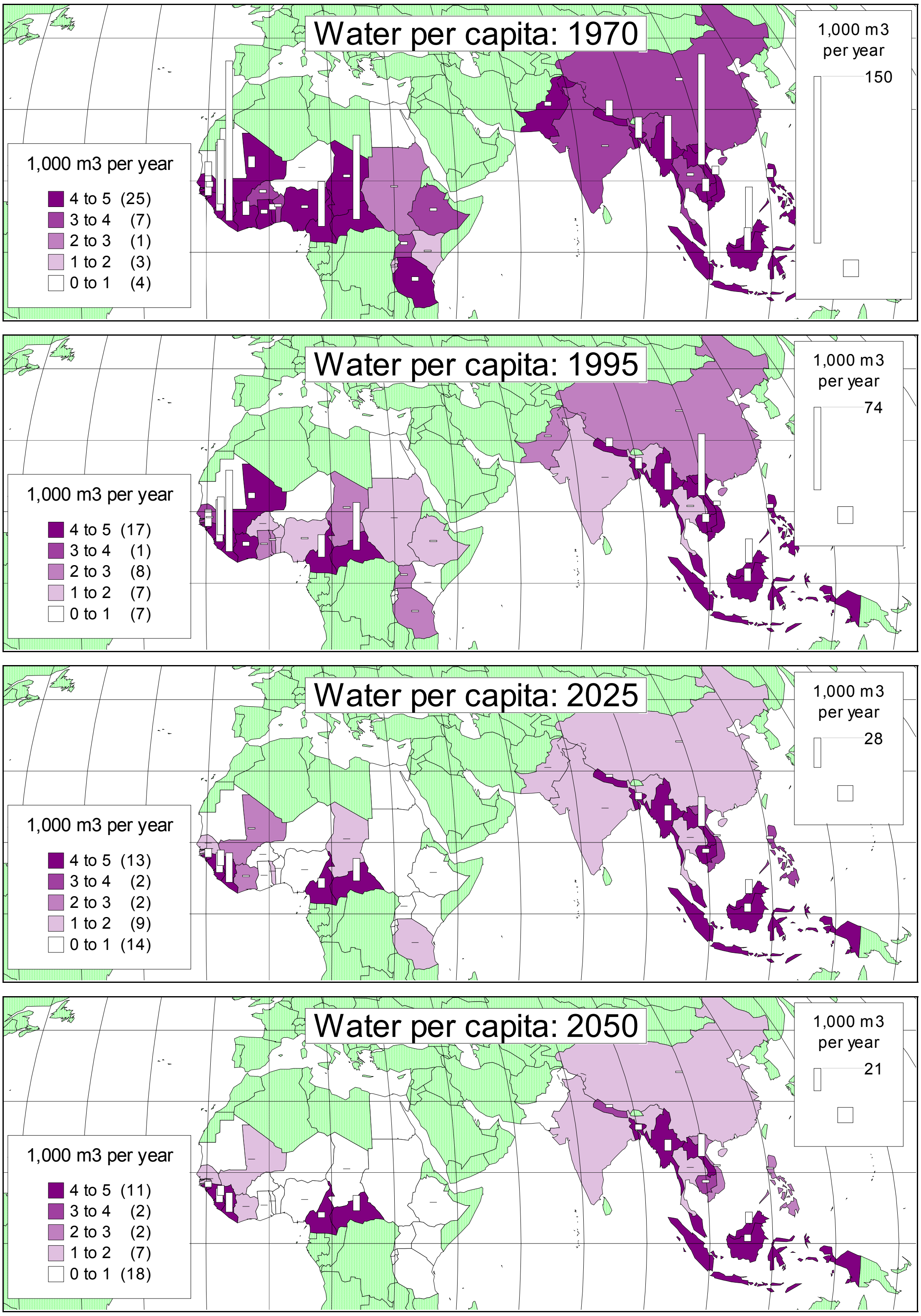


Figure 2.2j

Africa's water scarcity will worsen rapidly, but in Asia, the situation is less dramatic

Water resources availability per capita (1,000 m^3 per year) in study regions. Calculated on the basis of UN (1994) population projections and water availability data by SEI (1997). Present water outflows from a country to a territory of another country are excluded from availabe water resources. The number in parenthesis shows the number of countries in a category, and the column on right shows the scale by indicating the height of the tallest column in each map.



2.3 World's water use

Pertti Vakkilainen and Olli Varis

Water is used for many purposes. The most basic distinction can be made between water withdrawal uses such as irrigation and water supply to settlements and industries, and instream uses such as navigation, recreation, fisheries, and others. The dominating use in the global scale is agriculture.

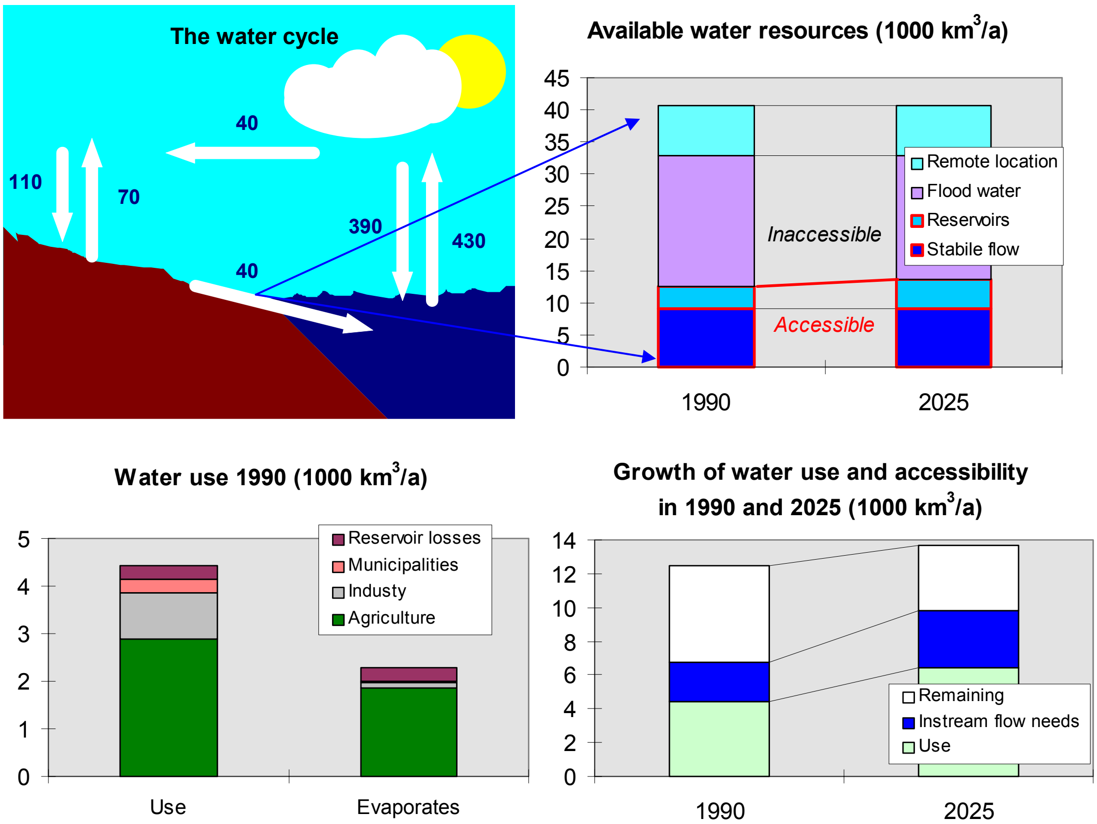
The water is consumed 69% by agriculture, 23% by industry, and 8% by human settlements. Estimations of the total amount of water consumption keep changing. According to Gleick (1993) 3,240 km^3 was consumed by withdrawals in 1990. The FAO's (1996) estimate is 4,430 km^3 per year but SEI (1997) estimates the consumption at only 3,500 km^3 in 1995 (see Figure 2.4a). When these figures are compared with the amount of accessible water there appears to be sufficient water for an even greater consumption than at present. In reality the situation is more complicated because water is consumed in many different ways (Figure 2.3a).

Ecosystem needs set limits to the stages and water quantities of the channels. Also navigation and recreational use make their demands. Part of the water withdrawals returns to the channel in the form of waste water, and the channels need to have water for diluting waste water. Demands to maintain and even to increase biodiversity set even stricter limits. How much water should be left in channels is difficult to estimate. Postel et al. (1996) estimate it to be 2,350 km^3 per year. When this figure is taken into account along with the figure for water consumption in 1990, water consumption is calculated to be 54% of the amount of water in constant use.

Figure 2.3a

Water availability vs. water use

The global hydrologic cycle (net flows), the available and accessible water resources, the possibilities to increase the accessible resources, and water use (Postel et al. 1996).



All water that is consumed is not ultimately lost but can be recycled through different treatments. It can be estimated that around 35% of the water used for irrigation returns to its channel and for industry and human settlement the corresponding figures are 91% and 83% (Shiklomanov 1993, Postel et al. 1996). The last-mentioned estimate the real "consumption" to be approximately 2,285 km^3 per year, which is approximately 18% of the amount of accessible water. In addition to this figure must be included used waters, which run from coastal areas directly to the sea.

The volume of accessible water can be increased by man. The drawbacks caused by temporal irregularities can be reduced by storing water in reservoirs or the soil during flood periods. Reservoirs are being constructed continually in different parts of the world but the number of large reservoirs, constructed per year, is continuously falling (Biswas 1992). Whereas about 1,000 dams over 15 m high were built between 1950 and 1980 per year, in 1990s the figure has fallen to 260 dams (IRN 1997). The rate of construction has slowed down because the best sites have been taken and due to the growing appreciation of the negative effects of dams. Also the continuous downward trend in the price of grain has contributed to the reluctance to construct new dams (See Chapter 10.1).

Sea water desalination is often put forward as a means of water production in water scarce areas. In comparison with total water consumption this is insignificant since desalination can only solve the problems of coastal areas in rich countries. Towing icebergs and letting them melt is an exotic method by which it is possible, at least in principle, to meet the water demand of coastal cities. Yet, there is no experience in practice on this, and there is no answer to the main problem: how to bring the massive quantities of water needed for irrigation to inland areas.

The uneven geographical division of water resources can be improved by transporting water from an area rich in water to a water-deficient area. On a small scale many of these transfers have been carried out in different parts of the world. Really gigantic plans have been drawn up but their realization has been held back by enormous costs and environmental protests. Perhaps the most notable plan is water transfer from the big rivers in Siberia flowing to the Arctic Sea to redirect them towards Central Asia (Box 10.2). This area is proposed to have an annual water deficit of around 100 km^3.

An even more noteworthy project is the so-called NAWAPA plan in North America. The suggestion is that 300 km^3 of water per year would be transferred from Alaska to dry areas in the south, comprising Canada, the United States and Mexico. The so-called Peace Pipeline Project suggests conducting water from Turkey to the Arab countries suffering from drought. Transporting water from Turkey by tanker has also been suggested (Turan 1993). Alaska is also ready to transfer water by tankers to California. According to the calculations it would be less expensive to use ships than desalination (Frederiksen 1996).

Contamination of water reduces the amount of accessible water. Waste water from human settlements contains organic material which consumes oxygen, and contains nutrients, making watercourses eutrophic. Waste water reduces the hygienic state of watercourses. Industrial waste often contains heavy metals and complex, insoluble chemical compounds which are harmful to people, animals and plants. Traffic burdens air, soil and water. Effective agriculture uses fertilizers and pesticides, some of which dissolve in surface and groundwater. Increased irrigation generates more and more drainage water, the salt content of which is as much as 10-fold greater than irrigation water itself.

Quantitative estimations of the extent to which water usability has fallen as a result of water contamination are not available. The situation in developing countries is, however, deteriorating rapidly. Wastewater treatment in these countries is only minimal as only approximately 10% of wastewater is treated (SEI 1997). In contrast many industrial countries have attended to their wastewater problems successfully over the last 30 years. Recently more attention has been paid to the fact that treated wastewater and drain water from irrigation areas are an important resource, which should not be undervalued. Wastewater that has been treated can be recycled for irrigation and industry. Often it can also be returned to the soil as artificial groundwater in which case it is also suitable for human settlement.

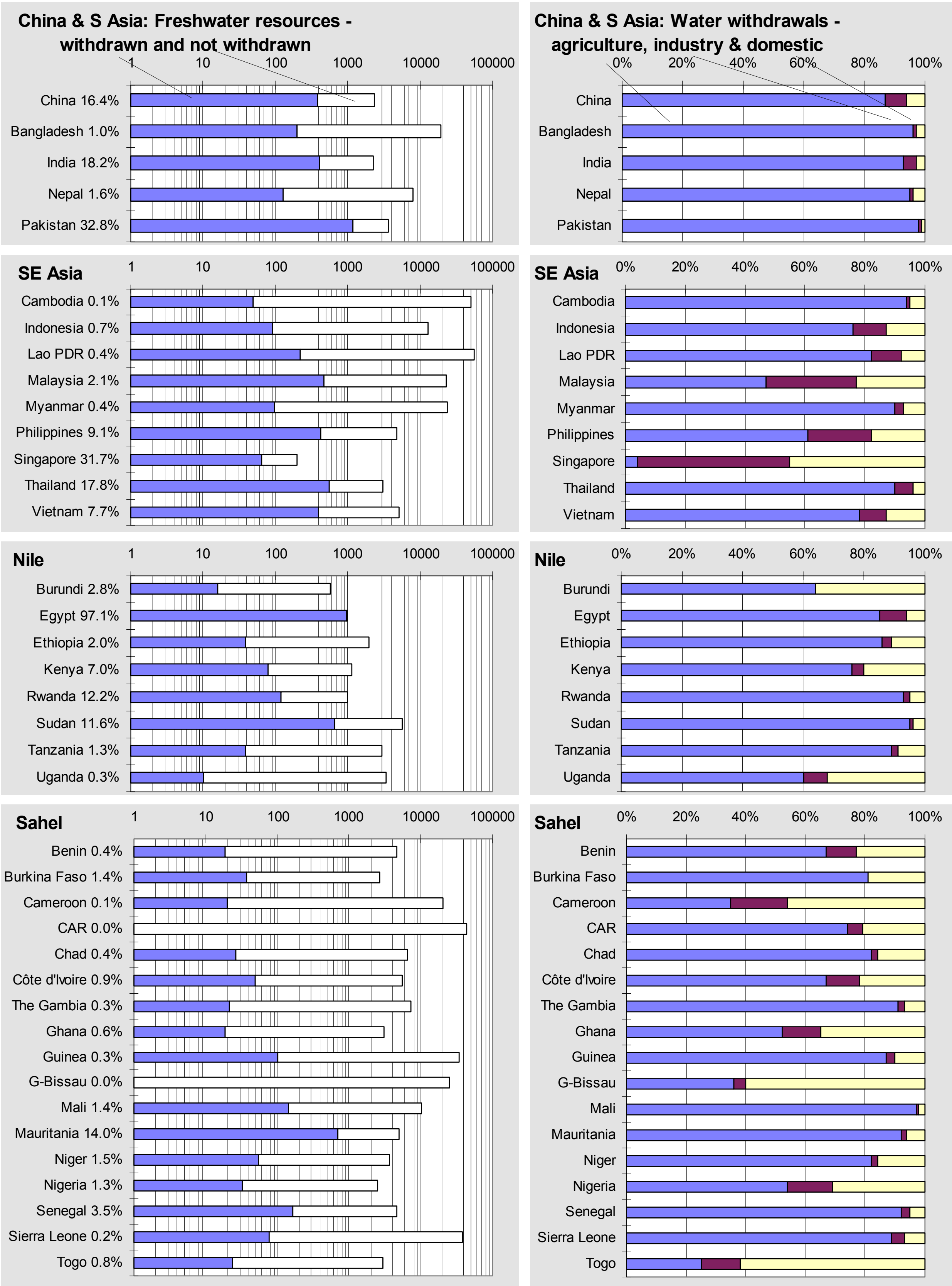
Water use is also made more difficult because many watercourses that are important water suppliers are located in areas that belong to two or more countries. According to Biswas (1992) there are 214 catchments spanning the territory of two or more states. If there is enough water for everybody there will be no problems but if water is scarce the situation can become difficult. In the worst cases water can be the cause of wars. Water that extinguishes fire can become an explosive in these areas. The situation in the Near East is an example of such a conflict.

Figure 2.3b shows the freshwater resources and withdrawals divided by agricultural, industrial, and domestic uses. The dominance of agricultural use is remarkable. The growing urbanization puts limits to and sets a rapidly growing pressure to the water use in agriculture, which is crucial for feeding the growing population.

Figure 2.3b

Freshwater resources and withdrawals by country

In the left panel, after the country name, the percentage of total withdrawals of freshwater resources is indicated. It should be noticed, that in many countries, the import and export of water by rivers distorts the figures on total freshwater resources markedly (source: World Bank 2004, data from 1987).



2.4 Water scarcity and vulnerability

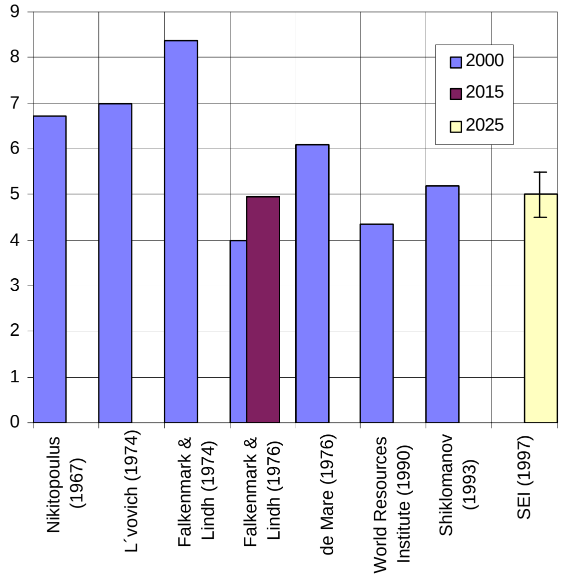
Olli Varis and Pertti Vakkilainen

Time is a scarce resource. This fact becomes clear when investigating the speed of the growth in various pressures that freshwater resources are subjected to in most parts of the world. Selected recent global assessments of freshwater vulnerability are summarized.

Global demand projections

When talking about water scarcity and vulnerability, the available and accessible water resources are related with water demands, which, in turn, is a very difficult issue to assess and predict. Some estimates are summarized in Figure 2.4a.

Figure 2.4a
Water use estimates disagree
Global water withdrawal estimates (1,000 km^3 per year) according to SEI (1997).



Postel et al. (1996)—referred to extensively in the 2 previous chapters—base their estimation on the hypothesis that water consumption per capita will remain on the present level and predict a demand of 6,400 km^3 per annum in the year 2025.

They estimate that river channels must get each year approximately 3,430 km^3 of water because the need for dilution increases with increasing pollution. Total annual use will then be 9,830 km^3. This is over 70% of the estimated amount of water in continuous use, which can be, according to their estimation, increased to 13,700 km^3 per annum (cf. Figures 2.2c and 2.3a).

One of the recent estimates (SEI 1997) predicts a remarkably smaller quantity of water withdrawal. According to an average scenario only 5,000 km^3 water per year will be used. In the most extreme scenario the amount would be 5,500 km^3 in around 2025. The basis for these scenarios is the assumption that water consumption will be increased in all sectors.

To what extent it is possible to reach this is uncertain as water consumption generally increases along with rising standard of living. At the same time as the population grew from 3.8 billion to 5.4 billion, i.e., by 40%, water consumption doubled (Postel 1992).

Critical situations and vulnerable regions

The above figures provide a general outlook of water sufficiency as far as the global situation on average is studied. The averages, however, do not tell the whole truth because, from the water availability viewpoint, important quantities are low water flows. Geographically water resources and the demand for consumption are unequally distributed. The combined global annual discharge does not vary much but if water availability is examined at the scales of catchments or continents, the annual runoffs vary considerably. Water availability is made especially difficult by hydrological persistence near the equator, which manifests itself in dry spells lasting for several years. Dry years follow each other.

When difficulties in meeting the water demand are estimated in geographical sectors the rating can be based on the relation of water consumption to annual runoff (Falkenmark and Lindh 1976, SEI 1997). If water demand is less than 5% of the total runoff. it can be met without problems. When water demand is near 10% the risk caused by temporary disturbances increases and the meeting water requirement demands careful planning of water resources. If water demand is 10% to 20% of the annual runoff the situation becomes problematic and large investment is the only solution possible. At between 20% and 40% the situation in developing countries requires massive investment and a large part of GNI has to be sacrificed for water management. A water demand above 40% is a serious water shortage that usually has to be met by desalination and using groundwater to the extent of groundwater depletion.

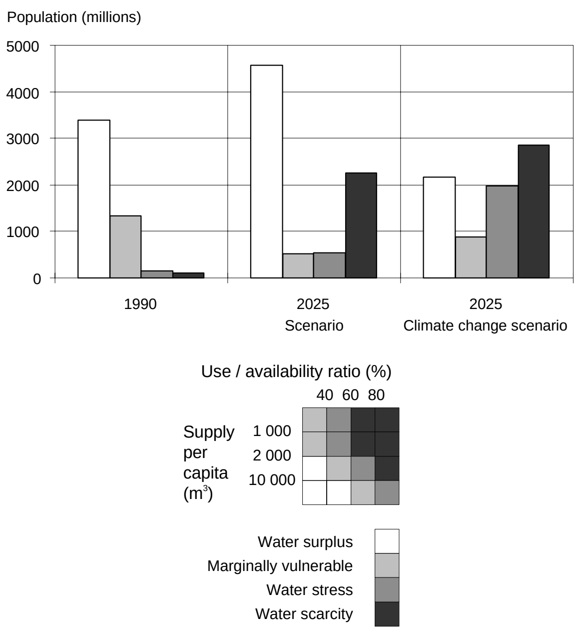
Kulshreshtha's assessment

Kulshreshtha (1993) estimated the change in water consumption in major areas until the year 2025 and described 3 scenarios, shown in Figures 2.4b and 2.4c. Only S America, N Europe, Central Africa, SE Asia and Oceania will be below the critical consumption level of 20%. There will be major problems will be in N Africa and Near East, where water requirement will exceed water supply manifold.

Figure 2.4b shows that the share and the number of the world population that will be suffering from the shortage of water is in an expanding phase.

It should be mentioned that this analysis only includes water quantity based on national, aggregate values and it is likely that including quality information or disaggregating spatially and temporally could drastically change the results. Incorporation of water quality problems would reveal that the water scarcity issue still an essentially more severe problem than shown in the Figures of this Chapter. The possible climate changes are likely to add to these problems.

Figure 2.4b
The number of people subjected to water scarcity is in rapid growth
Vulnerability of the global population to water supply deficits (above), and the use-availability classification used (Kulshreshtha 1993).



SEI's assessment

As a call for a comprehensive assessment of current and future freshwater resources by the UN Commission on Sustainable Development in 1994, the Stockholm Environment Institute (SEI 1997) was commissioned, by the Swedish Government for preparing this assessment together with various UN organizations.

The assessment first describes the availability, quantity, and variability of water resources, and their present use. Second, an analysis on current and future water needs and problems faced is presented. At the end, strategies and options for the sustainable development of global freshwater resources are reported.

The analysis on future water demands is based on a set of scenarios. On the supply side, 3 different scenarios are driven. One of them is based on the assumption that the climate will remain as it has been in the recent decades, and the 2 other ones assume the climate be changed due to human influence (see Chapter 4.3). On the demand side, the range of water withdrawals is projected using 3 scenarios: low, middle, and high. The time frame used is to 2025, and the analysis is made on a country level.

The results of the scenarios are presented as a set of vulnerability index values for each country. The 5 indices used, and the results of the Middle Conventional Development Scenario are shown in Figure 2.4c. Among these indices, which all describe a specific view to the water resources issue, the Composite Water Resources Vulnerability Indices I and II (WRVI-I and II)—in particular WRVI-I—appear to be the most useful to studies such as this, due to their interdisciplinary character.

Further studies

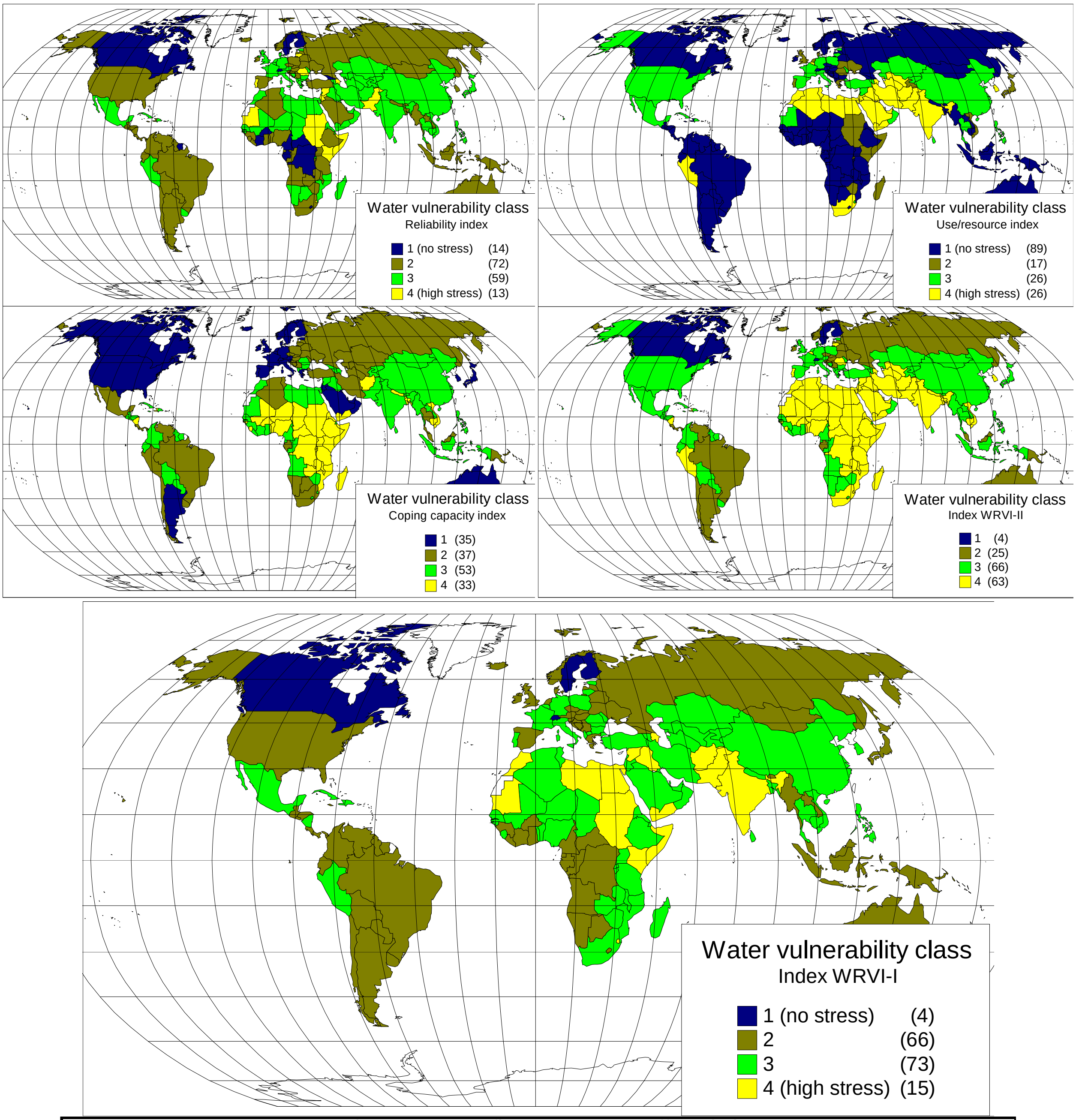
The SEI approach has been further refined and elaborated by several actors. The CGIAR organizations International Water Management Institute (IWMI) and International Food Policy Research Institute (IFPRI), as well as Joseph Alcamo's team at the University of Kassel in Germany have been particularly productive.

While the Kassel University team proceeds with increased spatial resolution using more and more detailed GIS approach, IFPRI and IWMI go on with a more demand-oriented approach using (agricultural) water demand scenario models in country, province or river basin scales. These models, known as PODIUM and IMPACT have been used as an important cornerstone of the Water Visions in the 2nd and 3rd World Water Forums in The Hague in 2000, and Kyoto in 2003, respectively.

Figure 2.4c

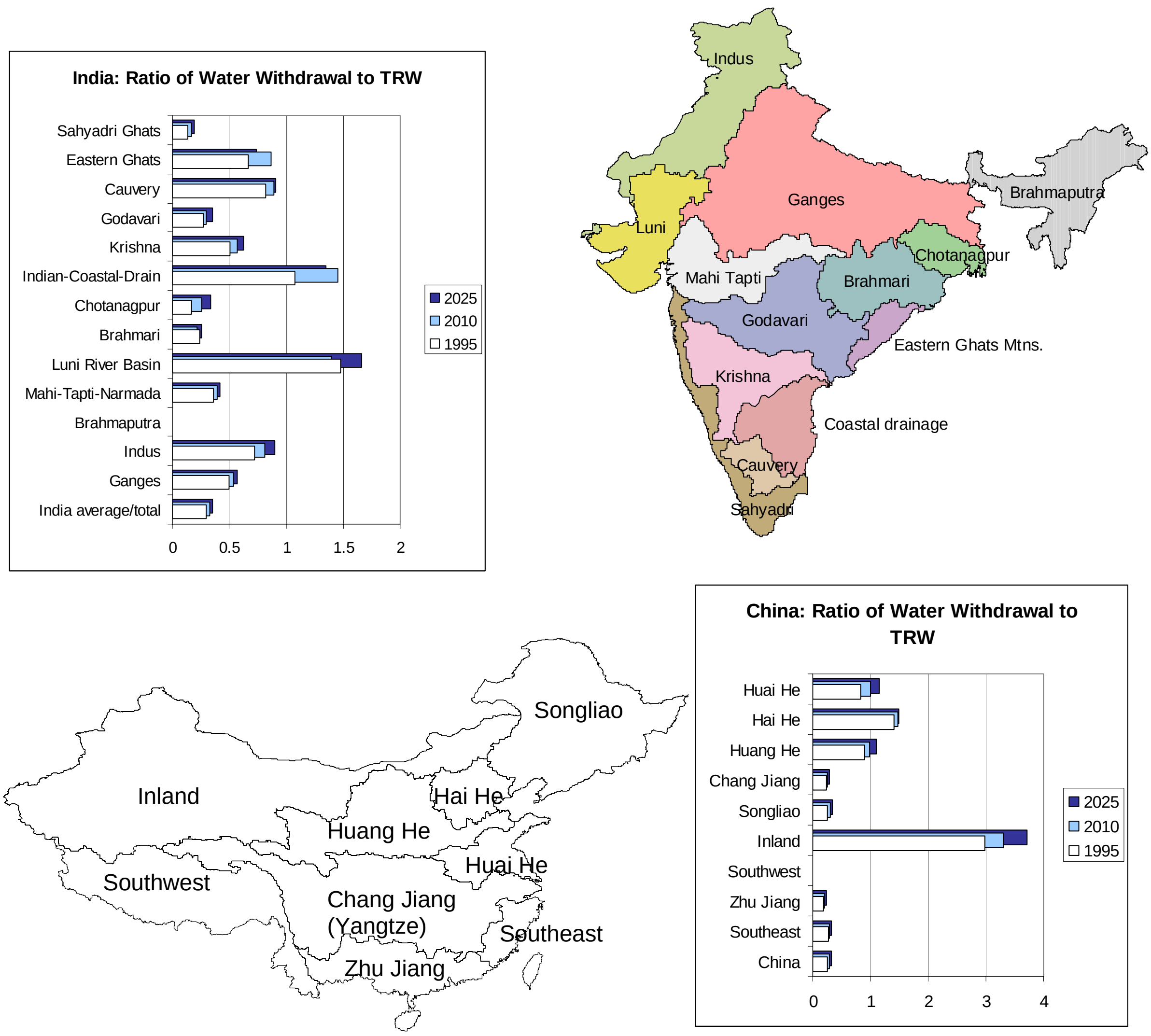
Water vulnerability indices projected to 2025 according to SEI (1997)

The five indices produced by the Comprehensive Assessment of the Freshwater Resources of the World by Raskin, Gleick, Kirschen, Pontius, and Strzepek. The Middle Conventional Development Scenario results are shown. The used indices are briefly described in the lowest panel.



Reliability	S/Q+COV+ID	*S/Q: Storage-to-flow in river basins*		*COV: Coeff. variation of precipitation*	*ID: Import dependence (%)*
	1 1 - 3	*1 > 0.6*		*1 < 0.06*	*1 < 15*
	2 4 - 6	*2 0.3 - 0.6*		*2 0.06 - 0.12*	*2 15 - 25*
	3 7 - 9	*3 0.2 - 0.3*		*3 0.12 - 0.18*	*3 25 - 50*
	4 10 - 12	*4 < 0.2*		*4 > 0.18*	*4 > 50*
Use-to-resource	Withdrawals of average annual resource flows	**Coping capacity**	GNP per capita	**WRVI-I**	Reliability+use-to-resource+Coping cap.
	1 < 0.1		1 > 8625		1 1 - 3
	2 0.1 - 0.2		2 2786 - 8625		2 4 - 6
	3 0.2 - 0.4		3 695 - 2786		3 7 - 9
	4 > 0.4		4 < 695		4 10 - 12
WRVI-II	Maximum of Reliability, Use-to-resource, and Coping capacity				

Figure 2.4d
Water withdrawal against total renewable water resources (TRW) in India and China
Source: Rosegrant et al. (2002).



Without going into details of these studies within the limits of this book, let us take some IFPRI results from Rosegrant et al. (2002) for India and China (Figure 2.4d). These results show how particularly high pressure is imposed to the water resources of certain parts of China and India.

In the Inland Catchments of China, already now the water withdrawal is 4 times the rate of renewal of the water resources. This is clearly an unsustainable situation.

Further particularly critical areas include the N China Plain (Huai, Huang and Hai He basins) and the following basins in S Asia: Indus, Luni, Indian-Coastal-Drain, Eastern-Ghats of India, and the Kaveri (Cauvery).

Options for demand management

In order to have sufficient water in areas that have become critical water consumption should be controlled. When the amount of water used for irrigation is often over 90% of total consumption the central issue is whether irrigation could be limited. In sporadic irrigation projects water use is inefficient, on average perhaps only round 40%. The unutilized water that has been lost upstream flows to be consumed in the lower reach or is infiltrated as groundwater. It often produces salinity problems and waterlogging.

The fact that effectiveness saves water is due in large part to effective irrigation that makes it possible to reduce salinity and to increase yields per hectare to a great extent. These factors conserve both water and soil on a large scale. When irrigation is studied, effective irrigation in the whole basin area should be included, not only water consumption in sporadic irrigation areas (Fredriksen 1996, World Food Summit 1996).

Another typical solution is to set a price for water and in this way include water in the market economy. This measure does not increase water quantities but transports water to an area, which can afford it, i.e. industry and human settlements. Without doubt, efficiency in water consumption will increase but at the same time new problems will emerge. Poor farmers in developing countries cannot compete for non-sufficient water resources. They cannot earn their livelihood in the countryside and an attractive alternative for them is to move to urban areas.

With the continuing population growth, water-related problems must be solved rapidly. Water must be conserved in critical areas but that will not be sufficient. Consumption of treated wastewater will be an important additional resource. Plants requiring less water can still be bred. In addition to these measures water must be stored in both reservoirs and aquifers. We have to remember that important water management projects cannot be implemented, nor technological, human, or institutional capacity can be established in a year or two but will take decades.

Time is a scarce resource.

2.5 Land use, food production and markets

Olli Varis and Pertti Vakkilainen

Similarly to water resources, the land is subjected to growing pressures by the mankind. The growing demand for food and agricultural production requires more land and more intensive exploitation of the land already in production. Also the expanding urban areas, transportation and industrial facilities, with degradation of arable land all put rapidly growing pressures to land resources, particularly in the study regions.

Growing population, stagnated farm area

World's population keeps growing and food demand keeps growing even faster due to changing consumption patterns: the world's population doubled in 1950-90, but the meat consumption grew almost 4-fold. In China, 8% of grain was fed to animals in 1978, but in 1990 as much as 20% (Brown 1995). Already 40% of the world's grain production goes to feed, and the share keeps growing (Brown and Kane 1994), and it will apparently grow fastest in the study regions.

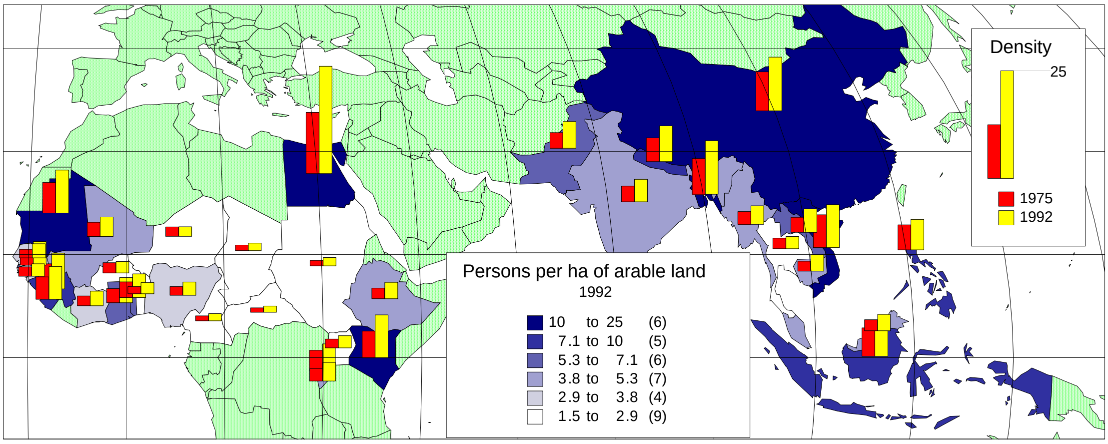
The area of arable land does not grow, however (Figures 2.5a and b). In contrary, it is in slight decrease in most parts of the world. This tendency is still stronger, when considering the area of cereal production. An exception with growing production areas is W Africa. Its cropland is in steady growth.

The world has about 1,379 million hectares (ha) of arable land, of which about one half, 700 million ha, in grain production. The irrigated area is 250 million ha, i.e.18% (World Bank 2001). The yield is higher on the irrigated areas and their share of the total production is as much as 1/3 (Postel 1993). Total global production per capita has increased until the end of the 1980s but since then has turned downwards and is now on the same level as it was 20 to 25 years ago.

Although the area of arable land per capita decreases steadily and rapidly, the food production per person has remained relatively steady. This could be explained to a great extent by the increased efficiency, primarily due to growing use of agrochemicals such as fertilizers and pesticides, and on the other hand as a result of growing irrigation area, introduction of new varieties, and improved agrotechnology.

Nevertheless, the development of the volumes of these factors, most drastically the use of fertilizers has not kept pace with population growth. The same tendency is expected in irrigation. With the words of Rosegrant et al. (2002): *"By 2025 water withdrawal for most uses (domestic, industrial, and livestock) is projected to increase by at least 50%. This will severely limit irrigation water withdrawal, which will increase by only 4%, constraining food production in turn."*

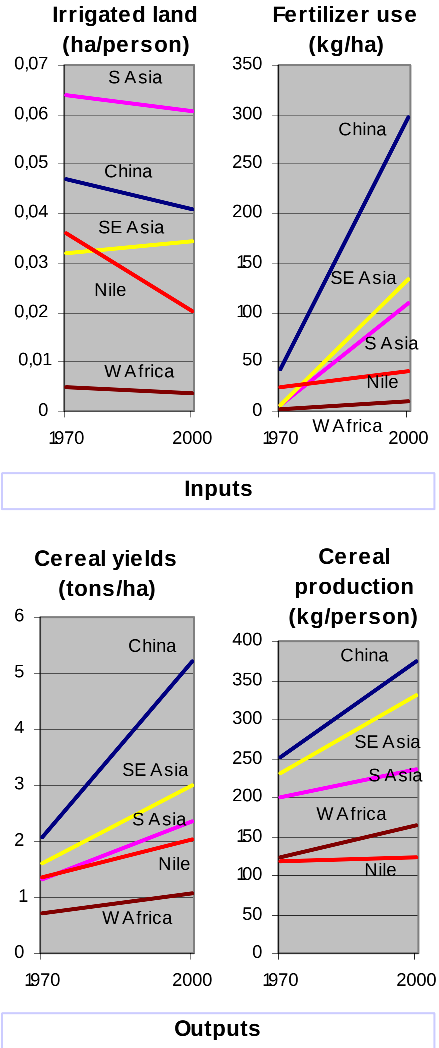
Figure 2.5a
Number of persons per one hectare of arable land
UNCHS (1996) data for 1975 and 1992 (columns) and 1992 (colors).



Regional outlook

As far as the studied regions are concerned it can be noticed that in every regions production per capita has increased since the 1970s. However in the Nile region the growth has been nearly nil.

Figure 2.5b
Agricultural inputs and outputs by region
Source: World Bank (2004).



Yields per ha have substantially increased, especially in China. In this case attention should be given to the noticeable increase in fertilizer use during the last three decades. As far as W Africa is concerned it should be noticed that lot of land has been taken over for cultivation during the last ten years without, however, not much increasing yields per ha. In this respect it clearly differs both from the trends in the other regions and areas outside this study.

These trends seem are very logical. The Asian regions are densely populated and it is not easy to obtain land for cultivation there. They are also becoming industrialized; SE Asia at the greatest speed, and China and S Asia behind it. Egypt is in the same situation; there is no space, and basic industry—often heavily subsidized—has been developed gradually. In W Africa and countries around the Nile, industry and foreign currency are scarce but more space is available.

The irrigated land per capita has remained more or less constant throughout the world, although W Africa is again an exception; it has concentrated on extending rainfed agriculture by extending arable area.

China, in turn, has leaned very much on agrochemicals and irrigation, although it seems to have been forced to cut down the growth rates in 1990s. It uses over three times the amount of fertilizers per a unit of land in comparison to the world average, and it already irrigates more than half of its arable land.

The amount of water is an evident constraint, particularly in the northern part of the country. Massive water constructions including the Three Gorges Dam and water transfers from the Changjiang (Yangtze) basin to the Huang He (Yellow River) basin are under way to meet the growing demands of water in the dry season and in the dry areas.

There is a wide-reaching discrepancy of China’s future trends. Some voices are very concerned about China’s capability to feed its people (Brown 1995), whereas the others are confident, that China will be able and willing to increase its arable land use efficiency fast enough to meet the growing food demand (Crook and Colby 1996).

One of the basic problems with any of the recent studies concerning China’s food production is the reliability of the statistics available. For instance, the estimates of China’s arable land area range from 95 to 140 million ha (Figure 2.5c). The lowest figures are from the official Chinese statistics (China Statistical Yearbooks), which, however, in the recent years mention in the footnote that “*…the figure for cultivated land is underestimated*”.

The most pessimistic studies have relied on the official figures (e.g. Brown 1995; see Box 5.3), whereas the optimists have used “corrected” estimates, which tend to range between 130 and 140 million ha. Heilig (1999) presents a detailed scrutiny of the data problems of Chinese statistics related to food production. He ends up using the area shown in Figure 2.5d.

S Asia has a large area of irrigated land per person, and the fertilizer use is still relatively low; around 1/3 of the Chinese level. However, the fertilizer use in African regions is still much below the S Asian level, being one order of magnitude smaller than in China.

Figure 2.5c

China's arable land area is not known

The lowest two values are presented by official statistics. They are only 70% of recent western estimates (source: Heilig 1999).

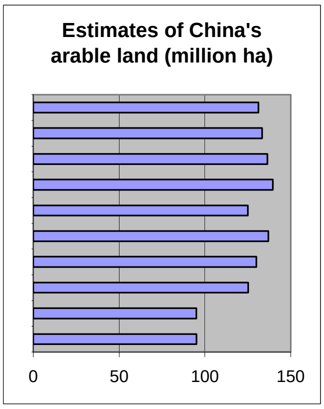
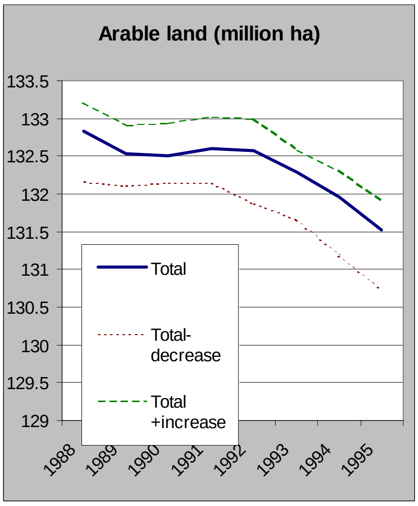


Figure 2.5d

China's arable land area shrinks

Annual decrease of arable land is greater than the annual increase (source: Heilig 1999).



In the period 1970-2000, the regions' share of world´s arable land area decreased a bit; from 40% to 37%, whereas their share of grain production increased from 60% to 71%.

At the same time the extent of both irrigation and fertilization has increased markedly in the study regions. However the former, if calculated per capita, has decreased everywhere except in SE Asia. The regions' share of the total irrigated arable land on the earth has remained at 42%, the share of the use of fertilizers of the global use has risen from 15% to 50%. China's share has merely risen from 8 to 26%.

In countries outside the regions, irrigation area has remained unchanged whereas the use of fertilizers has decreased significantly. This can be explained to a large extent by political changes since early 1990s in the former USSR and in the states within its influence, and their effect on production structures.

Figures 2.5e to g present an overview of land use and population density in a country level. The most striking feature is the land scarcity in China and S Asia. Clearly, the means of overcoming any pressures to natural resources are there very different from those best suited to the other regions. SE Asia is still rather well off with forests, whereas the African study regions have plenty of pastureland.

Figure 2.5e

China and S Asia are crowded

Land use per hectare of arable land in China and S Asia. Source: FAO (2001 and 2004).

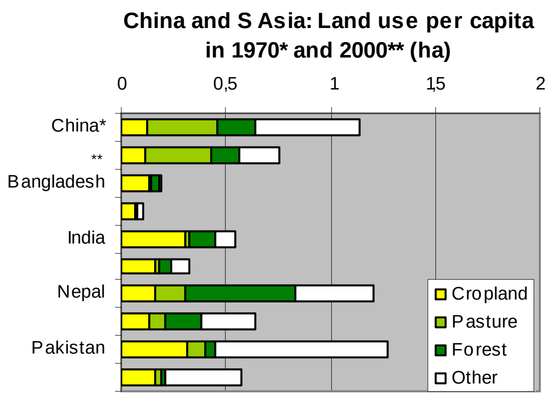


Figure 2.5f

SE Asia has still plenty of forest cover

Land use per hectare of arable land in SE Asia. Source: FAO (2001 and 2004).

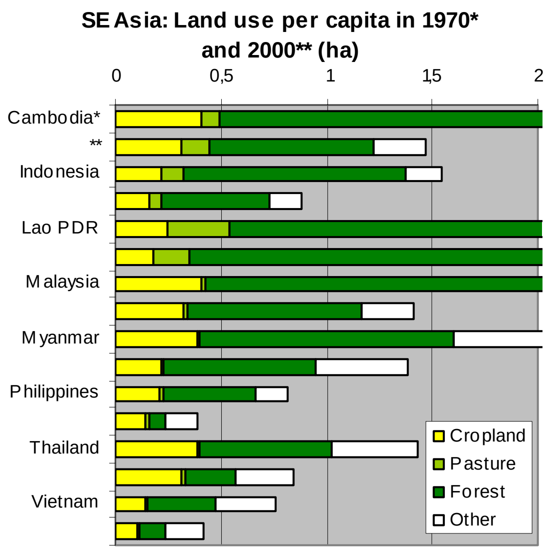
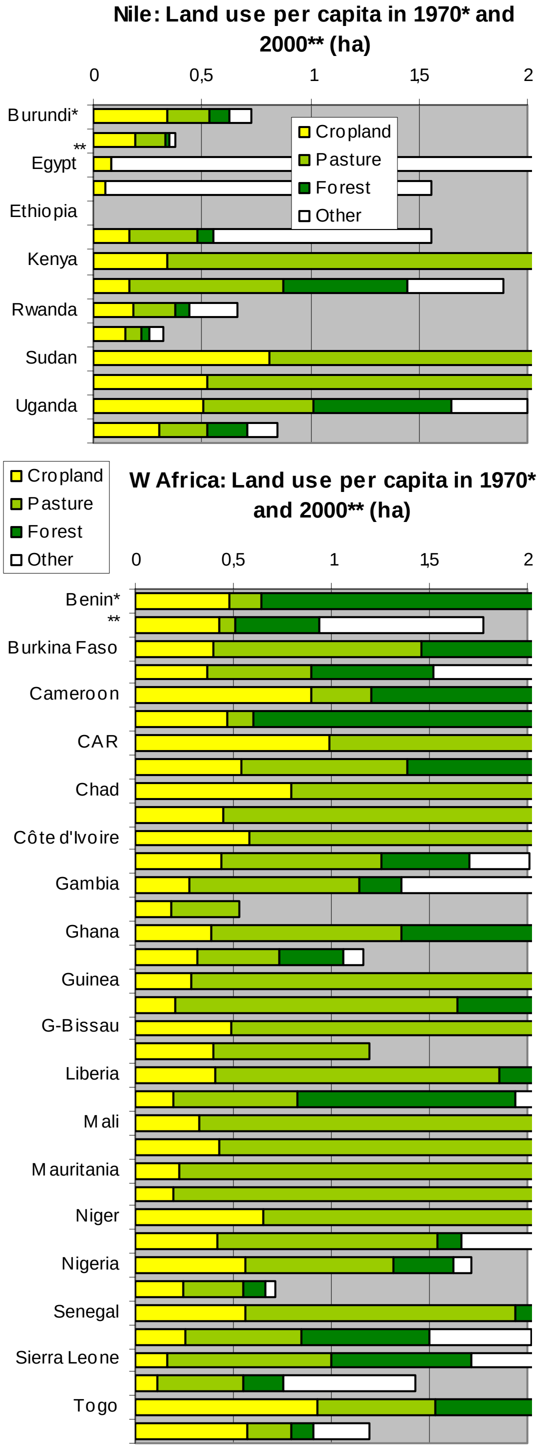


Figure 2.5g

African study regions are rich with pasture

Land use per hectare of arable land in the Nile region and W Africa. Source: FAO (2001 and 2004).



Self-sufficiency, self-reliancy, markets

Traditionally, food self-sufficiency has been an important element of the concept of an independent nation. This has been true China, former USSR, India, Libya, Sweden, Finland, and innumerous other countries. The ability to produce own food has been considered as a key stabilizing issue to the whole society in making it resistant against crises and pressures that originate from reasons—political, climatic, or other—that are beyond the government's control. Along with the globalizing economy, food has gradually become more a tradable good, and the food self-sufficiency paradigm has increasingly been replaced by the concept of food self-reliancy. Figures 2.5h to j provide more insight into the issue.

There are a few exceptions, however, of other land-scarce countries including Indonesia (particularly the island of Java), Philippines, Vietnam, Egypt (its population is concentrated very densely in the Nile valley), Burundi, Rwanda, and some Sahelian countries due to the fact that most of their area is deserted.

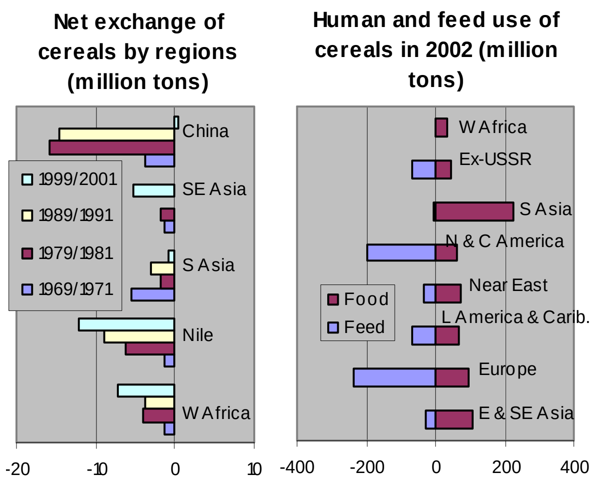
After the disintegration of the USSR the whole world firmly believed in the blessings of market economy. Privatization, removal of trade barriers and financial deregulation are measures, which together will probably have important positive effects.

Government-regulated influence is considered to slow down development and is therefore kept to a minimum. It is essential to the market that money is directed into projects, which give a higher yield on capital than in competing projects (Box 2.5).

Figure 2.5h

Self-sufficiency and feed use of grain

Data: FAO (2004).



The chances of agricultural investments to be competitive in this situation are not always good. In general their economic yield is small in relation to the capital that is needed and divided equally over a long period of time. Instead ordinary profitability studies favor investment objects, which yield profit as fast as possible. The rate of interest used in calculations has a strong impact on the final result in these comparisons, because the higher the interest used the more successful the projects that yield profit rapidly.

Figure 2.5i

Only a few study countries export grain

Self-sufficiency ratios by country (data: Alexandratos 1995).

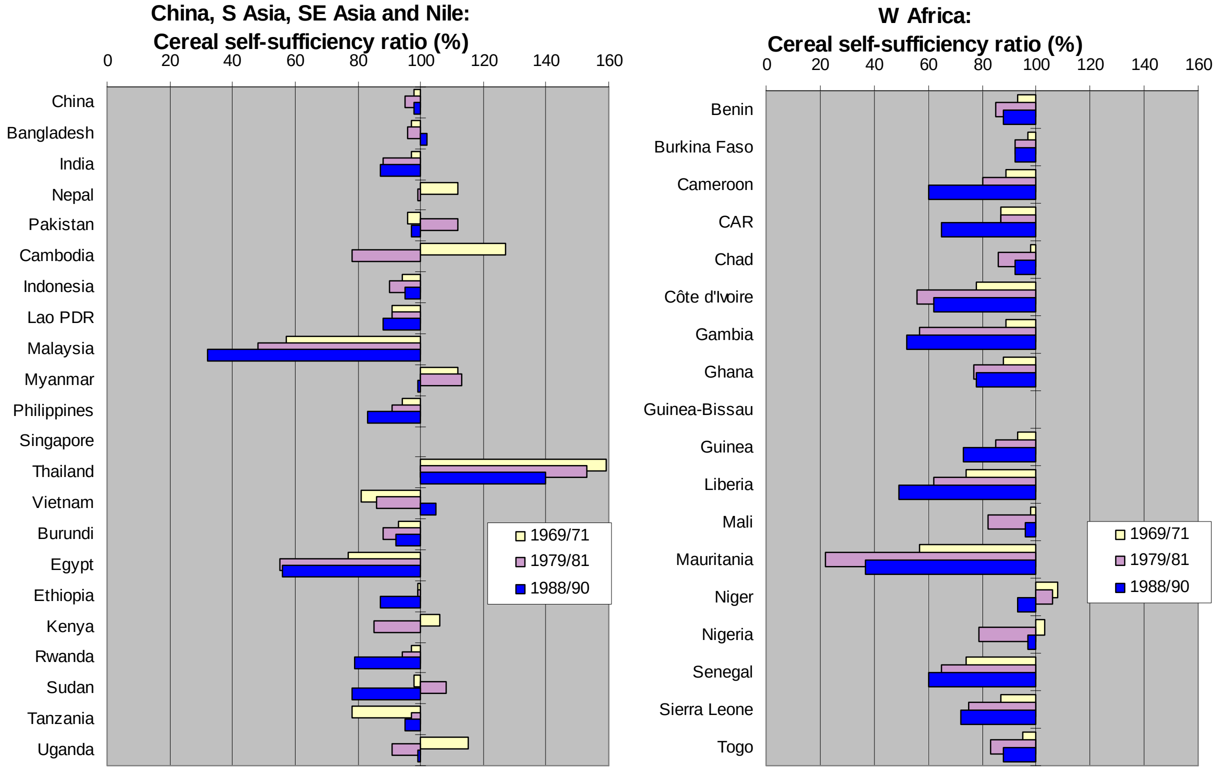
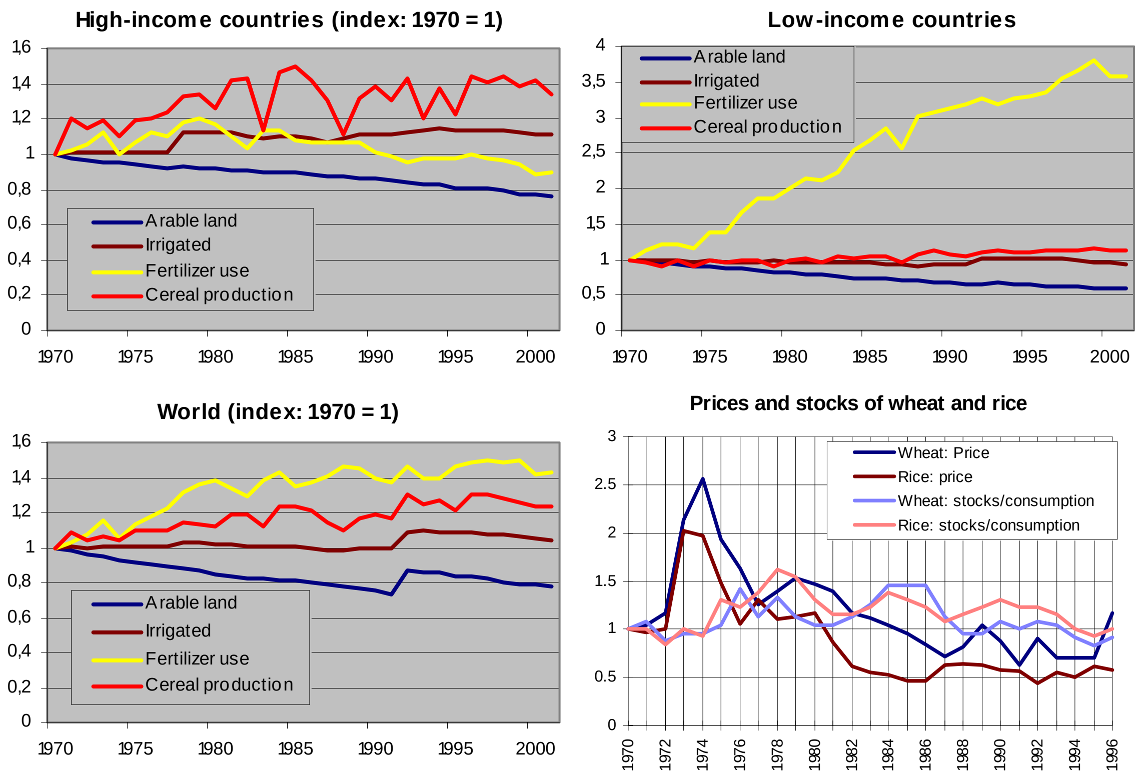


Figure. 2.5j

Land is getting scarce, stocks are running out, will food insecurity follow?

Indexed values of arable land, irrigated land, fertilizer use, and cereal production per capita in developing and developed countries, and the development of cereal prices and cereal stocks (source: World Bank 2004, World Bank 1997). For more discussion on food security, see Chapter 5.3.



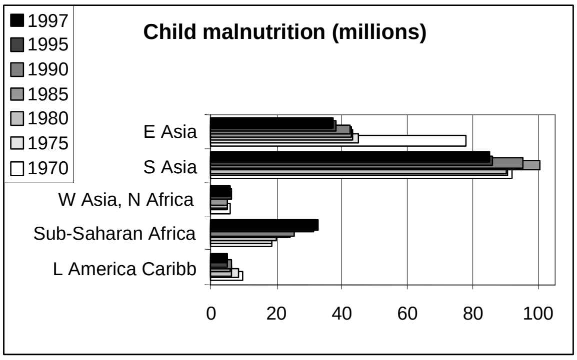
The price of grain is an important regulating factor in agricultural investments. It has been falling for the past 20 years, despite of the alarming number of undernourished people in the world (Figure 2.5k, see also Figure 2.2b). Investments in safeguarding the preconditions for agriculture have become less inviting.

The downward trend of the price of grain can be explained to a great extent by the fact that there is no interest in sacrificing money for expensive clearing of new land but increase in yield can be achieved by more fertilization instead. The price trend of grain can be seen as part of the reason why fewer reservoirs are being constructed than before.

Figure. 2.5k

The world's 180 million malnourished children

Source: Rosegrant et al. (2001).



Box 2.5

Mismatches in global food projections

Source: Vakkilainen and Varis (1999).

Will there be enough food to feed the mankind in the coming one to two decades? Water is the critical factor underlying this development. The available food projections exhibit a great variety, ranging from slight increase per capita to remarkable decrease. The disagreement is an indication of very high uncertainty associated to these projections.

The global food production has witnessed a marked increase during the last couple of decades. The grain production rose from 631 million tons in 1950 to 1 780 million tons in 1990. The grain production almost tripled in four decades (Brown 1996). The food production per capita did not grow in the 1990s.

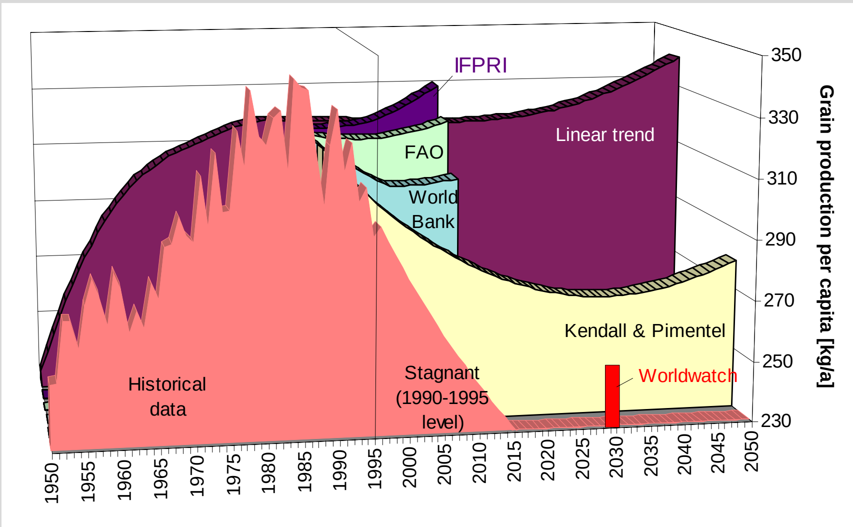
To avoid per capita decrease in food production, it should increase at least with the population growth rate. The growth rate of grain production should be around 78 000 tons each day, and 28 million tons a year. In addition, consumption patterns such as sharply growing meet use in many countries such as China, implies that the grain production must exceed remarkably the population growth rate (cf. Brown 1996). Due to such increasing affluence, the grain consumption in China has grown from 328 million tons in 1990 to 368 million tons in 1995. 80% of that growth went for feed. Whereas the global average of grain production is around 300 kg per year and per person, in United States, the average consumption (including feed use) is around 800 kg, in China, 300 kg and in India, 200 kg.

A number of food projections have been published. They represent a variety of assessment methods and approaches, and institutions. Figure 2.5l shows the results of five recent projections. Important is to note the enormous disparities between the projections. Equally alarming is the fact that these projections very scarcely refer to one another.

Figure 2.5l

Food projections are highly uncertain

The linear trend plotted indicates the growth rate of 27.5 million tons / year, which is the average growth rate in 1950-1990 (source: Vakkilainen and Varis 1999).



References to Section 2

ADB, 2000. *Strategic Options for the Water Sector: PRC.* Hydrosult, SOGREAH and IWHR, Beijing for Asian Development Bank, Manila.

Ahmad, Q.K., Verghese, B.G., Iyer, R.R., Pradhan, B.B. & Malla, S.K. (Eds.) 1994. *Converting Water Into Wealth: Regional Cooperation in Harnessing the Eastern Himalayan Rivers.* Institute for Integrated Development Studies (IIDS), Kathmandu.

Alexandratos, N. 1995. *World Agriculture: Towards 2010—An FAO Study.* Food and Agriculture Organization of the United Nations (FAO), Rome and Wiley, Chichester.

Biswas, A.K. 1992. Sustainable water development: a global perspective. *Water International* 17(2): 68-79.

Biswas, A. K. 1995. Environmental sustainability of Egyptian agriculture: problems and perspectives. *Ambio* 24(1): 16-20.

Brown, L.B. 1995. *Who Will Feed China: Wake-Up Call for a Small Planet.* The Worldwatch Environmental Alert Series. Norton, New York and London.

Brown, L.B. 1996. *Tough Choices, Facing the Challenge of Food Scarcity.* The Worldwatch Environmental Alert Series. Norton, New York and London.

Brown, L.B. & Kane, H. 1994. *Full House, Reassessing the World's Carrying Capacity.* The Worldwatch Environmental Alert Series. Norton, New York and London.

Chen, X., Zong, Y., Zhang, E., Xu, J. & Li, S. 2001. Human impacts on the Changjiang (Yangtze) river basin, China, with special reference to the impacts on the dry season water discharges into the sea. *Geomorphology* 41(2): 111-123.

Crook, F.W. & Colby, W.H., 1996. *The Future of China's Grain Market.* Agriculture Information Bull. 730. US Department of Agriculture, Washington D.C.

Czaya, E. 1981. *Rivers of the World.* Van Nostrand Reinhold, New York.

Dixon, J.A., Talbot, L.M. & LeMoigne G.J. 1989. *Dams and the Environment: Consideration in World Bank Projects.* Technical Paper 10. World Bank, Washington D.C.

Drakakis-Smith, D. 1987. *The Third World City.* Routledge, London.

Elarabawy, M., Attia, B. & Tosswell, P. 1998. Water resources in Egypt: Strategies for the next century. *Journal of Water Resources Planning and Management* 124(6): 310-319.

Elhance, A.P. 1999. *Hydro-Politics in the 3rd World. Conflict and Co-Operation in International River Basins*. US Institute of Peace Press, Washington D.C.

Falkenmark, M. & Lindh, G. 1976. How can we cope with the water resources situation by the year 2015. *Ambio* 3(1): 3-4.

Falkenmark, M.& Lindh, G. 1993. Water and economic development. In: Gleick P.H.(Ed.): *Water in Crisis*. Oxford University Press, New York.

FAO 1995. *Dimensions of Need. An Atlas of Food and Agriculture.* Food and Agriculture Organization of the United Nations (FAO), Rome.

FAO 2001. *Global Forest Resources Assessment 2000 – main Report.* FAO Forestry Paper No.140. FAO, Rome.

FAO 2004. *FAOSTAT Database.* FAO, Rome. www.fao.org/waicent/portal/statistics_en.asp (3.5.2006).

Frederiksen, H.D. 1996. Water crisis in developing world: Misconceptions about Solutions. *Journal of Water Resources Planning and Management* 122(2): 79-87.

Frederiksen, H.D., Berkoff, J.& Barber, W. 1993. *Water Resources Management in Asia.* Vol 1, Main Report. World Bank Technical Paper 212, Asia Technical Department Series. World Bank, Washington D.C.

Gleick, P. (Ed.) 1993. *Water In Crisis: A Guide to the Worlds Freshwater Resources.* Oxford University Press, New York.

Golubev, G. 1993. Sustainable water development: implications for the future. *Water Resources Development* 9(2): 127-154.

Hasan, S.& Mulamoottel, G. 1994. Natural-resources management in Bangladesh. *Ambio* 23(2): 141-145.

Heilig, G.K. 1999. *China Food: Can China Feed Itself?* IIASA LUC Project CD, Version 1.1. International Institute for Applied Systems Analysis (IIASA), Laxenburg.

ICID 1995. *International Program for Technology Research in Irrigation and Drainage: An ICID Vision.* International Commission on Irrigation and Drainage (ICID), New Delhi.

IFPRI 1997. *The World Food Situation, Recent Developments, Emerging Issues, and Long Term Prospects*. The International Food Policy Research Institute (IFPRI), Washington D.C.

Ilomäki, J. 2000. *Institutional challenge of developing transboundary water resources*. *Research Report* 2000: 1. Helsinki University of Technology, Water Resources Laboratory, Espoo. www.water.tkk.fi/wr/tutkimus/glob/publications/Ilomaki/indexw.html (3.5.2006).

IRN 1997. *Questions and Answers on the International Movement against Large Dams*. International Rivers Network (IRN), Berkeley. Press Release 25.3.1997.

Jacobs, J.W. 1995. Mekong Committee history and lessons for river basin development. *The Geographical Journal* 161(2): 135-148.

Kulshreshtha, S. 1993. *World Water Resources and Regional Vulnerability: Impacts of Future Changes.* RR-93-10. International Institute for Applied Systems Analysis (IIASA), Laxenburg.

LeMarquand, D.G. 1990. International development of the Senegal River. *Water International* 15(4): 223-230.

Magloff, L. 1999. Turning point on the Nile. *Egypt Today*, 1 November: 76-82.

Meybeck, M. 1988. How to establish and use world budgets of riverine materials. In: Lerman, A. & Meybeck, M. (Eds.): *Physical and Chemical Weathering in Geochemical Cycles.* Kluwer, Dordrecht.

Pike, J.G. 1995. Some aspects of irrigation system management in India. *Agricultural Water Management* 27(2): 95-104.

Postel, S. 1992. *Last Oasis. Facing Water Scarcity.* The Worldwatch Environmental Alert Series. W.W. Norton & Company, New York/London.

Postel, S. 1993. Water and agriculture. In: Gleick P.H. (Ed.): *Water in Crisis*. Oxford University Press, New York.

Postel, S.L., Daily, G.C. & Ehrlich, P.R. 1996. Human appropriation of renewable fresh water. *Science* 271(5250): 785-788.

Rabbi, M.F. & Ahmad, E. 1997. Environmental degradation of the southwest region of Bangladesh and need for a barrage on the Ganges. *Proceedings. International Conference on Large-Scale Water Management in Developing Countries:* EI42-EI49. 20-23 October, Kathmandu, Nepal.

Rosegrant, M.W., Paisner, M.S., Mejer, S. & Witcover, J. 2001. Global Food Projections to 2020: Emerging Trends and Alternative Futures. The International Food Policy Research Institute (IFPRI), Washington D.C.

Rosegrant, M.W., Cai, X. & Cline, S.A. 2002. World Water and Food to 2025: Dealing With Scarcity. IFPRI, Washington D.C.

SASTAC 2000. *South Asia—Water for the 21st Century: Vision to Action.* Global Water Partnership (GWP) / South Asia Technical Advisory Committee (SASTAC), Aurangabad.

Shahin, M. 1985. *Hydrology of the Nile Basin.* Elsevier, Amsterdam.

SEI 1997. *Comprehensive Assessment of the Freshwater Resources of the World.* Stockholm Environment Institute (SEI). Stockholm.

Shiklomanov, I.A. 1993. World fresh water resources. In: Gleick, P. (Ed.): *Water in Crisis*. Oxford, New York.

Szestay, K. 1982. River basin development and water management. *Water Quality Bulletin* 7: 152-162.

TDFF, 2005. *The Transboundary Freshwater Dispute Database*. Oregon State University, Department of Geosciences, Corvallis. www.transboundarywaters.orst.edu/ (3.5.2006).

Turan, I. 1993. Turkey and the Middle East: problems and solutions. *Water International* 18(1): 23-29.

UN 1994. *World Population Prospects: the 1994 Revision.* United Nations (UN), New York.

UN 2005. *World Population Prospects: The 2004 Revision Population Database*. UN, New York. http://esa.un.org/unpp (3.5.2006).

UNCHS (United Nations Centre for Human Settlements) 1996. *An Urbanizing World, Global Report on Human Settlements 1996.* Oxford University Press, Hong Kong.

UNESCO 1978. *World Water Balance and Water Resources of the Earth.* United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris.

Upreti, B.C. 1993. *Politics of Himalayan River Waters – an Analysis of the River Water Issues of Nepal, India and Bangladesh.* Nirala, Jaipur.

Vakkilainen, P. & Varis, O. 1999. *Will water be enough, will food be enough?* Technical Documents in Hydrology 24, UNESCO/International Hydrological Programme (IHP), Paris.

World Bank 1997. *World Development Indicators 1997 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 1999. *World Development Indicators 1999 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2001. *World Development Indicators 2001 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2004. *World Development Indicators 2004 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Food Summit 1996. *Food Production: the Critical Role of Water.* World Food Summit, Technical Background Document 7. Food and Agriculture Organization of the United Nations (FAO), Rome.

WRI (World Resources Institute) 1996. *World Resources 1996-97.* Oxford University Press, New York.

Zhang, Q. & Zhang, X., 1995. Water issues and sustainable social development in China. *Water International* 20(3): 122-128.

Zhang, Z., Chen, B., Chen, Z. & Xu, X, 1992. Challenges and opportunities for development of China's water resources in the 21st Century. *Water International* 17(1): 21-27.

3 TRENDS, THEORIES, AND DEVELOPMENT

The theoretical background of a multidisciplinary water project, policy, program or plan is merely a basket full of appropriate approaches for problem solving and their theoretical explanation. One important group of theories used consists of various macroeconomic formulations that are commonly used in theoretical works as well as policy making in relation to development of societies.

This section includes discussions on the trends and tendencies in freshwater management, on most important economic development theories, and their reflections and realizations to the complexity of water, food, poverty, and urbanization. This is done in order to provide a framework consisting of theoretical concepts and up-to-date mainstream views of the international water community, as background material for the various issues scrutinized in the later parts of this book.

In chapter 3.1, the key points endorsed by the Rio Earth Summit and the Dublin Water Conference, both in 1992, as well as those by the Bonn Freshwater Conference of 2001 and the Johannesburg Summit on Sustainable Development of 2002 are used as the starting point. They all reflect the contemporary thinking about ideal ways to solve water related problems. In addition, a selection of other trends and tendencies is provided, and the outlining philosophies of the Global Water Partnership and the CGIAR system are summarized. They offer more perspective and resolution to the issue. The United Nations Millennium Development Goals are also included in the Chapter.

Some of the topics introduced in Chapter 3.1 are discussed more thoroughly in Sections 7 to 10 on policy tools. As has been shown by, e.g., Frederiksen (1996), the complex character of the water issues does hardly allow such far-reaching simplifications as those endorsed by e.g. the Rio and the Dublin Conferences. For instance, the increasing appreciation of the public opinion, even in many developing countries, has forced the World Bank to change its policy in the funding of large-scale water projects. The oppositions towards such large projects as the Sardar Sarovar in the Narmada River in India have been strong enough to set them aside. The question arises, how demand-oriented, public-participation based systems can handle the water and food availability problems that India will be facing in the coming few decades – in a sustainable manner?

Economic development theories are summarized in Chapter 3.2. Starting from Adam Smith's classical economic theory, the summary evolves to neo-classical economy, perhaps the most accepted theoretical framework of today's development practitioners. The other theories include Malthusianism, Ricardo's classical theory of economic stagnation, Marxism, Keynesianism, Rostow's stages of economic growth, vicious circles theory, the balanced vs. unbalanced growth idea, structuralist theories, dependency theory, world-systems theory, the basic needs approach, neo-classical economy, new institutionalism, and UNDP's human development concept.

After that the water sector is discussed in the light of the development theories. Clearly, the theories have been subjected to sharp shifts in popularity, even recently. The realizations and implications to the water sector practice have, as well, been very much variable, and often theory has shown to be very far from practice.

3.1 Paradigms, trends and tendencies in water management

Olli Varis, László Somlyódy and Muhammad Mizanur Rahaman

The water sector has witnessed remarkable changes and developments in recent decades, and is expected to be subject to further changes. The basic issues are the increasing complexity, more attributes and their interactions to be considered, and a growing importance of the consideration of many temporal and spatial scales in parallel.

Water: What should be done?

The number and variety of development trends and tendencies is huge, as the water sector is a composite of very different issues in the nature and the society. Therefore, only some most characteristic points can be outlined in this context.

The water sector reflects very much the common tendencies and trends that prevail throughout societies. John Naisbitt's (1984) famous book of *Megatrends* summarizes the major trends (Table 3.1a) in a way, which still appears valid to a high degree, even though it was written two decades ago.

Table 3.1a
Megatrends by Naisbitt (1984)

From	*To*
Industrial society	Information society
Forced technology	High tech/high touch
National economy	World economy
Short term	Long term
Centralization	Decentralization
Institutional help	Self-help
Representative democracy	Participatory democracy
Hierarchies	Networking
North	South
Either/or	Multiple option

Another important cornerstone of the 1980s for the present-day trends is the gradual crystallization of the idea of *sustainable development* of human societies. Sustainability has been defined in a myriad of ways over the years, depending on the specific goal of the definition. Yet, the good old one by the Bruntland Commission (WCED 1987) is perhaps still the most used. It says that *natural resources should be managed so that the present needs can be faced, without compromising the ability of future generations to meet their own needs*.

The most quoted document from the 1990s in this respect was is obviously the resolution of the UN International Conference on Water and Environment that was held in Dublin, Ireland in 1992 as the main preparatory water event for the Earth Summit in Rio de Janeiro in the same year. The well-known Dublin Principles are:

- Fresh water is a finite, vulnerable and essential resource, which should be managed in an integrated manner.
- Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
- Women play a central role in the provision, management and safeguarding of water.
- Water has an economic value and should be recognised as an economic good, taking into account affordability and equity criteria.

The first point constitutes the need for integrated management and holistic comprehension. With increasing complexity and interaction in many ways: integration in many meanings is needed. This includes integration over water quality and quantity issues, over institutions, over sectors and sub-sectors, over various temporal and spatial scales, over water and land management, and many more (cf. Biswas 1976, Falkenmark and Lindh 1976, Kinnersley 1988, El-Ashry 1993, Serageldin 1995, Somlyódy 1995, GWP 2000, Somlyódy et al. 2001). The issue of Integrated Water Resources Management is elaborated further below.

The second and third points address the institutional and human issues. The decisions should be made at the lowest level possible, stakeholders and individuals need to be activated and supported to participate in planning and decision making, the gender issue should be put high on the agenda, and the water problems must be approached from the demand side more than done previously. Investments on people and transfer of experience are needed in the first place.

The last point emphasizes the importance of considering water as an economic good, in addition to its important social function. Accordingly, 'proper pricing' of water in order to allow efficiency, rationality, and cost recovery have been among the hot topics in the recent years. Also, along with the global, political and economic trends, privatization and public/private partnerships have been emphasized.

Integrated Water Resources Management

Integrated Water Resources Management (IWRM) is a concept, which is included in most contemporary water agendas, disregarding regardless of the purpose and scale of the task. Accordingly, the concept is interpreted in many ways and a number of definitions exist. Most commonly, the holistic and coordinated management of all the various aspects and uses related to water is emphasized. The most used definition of IWRM these days is the one by the Global Water Partnership (GWP 2000):

IWRM is a process which promotes

- the co-ordinated development and management
- of water, land and related resources,
- in order to maximize the resultant economic and social welfare
- in an equitable manner
- without comprising the sustainability of vital ecosystems.

The concept is nothing but new. However, it has become increasingly pronounced during the past one or two decades, obviously as a response to the growingly recognized problems of a too fragmented management of waters.

As was highlighted above, integration was already the first emphasis in the Dublin Conference in 1992. The first Dublin principle clearly articulates the need to IWRM. However, these principles were not influential enough to bring water high on the agenda in Rio. In contrary, the water community largely shares the view that water did not receive the attention it deserves in the discourse of sustainable development.

Gradually the water profession has raised its head in the latter part of the decade. The most visible undertakings include the creation of the World Water Council and the Global Water Partnership (Box 3.1a), as well as the organization of several major international events around water and development issues, such as the World Water Forums and Stockholm Water Symposia.

Box 3.1a

Global Water Partnership

One of the many actions taken towards the directions outlined, e.g., in the Rio and Dublin Conferences, and towards integration in particular is the UNDP and World Bank initiative for global water partnership from 1995. It includes four main features:

- Integrated programs at the national and international levels.
- Capacity building involving policies, institutions, and people.
- Sustainable investments are supported for innovative, integrated approaches.
- Global orientation to learn across frontiers.

As the Dublin Conference prepared a water agenda for Rio, the Bonn Freshwater Conference of December 2001 did the same for the Johannesburg Summit. IWRM was also on agenda, as condensed in the so-called five Bonn Keys:

- The first key is to meet the water security needs of the poor
- Decentralization is key. The local level is where national policy meets community needs
- The key to better water outreach is new partnership
- IWRM is needed to bring all water users to the information sharing and decision making tables
- The essential keys are stronger, better performing governance arrangements

The Johannesburg Summit took the water issue as one of its ten focal areas, and thus many think that water is far better taken into consideration as was done in Rio. The Framework for Action of Johannesburg contains many interesting recommendations with respect to water. Some of the most important ones include the following ones:

- Developing IWRM and water efficiency plan by 2005 for all major river basins of the world
- Developing and implementing national/regional strategies, plans and programs with regard to IWRM

- Improving efficiency of water uses
- Facilitating public-private partnership
- Developing gender sensitive policies and programs
- Involving stakeholders specially women in decision making, management and implementation processes

The first two items on the above list are very interesting with respect to IWRM. They define clear operational targets to the implementation of IWRM both in the river basin context as well as on jurisdictional level. How realistic these targets are is another question, but the important thing is that IWRM is very high on the Johannesburg agenda.

The summary of the EU Water Framework Directive in Box 3.1b is an example of many actions taken towards these directions.

UN Millennium Development Goals

Obviously the most "official" set of targets and principles for development are the United Nations Millennium Development Goals (Table 3.1b). All the 191 UN member countries have pledged to meet these goals by the year 2015. All the forty-one study region countries are members of the UN.

Integration: the horizontal dimension

Let us elaborate the integration issue a bit more. There are many ways to work towards the sustainable management of water. However, none of the sectors – e.g., water supply, hydropower, irrigation, industry – can do it alone. All pieces of the puzzle should fit together. The system components should be more or less in balance, including different sectors of service, political, economic and financial realities, social issues, human resources, institutions and operations management such as pricing. The constraints due to the simplest things, water and food, and the importance of primary education should not be forgotten. As the driving forces of integrated management, these are seen unavoidable, in order to meet the very real challenges directed to them by global development.

The integration concept includes integration over different sectors of urban and rural systems as well. One challenge is to foster, e.g., the water sector, the energy sector and the telecommunications sector to provide solutions that work together and with the rest of the society in large urban centers of developing countries. Telecommunications, for instance, can benefit the water sector in many ways.

Some examples of this potential include:

- increasing public awareness, education, decentralization possibilities,
- better resource allocation in time and space (better forecasts, data sharing etc.),
- sharing of expertise,
- transparency of policies, and
- better plans and management schemes.

Yet, these do not come automatically, nor often very easily. The connections of water and energy sectors are very tight, e.g., through hydropower, water convey systems, energy supply, and water and wastewater treatment processes.

In urban water infrastructure development, water and sanitation should be seen as one entity and they should be developed together (cf. Chapter 10.3). This is not often the case. Without proper sanitation, most of the positive effects on public health of water supply will be drained off. Moreover, water and sanitation projects should be accompanied with education, public awareness and community involvement. These issues are also crucial when increasing the efficiency of water supply systems.

Integration: the vertical dimension

Another challenging scheme is to further develop solutions that allow the integration of the top-down (governmental) and bottom-up (localized markets along with public awareness) implementation and control of water. The world is too complex to allow the acceptance of only one direction.

With increasing temporal and spatial dimension of the planning process, more integration to other sectors is needed (Figure 3.1c). At the contingency level (e.g. international commitments and regional cooperation, Chapter 8.3), all sectors are thoroughly interwoven. These overlaps gradually fade in importance when going through strategic planning (policies, plans, programs), tactical level (annual water allocation etc.) to operational level (plant or reservoir operation, or short term remedy, etc.). The growing recognition that the different aspects of water management form a continuum (e.g. Serageldin 1994, 1995) appears to reveal that the concern of water is no longer only on the operational or tactical issues as has been typical to in the past.

The need for generalistic and holistic views and comprehension are necessary facilitators of integrated

Box 3.1b

The European Union Water Framework Directive

Source: Rahaman et al. (2004)

The cornerstone of the EU Water Framework Directive (EU WFD) was the 1996 request of the European Parliament's Environment Committee and the Council of Environmental Ministers to the European Commission: *"Whilst EU actions such as the Drinking Water Directive and the Urban Waste Water Directive can duly be considered milestones, European Water Policy had to address problems in a coherent way. This is why the new European Water Policy was developed in an open consultation process involving all interested parties."* (CEC 2000).

All parties agreed on the need for a single piece of framework legislation to resolve these problems. In response to this, the Commission presented a proposal for the Directive with the following key aims (CEC 2000):

(1) Expanding the *scope of water protection to all waters*, surface waters and ground water. (2) Achieving *"good status"* for all waters by a set deadline. (3) Water management based on *river basins*. (4) "*Combined approach*" of emission limit values and quality standards. (5) Getting the right *prices* of water. (6) Getting the *citizens involved* more closely. (7) Streamlining *legislation*.

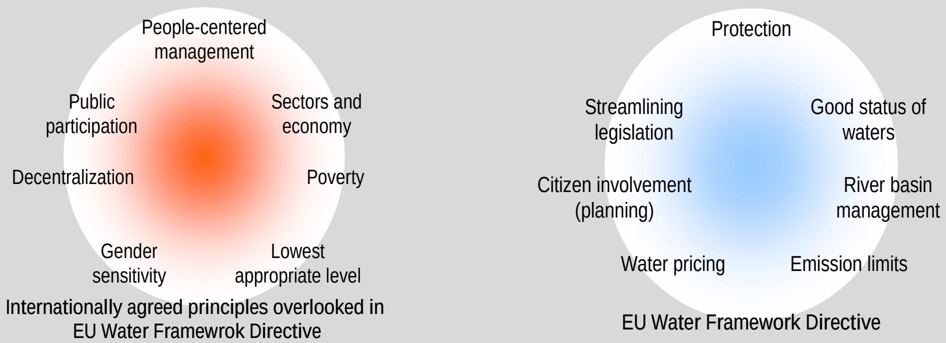
On 23rd October 2000, the EU WFD was adopted.

Does the EU follow the international recommendations? The outcome of four major international events regarding IWRM and the EU WFD were compared by Rahaman et al. (2004). Some notable mismatches were found between the principles of IWRM and the Directive. In Dublin, Rio, Bonn, Johannesburg as well as in the Water Forums, several EU countries played a leading role. EU countries also follow the outcome of these conferences when they decide upon aid for developing countries. But when comparing the principles of IWRM and EU WFD several mismatches can be found (Figure 3.1b). Rahaman et al. (2004) grouped them under seven issues, which are:

1. Gender awareness is omitted. No guideline for women's role in the provision, management and safeguarding of water.
2. Decentralization is neglected. No guideline to encourage and regulate the private sector.
3. No guideline to ensure co-ordination between different sectors.
4. EU water framework directive does not set-up clear guidelines for active participation of local people and water users in the management of water.
5. No focus on poverty.
6. EU water framework directive promotes technology-oriented management in case of drinking water and sanitation and ensuring good quality of water. But the better management calls for integration of technology-oriented management with human oriented management.
7. No standard guideline to develop responsibilities to the lowest appropriate level.

Figure 3.1b

The seven mismatches of internationally agreed principles and the EU Water Framework Directive



Consequently the question arises whether the outcome of different international conferences regarding IWRM are not so effective and efficient for better water management or whether there is a requirement for different principles of IWRM for developing countries and developed countries? Why the EU adopts different principles for their own and why they are following different principles when acting as a donor in developing countries?

Table 3.1b
The United Nations Millennium Development Goals

Eradicate extreme poverty and hunger	• Reduce by half the proportion of people living on less than a dollar a day • Reduce by half the proportion of people who suffer from hunger
Achieve universal primary education	• Ensure that all boys and girls complete a full course of primary schooling
Promote gender equality and empower women	• Eliminate gender disparity in primary and secondary education preferably by 2005, and at all levels by 2015
Reduce child mortality	• Reduce by two thirds the mortality rate among children under five
Improve maternal health	• Reduce by three quarters the maternal mortality ratio
Combat HIV/AIDS, malaria and other diseases	• Halt and begin to reverse the spread of HIV/AIDS • Halt and begin to reverse the incidence of malaria and other major diseases
Ensure environmental sustainability	• Integrate the principles of sustainable development into country policies and programs; reverse loss of environmental resources • Reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation • Achieve significant improvement in lives of at least 100 million slum dwellers, by 2020
Develop a global partnership for development	• Develop further an open trading and financial system that is rule-based, predictable and non-discriminatory. Includes a commitment to good governance, development and poverty reduction—nationally and internationally • Address the least developed countries' special needs. This includes tariff- and quota-free access for their exports; enhanced debt relief for heavily indebted poor countries; cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction • Address the special needs of landlocked and small island developing States • Deal comprehensively with developing countries' debt problems through national and international measures to make debt sustainable in the long term • In cooperation with the developing countries, develop decent and productive work for youth • In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries • In cooperation with the private sector, make available the benefits of new technologies—especially information and communications technologies

management. The aspects would possibly be best met through taking these into account at University education more than at present. These issues are discussed more profoundly in Chapter 7.2.

Change: From what to what?

An illustrative example of the prevailing trends is from the CGIAR's (Consultative Group on International Agricultural Research) mandate of 1995:

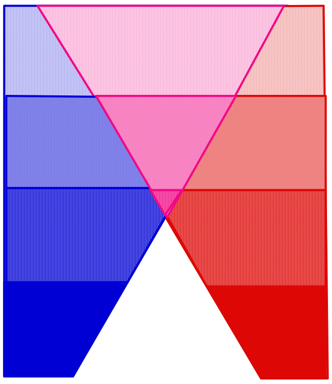
- from supply-oriented to demand-oriented,
- from technology-driven to problem-driven,
- from product-focused to methodology-focused,
- from the one-dimensional diffusion of technology to the management and coordination of knowledge systems, and
- from general to more specific activities.

They all should address sustainable use of natural resources.

The next example of trends and tendencies comes from the analysis of Maxwell (1996) on changes in thinking about food security. He uses the difficult and somewhat ambiguous terms modern and post-modern in his classification (Table 3.1c).

As the last example, Somlyódy (1995) and Somlyódy et al. (2001) have collected and broadly discussed the trends and challenges of freshwater management. A summary of the issues is given in Table 3.1d.

Figure 3.1c
Integration: the vertical dimension
With increasing scales, the issues become more integrated (Varis 1998).



Water management paradigms

In western countries, there exist some generally or widely accepted principles and paradigms in the exploitation and management of natural resources such as water. They are either strictly defined in the legislation or are obeyed as ethically and morally guiding principles. Novotny and Olem (1994) and Novotny and Somlyódy (1995) list the following water pollution control imperatives, which constitute a good example of such paradigms. Here the explanations have been condensed remarkably from the original ones.

- *Equity:* all stakeholders, polluters, etc. should be considered equally.
- *Sustainable development:* natural resources should be managed so that the present needs can be faced, without compromising the ability of future generations to meet their own needs.
- *No irreversible impacts* should be caused to the nature and the environment.
- *Regulation and statutes:* The legislation should be such that it protects resources and the quality of the environment in cases in which the market mechanisms fail in doing this.
- *Acceptance:* There must be concurrence on the part of all people and stakeholders to be regulated that they will obey the resources.
- *Discharger pays:* The polluter is primarily responsible of abatement and remediation costs.
- *Integrated approach:* The problems must be solved in an integrated manner.
- *Pollution prevention:* Potential problems should be anticipated in environmental policies, and reaction should be taken before problems occur.

In addition, the application of the *best available technology* approach is widely accepted. One of the above paradigms, sustainable development is discussed below in more detail.

Table 3.1c
Modern and post-modern development thinking (modified from Maxwell 1996)

	Modern	Post-modern
Underlying reality	Simple, uniform	Complex, diverse
Objectives	Growth Preoccupation with macro	Development Preoccupation with micro
Research approach	Measure Survey Reductionist Deduction Abstract models Aggregate	Listen Participatory rural appraisal Holistic Induction Complex reality Disaggregate
Planning approach	Plan Model Top-down Centralize	Enable Interact Bottom-up Decentralize
Implementation	Blue-print Role culture Standardization	Process Task culture Flexibility, innovation

Table 3.1d

Trends in freshwater management

Modified from Somlyódy (1995) and Somlyódy et al. (2001).

Past	***Present*** ***Future (expected and/or desired*)***
(1) General	
Local problems	Increasing scale
Fast response, reversibility, curative actions	Delayed responses, irreversibility, preventive actions
Limited number of pollutants	Multiple, sophisticated interacting pollutants
Point sources	Diffuse sources
Single media (water)	Multi media (water, soil, air)
Static, deterministic, foreseeable	Dynamic, stochastic, uncertain
Regional independence	Importance of global interdependency
(2) Control type	
"End of the pipe"	Source control, closing material cycles, land use management, concern on large scale projects*
Technical	Non-technical elements*
Discharge standard - rigid	Use attainability - flexible
(3) Infrastructure and treatment systems	
"Traditional technology"	Special treatment methods (biol-chem treatment, high-tech processes, upgrading, appropriate technology, natural treatment, small-scale treatment). New technologies
Landfilling of solid wastes	Increased reuse and recycling*
Large scale control and exploitation	Regional and small scale development, management and conservation. Flood plains, wetlands, and other ecosystems as valuable resources.
Massive, capital intensive urban infrastructure	Localized, small scale, creative infrastructure development*
(4) Monitoring	
Local measurements	Networks, remote sensing, continuous measurements
Conventional parameters	Special parameters (micropollutants, eco-toxicology, biomonitoring, etc.)
Monitoring of water	Integration of effluent and ambient monitoring and aquatic ecosystem monitoring
Poor data availability	Improved availability (data bases, digital maps, telecommunication), integrated information systems
Hands off “my” data policies	Open information flow
(5) Modeling	
Individual issues (processes, control, operations, planning, etc.)	Integration (model library, DSS, GIS, etc.)
Limited, numerically based results	Scenario based and visual. Use of multi-media
Use by experts	Use in administration, meetings, etc.
One correct paradigm - single discipline	Many paradigms known & accepted within/between disciplines
(6) Planning and project evaluation	
Poor/narrow definition of objectives	Clear goals and objectives*
Short-term view	Long-term view*
Cost evaluation	EIA, risk & multiobjective evaluation, social & political impacts*
Little concern on failures and adjustment needs	The future is never certain *
Positive and negative impacts separately	Positive and negative impacts together
(7) Science and engineering	
Science does not drive actions	"Science for Action" and combination of broad, emerging scientific concepts with engineering*
Problem isolation and engineering solutions	Improved planning*
Interdisciplinary gaps and barriers	Integration of quantity, quality, hydrology, economics, politics, social science and management*
Expert produces the optimal solution	Expert is a facilitator for communication and learning
(8) Legislation, institutions and development	
General rules and rigidity	Specific rules and flexibility*
Undivided implementation	Process view*
Little enforcement	Improved enforcement
Command and control	Polluter/user pays, improved policy instruments
Confusing institutional settings	Clearer structures and responsibilities *
Decisions by politicians and administration	Public awareness & participation, NGOs, enhanced communication (scientists, planners, community, government, etc.)*
National policies	International policies*

Sustainable development

By definition, sustainability is an inter-generation concept; but till 2025, just one generation ahead, the world population will grow with over 2.5 billion people, 80% being urban growth. It is clear, that there is no way back to a society, which could produce its own energy from renewable sources, recycle all the waste produced, and would not violate any other basics of the earth's ecosystem. Indeed, the development is towards the opposite direction with a very fast rate. The problems that the next generation – or the University students of today – must solve are huge.

Although water has been acknowledged to have a crucial role in sustainable development, the World Commission on Environment and Development (WCED) report overlooked it (Varis and Somlyódy 1997, Somlyódy et al. 2001). In spite of it, the impact on thinking of water professionals has been surprisingly large. The reasons are manifold:

- *It did not talk about environment* (even the wording was not used), but about development in general, which is by definition internal to economy (also from the water viewpoint).

- It was launched perfectly to international audience, but contained *a non-professional flavor*.

- *The basic message was easy to understand*. By now many professionals including water engineers were 'fertilized' by the idea of sustainable development and the 'puzzle' how to realize it.

A puzzle since specific *operational definitions* are still non-existent and there are doubts whether such definitions will ever exist, or is the concept doomed to remain rather as a guiding principle (cf. Peet 1992, Somlyódy 1995). Therefore, it is hard to judge whether a strategy or a development path is sustainable or not. The undefined abuse of sustainability is a risk: too many solutions are identified sustainable without real grounds (cf. Varis and Somlyódy 1997).

Sustainability has an economic, social, and ecological dimension. In terms of economy, the growth and efficiency in resource use is needed. The social dimension covers issues such as equitable distribution of wealth and poverty eradication. Ecological mandates are many, but they can be summarized in the requirement of not disturbing the basic functions of ecosystems, so as not to violate the earth's life-supporting system. Therefore, protection of ecosystems is increasingly required due to the expanding pressures to biodiversity, material flows, etc. Pressures are due to population growth, urbanization, climatic variations, consumption patterns, and many more issues.

There exists a severe market imperfection (market failure) regarding the environment:

- Environment is *a negative externality*: polluters do not pay, they impose the costs to the society, and to further generations.

- Environmental resources tend to have *a common property characteristic* (property is shared). Only with private goods, property rights are universally accepted and clearly defined. E.g. scatter settlements constructed illegally on common grounds, have no clear property rights, and consequently, there exist no incentives to work for development. Other examples are many, including the fact that next to almost all rivers and groundwater aquifers, understood as being commonly owned, leading easily to the tendency of resource over-use.

- *Irreversibility* of environmental systems: overgrazing, deforestation, loss of biodiversity and groundwater mining are among many examples.

Particularly in developing countries population, agriculture, poverty, and environment are closely interconnected. New land, food, water, and energy are needed, leading to deforestation and other environmental degradation. Technical and economic advancements are often harmful to the environment, but also poverty leads to degradation. These both should be combated by appropriate policy tools (Jalal 1993; cf. Figure 3.3a).

Economics-related policy alternatives include:

- *Pricing policies:* correct resource prices limit the consumption and overexploitation of the resource. Irrigation water is usually under-priced and subsidized. This leads to over-use. The same applies to fertilizers, pesticides, household water, etc., in many countries. There is a confrontation with the frequently proposed requirement of the social function of these issues used as an argument for subsidies, and the tendency of overuse of the resource in such situations (cf. Box 3.3a).

- *Green taxes:* reduce utilization of resources that cause environmental degradation. The approach is applied extensively, but it tends not to be politically easy.

- *Community development.* Particularly efficient in rural areas, but also in urban squatters. In global scale, cattle are probably the most important issue here. Overgrazing is very difficult to handle without community involvement.

- *Clear property rights* are needed, but they should also be *equitable*. In Latin America, clear property rights typically exist, but they are disadvantageous to the majority of people. Equitable distribution of land is essential.

- Better *status of women*, and *social division of labor*.

The UNCED Rio Incentive on Environment and Development of 1992 pointed out the following issues:

- *Sustainable development*.

- *A just world*. People from all nations benefit from the growth of economic output.

- *Urban development* that is habitable.

- *Efficient utilization of resources*. High debts lead to environmental degradation. Try to extend national resource use. Cancellation of external debts should be considered.

Much time has passed since Rio, but a general feeling tends to be that we are not moving towards these goals fast enough, and particularly towards sustainable development.

One of the key points is that the implementation of any sustainable policy should be affordable. The fastest urbanization rates are in areas where there are very limited possibilities to plan systems within a longer time perspective.

In low-income economies, is it realistic or even justified to say that sustainability should be an issue? Definitely not always realistic but still justified. It is there where the highest number of people is touched.

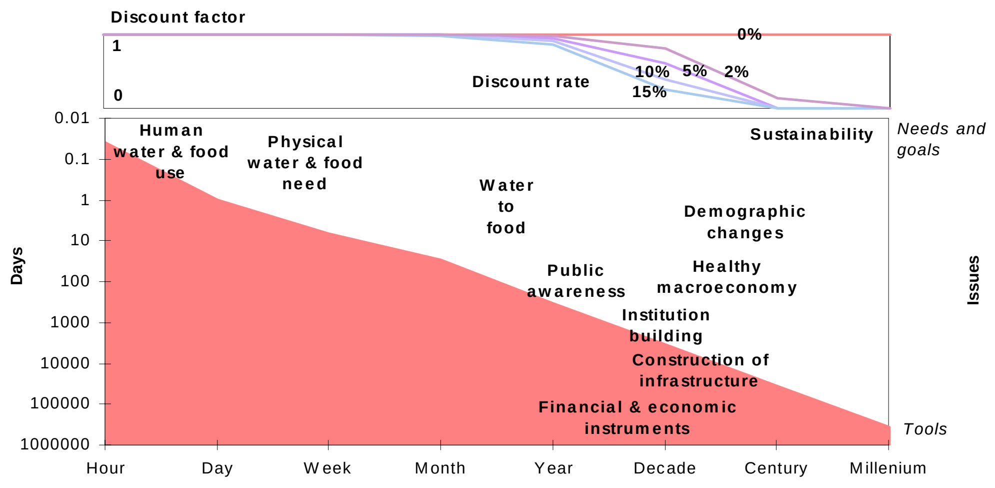
Whereas the governments, cities, and other social units will be heavily involved to provide services to meet the immediate needs – a task for which many technical, economic, financial, and institutional solutions exist but may not be easily realizable due to various constraints including time (Figure 3.1d). It appears that there is an urgent need of the international community to react with action plans, guidelines, and measures to combat excess and rapid congestion of people to urban areas with no prerequisites to proper services, and unsustainable pathways to urban development.

Urban models in which material cycles are closed – e.g., by mixing agricultural areas to congested areas – are needed (cf. Chapter 6.1). Technology options with low capital costs are crucial. Nothing can compare in importance to pollution prevention actions; wastes should be returned to the production cycle as much as possible. These all are heavy requirements which should come true. Without them we just fall into fruitless, unconstructive skepticism.

Figure 3.1d

Sustainability vs. financial rationality

Sustainability is a long term concept, that stays often in conflict with the immediate needs and financial realities. The figure shows that a financially rational solution does not include the sustainability criteria, and many crucial tools for balanced development are discounted away. Solutions that meet these both ends are needed, but the more short the economy is of resources, control, and public awareness, the less sophisticated tools can be used, and the more focus is in the immediate needs (Varis and Somlyódy 1997).



3.2 Development theories

Olli Varis

Public policy-making by governments, international agencies, donors, etc., is a product of a mixture of economic, political, ideological, cultural, religious, and mythological ideas, patterns, concepts, and models. Here, the most important development theories are summarized. There is a tendency that one theory becomes fashionable in a certain time and place, and its limitations as well as the wisdom in the others are simply forgotten.

The concept of development

Although development is a highly situation-specific, subjective, ambiguous, and widely argued concept, some typical features can be detected and used in a comparative sense. The developed countries (DCs) or the north, when compared to less developed countries (LDCs), developing countries, the Third World, or the south, typically have higher levels of income, capital stock, education, technological capability, infrastructure, service and industrial base, and income equality. The political and economic institutions in DCs are typically more democratic, stable, and effective.

Success in all them is understood as development. It is common that a country that shows advance in some of these directions also develops in the others. In economic terms, development seems to be unavoidably linked to savings and investment. Development process needs human resources and capacity, both allowing the mobilization and efficient exploitation of resources. An institutional set-up is crucial.

According to Ehrlich (1990) and Esfahani (1996), *a country can be called developed, when it has acquired an institutional setup that allows it to mobilize resources and carry out changes necessary to systematically and effectively deal with problems that the country is facing*.

The concept of development is jeopardized too often with the use of highly reduced indicators such as GNI, purchasing power parity-adjusted GDP, Human Development Index, etc. This is because simple, operational concepts are needed in policy-making and comparisons. There is a danger that too simple indices are being used as indicators of such a complex issue as the development of a country (Chapter 4.5).

Time passes, ideas come and go

Even the recent history has witnessed sharp ideological and political changes in many countries the world throughout. The 1990s have seen the collapse of most former communist countries and certain dominance shift from USA and its Western allies to Japan and its Asian partners. The consequent global economic restructuring process has yielded such trends as liberalization of trade, increased privatization, decreasing public sector, and growth of the informal sector.

There are many positive development signs, although the instability of the global economic system has been felt very strongly by economically liberalized countries such as Indonesia, Brazil, Thailand, and many more. These trends have reflected in the popularity and development of theories as outlined below.

The policies of international organizations tend to come along with such transitions. Those changes have also been reflected in national policies and in the policies of foreign development assistance donor organizations, concerning the exploitation of natural resources. It would be overly courageous to suppose that such changes would not take place in the coming few decades, and therefore, within the framework of this book, it is useful to present the key theoretical concepts behind development thinking and consequent planning and policy making.

The theories are only a narrow projection of societies and their development. Still, they offer highly useful patterns of thinking and conception of macro-scale phenomena and actions taking place, even in water resources development. For instance, the planning-optimistic era (top-down) has been largely replaced by an emphasis on bottom-up approaches stemming from public awareness, transferring decisions to the lowest institutional level possible, etc., as was summarized in Chapter 3.1. The strong government paradigm is, yet, already evolving (Stiglitz 1998), since tendencies such as these appear to evolve like a pendulum, moving from one end to the other.

The most important pre-World War II development theories can be summarized as follows. More comprehensive analyses have been presented by, e.g., Ward et al. (1991), Drakakis-Smith (1992), Nafziger (1997), and Todaro (1997).

The classical economy

The classical economy (Adam Smith 1723-1790) has the following cornerstone: The only real measure of value is labor, and the division of labor makes the production more efficient. In contrast to *mercantilism,* which offered protectionism, markets should be allowed to function freely.

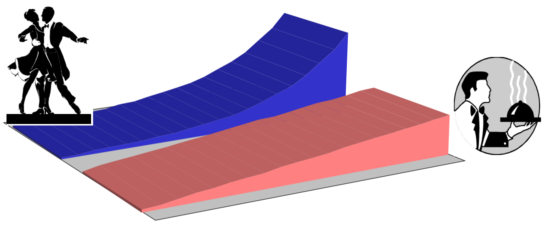
The government should provide the legal framework: *law and order*. Other interventions should be minimal. Only government investments to infrastructure such as canals and roads were advocated. The classical views have been challenged by, a.o., the theories described below.

The Malthusian view

According to Thomas Malthus (1766-1834), food production is bound to grow arithmetically while population growth is geometric. The land becomes a limiting resource, and marginal returns will be diminishing. The population size would be controlled by famines, diseases, wars, etc. (Figure 3.2a).

The major criticism against Malthusian views have been due to the ignorance of technological progress, and to the underestimated impact of education, industrialization, economic modernization, urbanization, among other issues, that have been observed to reduce fertility rates in modern societies, yielding the so-called demographic transition (see Figure 7.1a).

Figure 3.2a
Malthusianism
Population growth is geometric, whereas the growth in food production is arithmetic.



The theory of economic stagnation

This classical theory by Ricardo (1772-1823) is pessimistic about the possibility of economic growth. Availability of arable land limits growth (in this respect in similar terms to Malthus). Diminishing returns – marginal productivity decreases when population grows – would yield a decreasing standard of living.

Technological progress could only temporarily check diminishing returns, and capital formation was seen the only way of postponing or avoiding them. The theory has been criticized above all of the underestimation of the impact of technological advance.

Marxism

The historical materialism of Karl Marx (1818-1883) is based on the dialectic view of productive forces and production relations. The following development pathway was proposed: Societies develop from *primitive communism* consecutively through s*lavery*, *feudalism* and *capitalism* to *socialism* and finally to *communism.*

The small business people including farmers will lose the control over their workplaces due to the growth of monopolies. The wage level is controlled by the reserve army of the unemployed. The proletariat revolts, takes over the control of capital, and establishes socialism. While entering to communism, the state withers away.

According to Marx, *water and air as basic commodities should never be subjected to economic charge.* They should be always freely available to anybody. This argument is still used frequently, e.g., against the statements of the Dublin Principles and the Rio Earth Summit statements (cf. Chapter 3.1), according to which water should be considered as a scarce resource with both economic and social value. Marxists are not the only opponents of the tendency that water should also have an economic value.

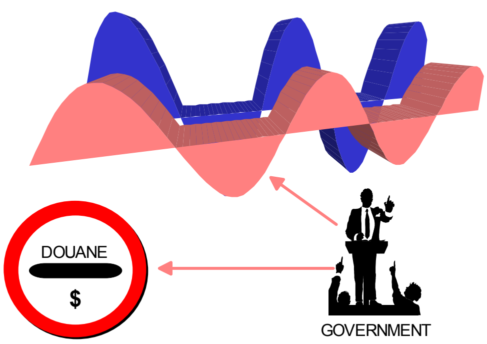
The major critics have been directed towards the development pathway, which has not been withstanding with observed realities, as well as towards the exaggeration of the contrasting interests of different classes of the society. This theory was highly popular in many parts of the world until 1980s, but it suddenly became disliked in the shift of the decade to 1990s, by the collapse of the USSR.

The Keynesian view

In the theory of J.M. Keynes (1883-1946), prevention of economical crises was proposed by adjustment of demand through government control of credit and currency (Figure 3.2b). The employment in a country increases with growing GNP. Unemployment should be diminished by either private consumption and investment, or through government spending. The latter applies particularly to periods of economic recession.

The strongly controlling role of the government has been criticized, along with the observation that the growth of employment is likely to be slower than the output growth. Therefore, there exists a trade-off between output and employment, particularly from the public investment standpoint. Furthermore, Keynesianism has been criticized as being unsuitable to developing countries due to their limited ability to interventions and economic control, and to the observation that the urban pull forces are often remarkably enhanced.

Figure 3.2b
Keynesianism
The government has a strong role in controlling credit and currency, and it also stabilizes business cycles with public savings and investments.



After the World War II, there has been a rich input to development theories. According to Nafziger (1997) and Todaro (1997), the key contributions have been the following.

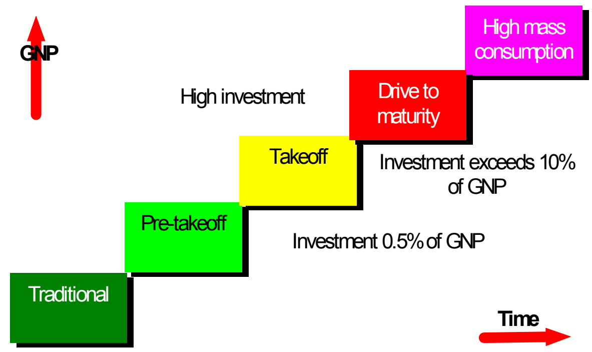
The stages of economic growth

Rostow's approach from the early 1960s proposed that the development of societies follow the subsequent stages:

- *A traditional society.* In Europe and North America, this situation prevailed in the pre-18th Century.
- *Preconditions to take-off*: improved infrastructure, revolution in agriculture, and expansion of foreign trade.
- *Takeoff*: a decisive expansion transforming country's economy and society with indicators such as rapid growth in the investment rate and at least one manufacturing sector, plus a speedy development of the political, social and institutional framework.
- *The drive to maturity:* regular, self-sustained growth period with predominantly urban labor force.
- *The age of high mass consumption.*

Rostow's model is also known as the linear growth theory (Drakakis-Smith 1992). It has been criticized of being imprecisely defined and hard to test in practice, but nevertheless, it has been a widely accepted theory, especially in the 1960s in the U.S. and many international agencies (Figure 3.2c).

Figure 3.2c
Rostow's stages of growth

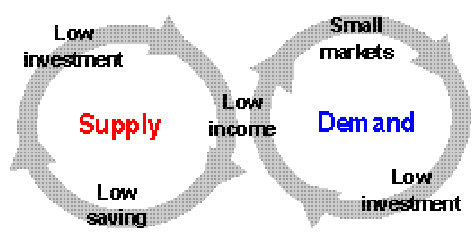


Vicious circles theory

The poverty is bound to various vicious circles, which perpetuate themselves (Figure 3.2d, see also Varis 1999). In the supply side of an economy, low incomes lead to a low savings rate, hence to low investment, which means low income. In the demand side, the circle from low incomes go to small markets, to low level of investment, and back to low incomes.

Therefore, it is very difficult for poor economies to become richer. This theory has been challenged by the observation that many low-income and middle-low-income economies have been able to show high growth rates that have sustained for years.

Figure 3.2d
The vicious circles theory



Balanced vs. unbalanced growth

A big (external) push of investments is a prerequisite to balanced growth, and the only way to break the vicious circles of poverty. Factors such as investment and infrastructure do not grow steadily, but sizable jumps are needed. Infrastructure is seen as a social capital that reduces costs to other industries. Economies of large scale are emphasized: large units have smaller unit costs, also in infrastructure including water sector.

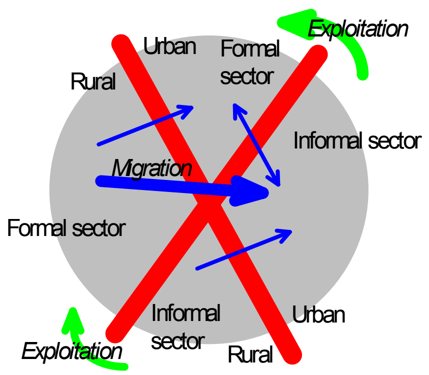
Hirschman's unbalanced growth thesis puts emphasis on the forward and backward linkages within an economy: public policy should favor the sectors that have high backward-forward linkages. Manufacturing has typically high, and agriculture low linkages.

However, critics claim that developing countries should not neglect agricultural production. Also the problems of high centralization and large units are noteworthy, and the experience from, e.g., former centrally planned economies has been discouraging in this respect.

Structuralist theories

The dualist theory of economic development is an umbrella term that covers concepts such as *sector theory, marginalization theory;* and *structuralist approach* (Drakakis-Smith 1992, Nafziger 1997, Todaro 1997). A society can be subdivided into a traditional and a modern sector (Figure 3.2e). The former is characterized by agriculture, handicraft manufacturing, etc., while the latter consists of industrial manufacturing, modernized agricultural industry, etc.

Figure 3.2e
Dualist view of a society



In the traditional sector, there is usually surplus labor with marginal productivity of labor close to zero. The modern sector can provide increasing capital intensity and high marginal productivity.

Today, the division is often made between informal and formal sectors (e.g. de Soto 1989), and the former is no longer considered as unproductive: in many urban centers in the third world, the informal sector may contribute up to 90% of all economic activity. Individuals are not often able to smoothly adapt to changes; within urbanization, falling into social and economic marginals such as squatters that are within the informal economy.

These theories have increasingly been incorporated into development strategies since the 1980s on, although the dualistic nature of societies does not always show such sharply distinguishable patterns as the theory suggests.

Dependency theory

In the global scale, one can distinguish areas of development and underdevelopment. They can be called center (or *core*) and *periphery*, which are interconnected and interdependent.

Typically, the periphery is more dependent than the core, in terms of financial, technological, managerial and entrepreneurial dependency, and is exploited by the core. Urban centers in the periphery diffuse underdevelopment rather than development. Development and underdevelopment would be two sides of the same coin; a zero-sum game. This results in an international division of labor.

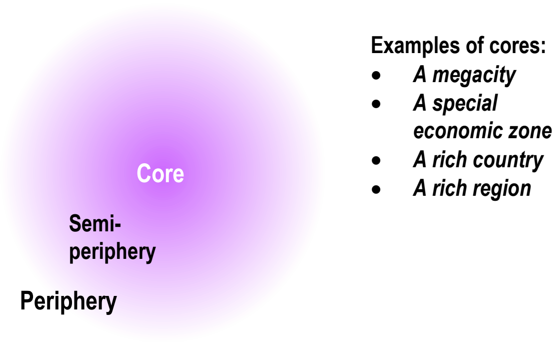
This approach was popular in the 1960s and 70s. Extremists claimed that the only way for a developing country for independence would be to withdraw from the world capitalist system, or at least to nationalize the basic industries.

This approach has faced severe problems due to empirical evidence: Huge practical problems have emerged in establishing a development strategy along these lines. Some developing countries (periphery) have developed, but not along these lines. The key role of capacity has not been acknowledged by the dependency theory.

World-systems theory

This approach can be seen as the successor of the dependency theory in many ways. It has relaxed the contrasts between the core and the periphery, and proposes intermediate, semi-peripheral concepts as well. These clusters are global, but local counterparts – such as urban centers – can be seen as well (Figure 3.2f). The division of production systems lacks the Marxistic flavor of the dependency theory: there is a single mode of production, capitalism, which is superimposed over varied forms of labor control. Global accumulation theory favors the core. The semi-peripheral countries (newly industrialized countries, former centrally planned economies) are often competitors of the core. The theory has gained popularity since the 1980s, but critics pay attention to its abstractness and low operationality.

Figure 3.2f
World-systems theory



The basic needs approach

Assuming that the development will in long term diffuse wealth throughout the societies, in short term, the basic needs (nutrition, housing, health, income) of the poor should be met. This is irrespective of the political system in question, as well as whether the income and services originate from the formal or informal sectors. Statistical indices are used in development planning to fulfill minimum acceptable standards for the poorest households.

In the last two decades, the approach has been very popular, but the critical voices point to the problems of non-productive investments, and that the aid is cosmetic and very short term, not addressing the basic inequalities in the society.

Neo-classical approach

The 1980s saw a counter-revolution of the straightforward ideas of the classical economy described above. This has been largely due to practical reasons; issues such as sound money, free markets, predictable property rights, and small governments, have shown efficiency in development, especially in economic terms. The so-called Washington consensus (World Bank, International Monetary Fund, and other Bretton Woiod Institutions) has suggested the following approach:

- *Remove price controls;*
- *Apply fiscal discipline;*
- *Prioritize government expenditure in infrastructure and human development;*
- *Implement tax reforms;*
- *Execute financial liberalization;*
- *Remove foreign exchange controls*;
- *Promote foreign investments;*
- *Privatize public enterprises;*
- *Deregulate economy;*
- *Protect property rights.*

The greatest problem is institutional set-up, which is missing from this concept. It has recently been criticized strongly (Stiglitz 1998) due to negative experience of instabilities in many newly industrialized economies in SE and E Asia and in Latin America. Special attention has been paid to the need to control the short-term external cash flows by governments.

The neo-classical theory and philosophy is the cornerstone of the fashionable liberalistic economic policies that are advocated by many international organizations and donors, not least the Bretton Wood Institutions, and opposed by many NGOs, grassroot level actors etc.

New institutional economy

Recently, many basics of the neo-classical approach such as perfect markets, economic rationality, and perfect information have been challenged by new institutionalism. As the name implies, the various, important roles of institutions (*legislative, executive, juridical, administrative*, and *informal* ones such as culture, other informal norms, and religions, as well as *structure and character of social interests*; see North 1990) are emphasized. They are defined as the rules of the game in a society. The players are the various organizations and individuals. The institutions regulate various transactions between and among production and consumption, and their roles and set-ups are a dynamic process and flexibility should exist (Figure 3.2g).

Figure 3.2g
New institutionalism

Institutions provide the stability to the society, and to a certain extent define, why some countries develop and some do not. One basic thesis is that the informal sector should support the formal sector (Chapter 8.2).

New institutionalism has found upward notice in the analyses of transitional countries, such as former centrally planned and rapidly industrializing ones.

Human development

Although economy is an important determinant of the development of a society, it cannot be considered as the only criterion. The United Nations Development Program (UNDP 1995) lists three essential levels of *human development*:

- A long and healthy *life*.
- Ability to acquire *knowledge*.
- An access to the *resources* needed for a decent standard of living.

According to UNDP, these three determine many of the chances to human development, which is defined as a progress of *enlarging people's choices*. Such choices include social, economic, and political freedom to opportunities for being creative and productive, and for enjoying personal self-respect and human rights. Accordingly, the UNDP view to development is to enlarge all human choices, not just income.

UNDP has developed an index for human development (HDI, Human Development Index). It is a composite of life expectancy at birth, educational attainment (adult literacy, and enrollment rates to primary, secondary, and tertiary education), and income. For computational principles and details, see UNDP's Human Development Reports, which are released annually. In Chapter 4.5, the human development issue is elaborated further with a view of the study regions.

The human development paradigm has four components:

- *Productivity*. The ability for each individual to increase their productivity and participate in the process of income generation.
- *Equity*. Individuals must have access to equal opportunities.
- *Sustainability*. The future generations must as well have the access to those opportunities.
- *Empowerment*. Development is not just *for* people, but *by* them. People must participate fully in the development process.

Economic development, measured as annual per capita GNI growth rate, correlates well with human development. There are many issues that are mutually supporting (Figure 3.2h). However, for a large number of countries, this relation is weak (Table 3.2). Within the case regions, China and many SE Asian countries have shown high growth in both GDP and HDI, whereas most African study countries have witnessed slow growth in these indicators.

There are many connections between the so-called endogenous development theories from modern development economy theory (for instance, Todaro 1997) and UNDP's human development paradigm. Here, the former ones have been left beyond detailed analysis because the UNDP approach appears to be operationalized efficiently, and it has gained much use, e.g., within the UN organizations.

Table 3.2

Human development vs. economic progress

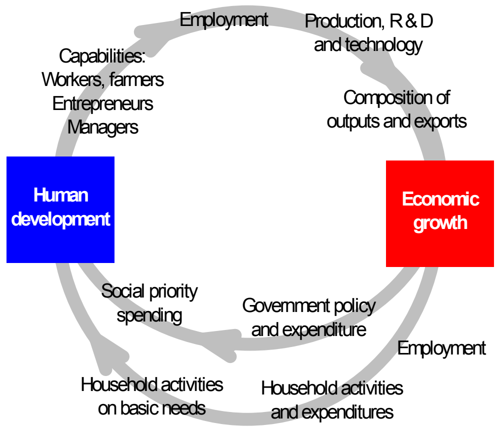
Selected countries from UNDP's (1996) analysis of the relation between growth rates of human development index (HDI) and GDP per capita. The section Low HDI/High GDP growth was found to be a trap with a difficult access to the High HDI/High GDP growth section. The analysis included eighty-seven countries.

HDI	GDP growth	
growth	Low	High
High	24 countries incl. *Switzerland, France, Jamaica, Nicaragua, Sri Lanka*	14 countries incl. *Rep. of Korea, China, Hong Kong, Japan, Singapore, Malaysia, Indonesia, Thailand, Spain*
Low	42 countries incl. *Niger, Haiti, Ghana, Zimbabwe, India, Tanzania, Congo, Sudan, Rwanda*	7 countries incl. *Pakistan, Hungary, Egypt, Lesotho*

Figure 3.2h

The virtuous circle

From human development to growth and back to human development (according to UNDP 1996).



3.3 Water sector vs. development theories

Olli Varis

It seems typical to societies that some ideologies and concepts grow too self-evident to evoke real criticism and evolution of ideas, until the prevailed concept fails in some very profound sense. It might help to comprehend the subsurface movements of such thoughts—hidden too often from even policy-makers and experts—if their place is seen in the mosaic of historical theories. Here, development theories are discussed as they appear in basic concepts of the water sector.

Introduction

Although the development theories as summarized in Chapter 3.2 have many controversies with one another, and they view the development process from very different angles, there is some consensus on the key factors that should be provided in order to develop societies. These issues – institutions, political system, economy, income, technological capability, infrastructure, service and industry base – were already touched in the beginning of Chapter 3.2, and will be scrutinized later in this book. Here, some real-life controversies, pitfalls, and problems involved in and associated with the application of the theoretical concepts in the water sector practice are discussed.

Each of the development theories views an overly complicated melange of issues from a specific angle. Therefore, in many occasions, more than one of them can apply in parallel without confrontations. However, marked differences exist in their priority setting, as well as in consequent policy tools.

Development theories offer most interesting views to the development process. They can be very useful in many practical situations even within water management, but there are innumerable cases in which such theories have blinded the eyes of those making decisions in the real world. Therefore, no theory can and should replace the common sense.

The neo-classical boom and its challengers

The globally prevailing trends of today – privatization, trade liberalization, shrinking influence of governments and public sectors, growing informal sectors, belief on market mechanisms – represent by and large a liberalistic view to economy which goes very much along the lines of the neo-classical philosophy. Even the term of *laissez-faire* capitalism is increasingly used to describe this tendency, meaning minimum government intervention. This has been strongly reflected in water management paradigms in the 1990s (Box 3.3a).

Traditionally, the classical views have found sparsely acceptance by the leaders of developing countries. The free market has been argued to provide insufficient mechanisms for the desperately needed infrastructure development (although in principle advocated by the holders of classical views) and capital formation.

One of the most known quotations of such views is the one by Nkrumah, Ghana's president in 1957—1966: *The vicious circles of poverty, which keep us in our rut of impoverishment, can only be broken by a massively planned industrial undertaking*. He was strongly for planning and against free markets (Nafziger 1997). In accordance with his views, the massive construction of the Volta River took place, in order to mobilize the power of this large river with the Akasombo Dam (Chapter 10.1) to the benefit of Ghana's development.

In the 1950s and 1960s many developing countries took elements and influences from the Marxist-Soviet model, and developed their own variations of it. Such countries include, for instance, China, India, numerous African countries, and a few Central American countries. Heavy industry was favored, the long-term planning by the state was seen important, as well as a strong control by the politically monopolistic state over almost all parts of the society. The Soviet model collapsed due to several unbalancing factors that hindered economic and social development, and most of the countries that followed this model have abandoned it, or developed their own solutions towards a more mixed system of markets, private sector, and state intervention. In the global perspective, China's policy in relation to privatization and foreign capital entrance to its water sector, agrobusiness, and water-related industries is a highly interesting exercise.

In the late 1980s this boom of neo-classical ideas was strongly boosted by the collapse of centrally planned economies, and the monetaristic policies of Anglo-American countries in those times. The evidence appeared to show that market mechanisms should be allowed to work in an economy. This strategy would be most efficient in providing rapid economical development.

Recent years, again, have seen a sharply increasing criticism against the classical views, especially in the former centrally planned countries and other transitional economies. Even the Washington Consensus (see Chapter 3.2) has been criticized by bodies such as the World Bank itself (Stiglitz 1998). This is due to the severe failures of the economic policy-making in SE Asia, Brazil, and in some other areas that have implemented liberal policies, often in close consensus with the IMF.

The criticism by North (1997) comes from the new-institutional direction: The neo-classical approach has failed in many respects, he argues. Public sectors have collapsed, but the used policies have not been efficient in providing anything instead. Incentives have been strong to those acting in informal businesses, and the state has eroded. The institutions and organizations would have been needed more to provide the people the necessary incentives to produce (not just transact), to act honestly and supportively to the society, and so on. According to North, the institutions should guarantee that the formal sector is supported by the informal one, otherwise the latter constitutes an erosive factor to the society (cf. Figure 8.2e).

There is much evidence that rather strictly government-controlled countries have shown exceptional success in both economic and human development (UNDP 1995, Nafziger 1997). The best example is the Republic of Korea; it has faced severe problems when opening itself to foreign economic influence. These countries have been much influenced by Japan, with heavy public investment on infrastructure, extensive government-initiated investment programs, government control over excessive business cycle-generated instabilities, a highly developed public education system and other favorable policies to human resources development. The application of the Japanese model in most developing countries may be troublesome (Nafziger 1995). However, many lessons can be learned that often are used as arguments for institutional or even Keynesian views and against minimum-intervention policies by classical theories.

Keynesianism, the traditional challenger of classical views, used to be much favored a few decades back, but it appears to have gradually lost its attractiveness. Unemployment has been stated to be a much more complex issue in developing countries than just a problem of decreased aggregate demand during low business cycles, as Keynes suggested. Therefore, the applicability of the Keynesian model, particularly in the Third World, has strongly been questioned (Todaro 1997).

The basic institutional question here is the government's role vis-à-vis market mechanisms in providing an access out of the vicious circles. It seems that no simple and theoretically straightforward solutions exist. It can be however believed that the role of the government should be stronger than many classical economists propose.

It is commonplace, that rich countries such as EU members and the US protect their own markets from the cheap products of developing countries (Nafziger 1997). This is the case both with primary products such as food and secondary ones such as industrial products. In the same time, these countries promote the free-trade paradigm to their own products and capital to enter the incompetitive markets of developing countries.

Water: not just economics

Water, as defined in the Rio and Johannesburg Summits, should be seen as both a social and an economic good (Chapter 3.1). Therefore, the economic dimension is only one part of the story. So is the social function as well. Water is often a very political issue (the less the supply is in comparison to the demand, the more political interest it attracts). Internationally the same applies as well. According to Biswas (1993), there are 214 internationally shared river or lake basins in the world. A high number of them are potential or actual sources of conflicts on political or even military level, yet the whole picture is still largely unknown (see also Wolf et al. 2003).

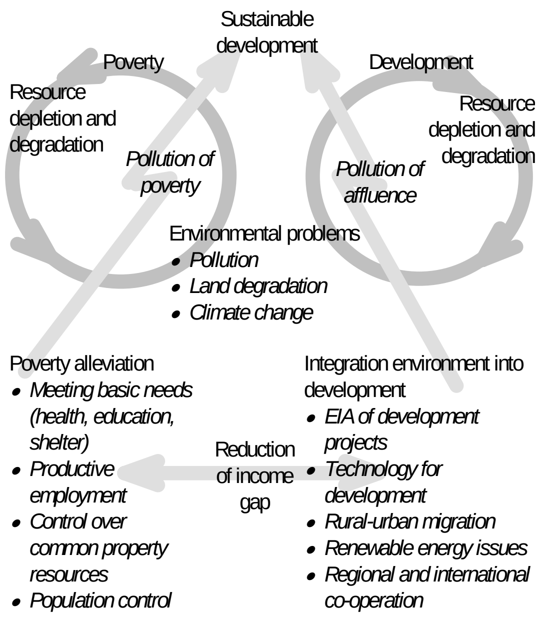
Water is often considered mainly as a public good, although voices demanding greater appreciation of its economic value are getting stronger. In this respect, the key institutions represent fundamentally diverging views. For instance, when comparing the policies of the World Health Organization and the World Bank, the former emphasizes the social function of water, whereas the latter tends to favor the consideration of water as an economic good.

The nature itself and the request for sustainable resource use both set additional constraints to the consideration of water simply as either a social or an economic good. The well being of the nature is highly important; it cannot just be seen as an externality in an economic analysis. In many ways, welfare of the nature goes hand in hand with sustainable development: we should not compromise the ability of future generations to enjoy and exploit natural resources and the nature.

In practice, various trade-off situations tend to occur between short-term economic development and sustainability. In a longer term, however, it is apparent that these goals are mutually supportive. Perhaps even a parallel can be seen to the human development scheme (Table 3.2b): sustaining economic growth appears very difficult to be realized without investing in human development. Hence, there are evident contrasts in short term, but they fade away with increasing time horizons, and become prerequisites for one another.

The consideration of long-term issues is the easier the wealthier the economy is. Developing countries face here vicious circles of poverty, environmental degradation, resource depletion and degradation (Figure 3.3a). Due to their lack of human, political, and institutional capacities, they have typically far less abilities to break these circles than rich countries do.

Figure 3.3a
Poverty, affluence, and environment nexus
Breaking the vicious circles of environmental degradation, poverty, and affluence (Jalal 1993).



Water: a basic need

The basic needs approach has been integrated in many development philosophies. Poverty alleviation stays high on most development agendas of today. It is accordingly written in the first UN Millennium Development Goal (Table 3.1b). This tendency is closely related to the simple but important concept of the basic needs approach.

Water is a basic need in many ways: as drinking water, in sanitation, in public health, and in food production. In economic development its role is crucial; most developing nations depend on local food supplies and export income from agricultural products to enable import of manufactured goods and primary products they cannot produce themselves.

Globally, food availability and security are among the mankind's major threats. Somewhere, the food must be produced, and the expansion of agricultural production has to take place.

The individuals that suffer most from food and water scarcity tend to have the weakest voices in local and global policy-making. As often happens, the successful export of foodstuffs from a developing country hits worst back to the domestic poor. Their food becomes less accessible to themselves, given their lacking economic power. The foreign trade benefits go to others.

In the Senegal River valley in W Africa, the late 1980s saw a construction of two dams, the Manatali and Diama. The purpose was to provide the badly needed growth in food production (irrigated agriculture), energy generation, and transport (navigation). The ambitious plans turned to a degradation of the livelihood of the river valley dwellers, whose access to their traditional herding, farming, and fishing activities was deteriorated in many ways. At the same time, the irrigated agriculture, navigation and hydropower generation were by far not as successful as planned. They failed in a profound manner (Varis and Lahtela 2002, Lahtela 2003).

Chapter 3.1 mentioned that there seems to be a shift from supply focus to demand focus in water and food issues. The basic problem setting in neo-classical terms would be though that the demand and supply should meet equilibrium. This is fine, but it must be realized that in the world's economic system, not all are equal. In Sub-Saharan Africa, most countries have the mean per capita calorie consumption less than 60% of the level in industrialized countries. They have the demand for more and better nutrition as well as more and better quality water for irrigation, water supply and so on, but they cannot afford these basic needs.

There are some interesting implications of the basic needs approach to the urban-rural nexus. Urbanization in general offers improved possibilities to economic well being, and in addition lower birth rates. Can we thus use urbanization as a synonym to development?

Clearly not always. In many cases, basic needs are easier to meet in rural areas, if compared with urban squatters with a broken social fabric, no property rights, no feeling of ownership to environment, no possibilities to produce own foodstuffs, poor access to water, congestion-related problems both in social and in ecological sense, and many more. Such marginal urban communities tend to be worse off in terms of basic needs than economically comparable rural communities. Their formation should be avoided, as long as the basic needs of the people cannot be met.

Infrastructure and development

From many different directions, infrastructure is related to water. Infrastructure has been emphasized throughout in development theories. Even classical and neo-classical economics prioritize infrastructure development and education to other purposes of public spending. In Rostow's linear theory, infrastructure is a basic prerequisite for achieving the takeoff phase in economic development.

Yet, the infrastructure development may easily bias the society's rural-urban balance, typically enhancing urban bias. In many cases, intensive urban infrastructure development has boosted immigration to cities, outpacing the developments achieved and creating another vicious circle of unbalanced development. It is a challenge to the water sector to consider the unwished impacts of water policies that lead to enhanced rural push and urban pull forces.

The structuralist theories pay particular attention to two opposite fronts within a society; the traditional and the modern sector, and the formal and the informal sectors. The informal sector is a great challenge to water development, and so is the development of solutions for the traditional sector, to make these parts of the society to support the rest of the society, and to allow the individuals a proper livelihood that does not drive those in the latter one to enter the former one (see Chapter 8.2).

Large scale vs. stability and sustainability

Economics of scale have been emphasized in many theories, but there are social, cultural, institutional, and other barriers or social features that tend to favor rather small-scale developments in comparison to large-scale ones.

This is a burning question in Sub-Saharan Africa, where large-scale water transfer systems, large reservoirs and irrigation programs have been a rarity. And where such developments have taken place they have failed far more often than in other parts of the world, as the above-mentioned Senegal River experience clearly shows.

In many parts of Asia, large-scale projects have been favored, but international opinion has turned increasingly negative to such constructions. The culmination has been the Sardar Sarovar Dam project in the Narmada river, India, which has contributed to the World Bank policy to become less favorable to large water projects than previously (Pike 1995, Chitale 1997). The government goes on with large-scale projects anyhow, despite of strong internal and external opposition.

The same policy outlines apply to China, which goes on with massive dam construction in its major rivers such as the Yangtze (Three Gorges Dam being an example) and the Lancang-Mekong, irrespective of the criticism of neighboring countries and international organizations.

In Nepal, the discussion goes vigorously on whether the enormous water resources of the country—the headwaters of the Ganges River—should be utilized through small or large-scale water developments (Ahmad et al. 1994, Bastola 1994, Thapa 1997). The largest water projects proposed for Nepal have the order of magnitude of 10 times the national budget of the country. In the case of Nepal, it is clear that such projects cannot be financed nor controlled by national authorities. They may have a destabilizing influence to the whole society, not to mention the human trouble to those to be resettled by such schemes. Nepal's stability is extremely fragile as the tragedies with the Royal Family massacre and civil hostilities right after the turn of the Millennium show.

Whereas the national stability should not be forgotten, problems with stability occurs at many lower levels of a society, in the individual farm level, for instance. The economically rational approach would often be to make benefit of the economics of scale by adopting the philosophy *one farm, one crop*. The farmers tend to act differently: several crops reduce risks, balance work load, and are ecologically more stable and sustainable.

Land and food: was Malthus right?

Was Malthus (or Ricardo who had similar terms as Malthus in terms of availability of arable which is limit to growth) right in stating that it is ultimately the food supply that will set the boundaries for the growth of human population? Can we only postpone the situation of facing the limits with technical and social advances? How about Africa? That continent is perhaps the most 'Malthusian one' in these decades. Asia, even the most populated countries such as India, China, Pakistan, and Indonesia seem to have gained reasonable control over high birth rates by various means.

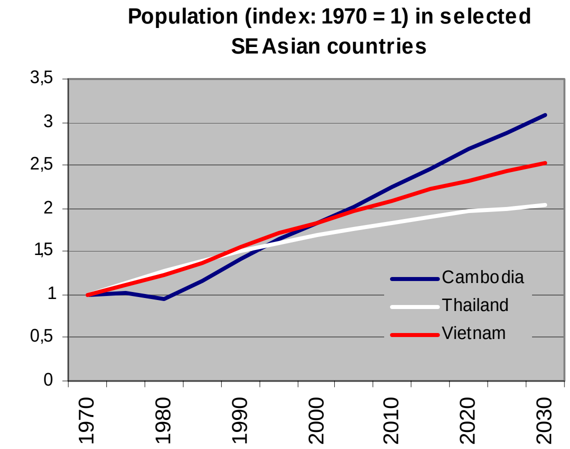
After all, catastrophes such as famines and wars that kill humans in numbers tend to have no decreasing influence in population in long term, but rather in contrary, as the Cambodian experience shows (Figure 3.3b).

The world population that belongs to the high-income group is decreasing in proportion. However, population growth in the world is now less than linear—not exponential as Malthus suggested—and the population projections have several times been corrected downwards in recent years (e.g. Alexandratos 1995).

Figure 3.3b

Wars vs. wealth in population control

Thailand has enjoyed peaceful and economically stabile conditions over the last few decades, whereas Cambodia and Vietnam have suffered from wars and economically unsuccessful periods. The population growth of Thailand is more stable, and in long term is much lower than in the other two countries. Data from UN (2004).



Cores and peripheries in the case regions

The world-systems theory offers an attractive terminology and conceptual framework for many political, social, and economic considerations. Reflecting on the case regions, SE Asia has very distinguishable cores. The region is closely connected to China and other E Asia, and in this perspective, they should not be separated.

E Asia's cores include above all Japan and the Asian Tigers (Korea, Taiwan, Singapore, and Hong Kong). The city state model has been exceptionally successful in the two last mentioned cases, and the approach has been imported also elsewhere. SE Asian cities such as Kuala Lumpur, Metro Manila, and Bangkok Metropolitan Area, are semi-independent (Drakakis-Smith 1992). Over the last two decades, China has developed Special Economic Zones that act as cores, aimed to generate and distribute wealth to different parts of the nation. Consequently one can say, that the approach appears to work well in E and SE Asia.

The associated problems have been largely due to congestion-related issues such as breaking of material cycles, disturbed social fabrics, enhanced pollution, and others, that can be considered typical problems to rapid urbanization, which in these regions has indeed been exceptionally fast over the last decades.

The periphery areas have developed as well, and benefited from the economic development of the cores, but the contrasts between core and periphery areas have grown enormous, and the uncontrolled urbanization has yielded massive formation of squatter settlements around many cities.

In S Asia, the cores are not as distinctive as in SE and E Asia. The countries have not attempted to favor some areas over the others in the same manner. Clearly though, the megacities of India and Pakistan can be seen as engines of wealth to those nations, but still, their role as core areas appears not to be as strong as the cores in SE and E Asia.

Sometimes, it can be questioned, whether the megacities in S Asia do produce more wealth or poverty—are they sinks or sources of development? Apparently, they produce more wealth, but the number of those, who have no access to wealth, is enormous in that very part of the world. The price that SE and E Asians are paying for strong cores is the enhanced instability of the region; the cores are vulnerable to world economy—to its good and bad features in a very augmented way.

In Africa, there are not many clear growth centers. Within the Nile region, Cairo is definitely a core, or rather one should consider the whole Nile Delta, even the Nile valley downstream of Aswan as one. The other Nile region countries have not been successful in creating areas or cities that could be considered as core areas globally or even continentally. Nairobi, Dar-Es-Salaam, Addis Ababa, with other capital cities, have grown enormously in terms of population, but their economic influence is inferior to that of Cairo—not to talk about cities in E and SE Asia.

Lagos is a city with much potential of becoming a remarkable core of the W Africa region. However, the unstable economic development of Nigeria has not allowed it to attract foreign capital in the way numerous other Third World cores have done. The same applies to several other cities within the region, such as Abidjan and Dakar. The region seems to lack such clear strong economic areas as Republic of South Africa, and Egypt with other Maghreb countries in N Africa.

Complex world: a challenge to education

It is not difficult to find examples, where too narrowly comprehended development schemes have created more problems than they have solved.

In the water sector, such cases include boring of deeper wells that has led to overexploitation of groundwater and enhanced desertification (e.g. North China Plain and Gujarat in India); creation of water markets with "proper" pricing aimed at better cost recovery and capacity building but causing creativity in digging private low-quality wells and making holes to water pipes to extract water at no cost (e.g. Dhaka in Bangladesh); improved water supply without proper wastewater treatment or even sanitation that has caused environmental deterioration and health problems (e.g. Karachi); building of dams without proper analysis and remediation of adverse environmental and social effects (e.g. Pak Mun dam in Thailand), just a few examples to give a flavor.

Highly educated people should possess a generalistic view to avoid such undesired development paths, because much of the development is in their hands anyway. This is an important cornerstone for both the Integrated Water Resources Management and to sustainable development, underlined in Chapter 3.1.

Development is profoundly bound to the human resources and to the human development as has been highlighted by many (cf. UNDP 1996). Without deep-going education of people and other baseline social considerations, developments such as the Rostow's procedure can hardly be sustained.

Buzzwords: incentives to act or not to act?

The contemporary paradigms for water management such as those listed in Chapter 3.1 are without doubt elaborate ones and easy to accept. Such paradigms, ideals, models, principles, and dreams are mandatory in meeting challenges and changing the conditions from worse to better. Anyhow, the reality, with all its intangible and unwanted features, must be seen and comprehended.

Problems arise when such paradigms drive the scientific community, governments, and policy makers to work on issues that comfortably meet the criteria, but are not the most relevant ones, or are even next to meaningless, in the framework of the entity. The paradigms should not be dreams that blind the eyes from seeing the reality, for instance, from realizing the orders of magnitudes of the processes and issues at hand, or kill the creativity to find new solutions and views.

Repetitive use of buzzwords often causes an erosion of the factual content and meaning of those words, and loosens the connection to action. A well-tasting collection of buzzwords is a problem in situations if it commences to remove the pressure from taking real actions.

Many associate the water problems to the Middle East because of the remarkable notice those countries receive due to various political and often religious reasons. However, at the same time it is dramatically forgotten that the quarter of a billion people in W Africa are subjected to continuous water scarcity, and the western press notices their problems only within the context of catastrophic droughts. The Aral Sea issue did not touch the Western world until a decade ago. Water-related, presently smoldering time bombs that may touch populations that are expressed with hundreds millions are in Northern China, Pakistan, some parts of India, East Africa, and so on.

In the end, it is all up to humans, at least mainly. Dreams, paradigms, ideals and principles are needed and they are even very important. The lack of commonly accepted norms of thinking such as moral and ethics (Box 3.3b) is a great hinder to development in many parts of the world today. The greatest need is still perhaps of those who act, realize, and challenge the prevailing paradigms with experience.

Box 3.3a

Does money make the water go round?

There are many ways to make and maintain the urban water infrastructure efficient. Along with the globally prevailing trends of deregulation and privatization, a.o., the World Bank's agenda (Serageldin 1994, 1995, see also the critical comments of Frederiksen 1996) is in favor of making water dominantly an economic good.

It has been shown in many cases, the argument goes, that governments are unable to tackle the issue. Public awareness and community involvement, together with higher a involvement of the private sector are believed to facilitate a more successful development than the patritionizing public sector approach of the past.

With better checks and balances, particularly in terms of enhanced cost recovery, the water infrastructure should have better possibilities for capacity building, and therewith to meet its requirements, and to run without subsidies (Figure 3.3c). Subsidies are often considered of being most beneficial to those with tap water supply, i.e. the rich and the middle class.

Many studies show that if the money used by the poor to buy water from water vendors, usually in the informal sector, would be used for water infrastructure installations the funds would be enough. Also the willingness to pay would be there since the piped water infrastructure would in long term save reasonable sums of money.

What is missing? The bigger the urban center is, the more complicated and far-reaching solutions for supplying water and taking care of waste are needed. The control over the informal sector, which dominates the economy in many cases is missing. The priorities of water and sanitation, especially for the poor, are not always too high, both in the government and in the individual level. The path from water vendors to piped water for everybody is long and it requires commitments from so many stakeholders that it just hasn't too often taken place. Perhaps the solution to this is not as simple as many agendas suggest.

Figure 3.3c

Does the money make the water go round?

The present tendency of considering water as an economic good, despite its many merits, includes severe pitfalls, especially in terms of inability to cope with the poor, the environment and the informal sector (Varis and Somlyódy 1997, Varis 1998).

The financial performance of the water infrastructure sector is often very poor. While it typically has a cost recovery rate of 1/3, implying that the majority of running costs has to be covered by public funds, sectors such as power and gas are much closer to financial autonomy. Some sectors such as telecommunications even make profits.

With better checks and balances, particularly with enhanced cost recovery and 'proper' pricing of water, the sector should be better off for capacity building, and therewith to meet its requirements, and to run without subsidies. Subsidies are often considered of being most beneficial to those with tap water, i.e. the rich and the middle class.

The responsibility issues, the fate of the secure, affordable water to the urban poor, the subsequent public health problems, and the equity issue among other things, have evoked wide concern. I share this concern. A trap in thinking may yet be the belief that all the poor are willing to pay the real price for water. There has been a great, thus far, in digging own wells (with often very low quality of water), boring holes to water pipes and many other ways to get water without expenses. Consecutively, I raise the following questions:

- How the above issues can be realized within the informal sector without strengthening the positions of those having the informal power (making weak governments still weaker)?
- How it will impact the public health and the urban poor in particular (less social function for water)?
- How do these issues handle with the sustainability issue as discussed above (the nature does not charge for water, nor does it pay for it, even when its needs are crucial, also for our survival)?

These hardly are easy questions to answer, yet a skeptic might say that the result may not be that different from those of strengthening the governments. After all, the importance of the externalities of this scheme is in our view not comprehended properly.

Box 3.3b

Water and ethics

Source: Rahaman and Varis (2005).

Although water ethics are now becoming important for water management, there is a lack of discourse on water ethics. The World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) set by UNESCO in 1997, has played a pioneer role in this regard. COMEST seeks to motivate scientists by adding an ethical dimension to their intellectual freedom. A COMEST sub-commission on the ethics of fresh water was established in October 1999. It tried to find out common ethical principles related to water, which can be accepted as applicable in all geographies, in all stages of economic development and for all time. In 25th October 2000, Lord Selborne, Chairperson of the COMEST sub-commission on the ethics of fresh water, published his “The Ethics of Freshwater Use: A Survey”. The survey draws on a rich and varied body of discussion and documentation to provide an overview of the practical areas of concern so as to move relevant ethical stances. The aim of the survey is to help lay a foundation of trust, justice and equity in the availability of and access to freshwater resources for the entire community of nations (Selborne 2000).

The Universal ethical principles that are directly acceptable to water were pointed out. These are as follows:

- *The principle of human dignity*: there is no life without water and those to whom it is denied are denied life.
- *The principles of participation:* all individuals especially the poor and women must be involved in water planning and management.
- *The principle of solidarity:* water continually confronts humans with their upstream and downstream interdependency.
- *The principle of human equity:* taken to mean rendering to all persons their due and which describes perfectly the challenges in river basin management today.
- *The principle of the common good:* water is a common good and without proper water management human potential and dignity are diminished for all and denied to some.
- *The principle of stewardship:* much of water management is about finding an ethical balance among using, changing and preserving our water resources and land.

The UNESCO monograph edited by J.C.I Dooge (2003), “*Water and Ethics*”, is part of the outcome from the Working Group on the Use of Freshwater Resources established in 1998 under the theme Water, Civilization, and Ethics. The issues discussed are varied. The key aim of the book is to provide a wide-ranging dialogue on these issues by experts in the relevant disciplines in the natural sciences and in social sciences. It is worthwhile to say that the publication aims also to play an indispensable role in accelerating the COMEST proposed UNESCO projects, global Research and Ethical Network (RENEW) and Global Organization of Universities for Teaching, Training and Ethics of Water (GOUTTE).

These two publications of UNESCO are most influential in the field of water ethics. They give basic ideas and clear understanding, raise some ethical dilemmas, set general guiding principles and enhance water dialogue on water ethics and future research. Indeed these are general in nature and further research, analysis and dialogue is necessary to address our responsibility to one of the most crucial aspects of water issue; ethics.

References to Section 3

Ahmad, Q.K., Verghese, B.G., Iyer, R.R., Pradhan, B.B. & Malla, S.K. (Eds.) 1994. *Converting Water Into Wealth: Regional Cooperation in Harnessing the Eastern Himalayan Rivers.* Institute for Integrated Development Studies (IIDS), Kathmandu.

Alexandratos, N. 1995. *World Agriculture: Towards 2010—An FAO Study.* Food and Agriculture Organization of the United Nations (FAO), Rome and Wiley, Chichester.

Bastola, S.N. 1994. *Water Resources Development of the Mighty Himalayan Rivers (Indus, Ganga-Yamuna, Brahmaputra Rivers).* Lalita Printers, Annam Nagar.

Biswas, A.K. 1976. *Systems Approach to Water Management.* McGraw-Hill, New York.

Biswas, A.K. 1993. Management of international waters: problems and perspective. *Water Resources Development* 9(2): 167-188.

CEC 2000. *Introduction to the new EU Water Framework Directive*. Commission of European Communities (CEC), Brussels. http://europa.eu.int/comm/environment/water/water-framework/overview.html (3.5.2006).

Chitale, M.A. 1997. The Narmada project. *Water Resources Development* 13(2): 169-179.

Drakakis-Smith, D. 1987. *The Third World City.* Routledge, London.

de Soto, H. 1989. *The Other Path.* Harper and Row, New York.

Dooge, J.C.I. (Ed.) 2003. Water and Ethics: Preliminary version. United Nations Educational, Scientific and Cultural Organization/ International Hydrological Programme (UNESCO/IHP), Paris.

Drakakis-Smith, D. 1992. Concepts of development. In: Dwyer, D.J. (Ed.): *South East Asian Development*. Longman, Hong Kong.

Ehrlich, I. 1990. The problem of development: Introduction. *J. Political Economy* 98 (5, Part 2): 1-11.

El-Ashry, M. 1993. Policies for water resources management in arid and semi-arid regions. In: Biswas, A., Jellali, M. & Stout, G. (Eds.): *Water for Sustainable Development in the 21st Century*. Oxford University Press, Oxford.

Esfahani, H.S. 1996. *The Economic Development.* University of Illinois, Urbana-Campaign.

Falkenmark, M. & Lindh, G. 1976. How can we cope with the water resources situation by the year 2015. *Ambio* 3(1): 3-4.

Frederiksen, H.D. 1996. Water crisis in developing world: misconceptions about solutions. *Journal of Water Resources Planning and Management* 122(2): 79-87.

GWP 2000. *IWRM at a Glance*. Technical Advisory Committee (TAC) / Global Water Partnership (GWP), Stockholm.

Jalal, K.F. 1993. Sustainable development, environment, and poverty nexus. Occasional Papers 7. Asian Development Bank (ADB), Manila.

Kinnersley, D. 1988. *Troubled Water.* Shipman, London.

Lahtela, V. 2003. Managing the Senegal River: National and Local Development Dilemma. *International Journal of Water Resources Development* 19(2): 279-293.

Maxwell, S. 1996. Food security: a post-modern perspective. *Food Policy* 21(2): 155-170.

Nafziger, E.W. 1995. *Learning from the Japanese: Japan's Prewar Development and the Third World.* M.E. Sharpe, New York.

Nafziger, E.W. 1997. *The Economics of Developing Countries.* 3rd Ed. Prentice Hall, Upper Saddle River.

Naisbitt, J. 1984. *Megatrends. Ten New Directions Transforming Our Lives*. Macdonald, London.

North, D.C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, Cambridge.

North, D.C. 1997. *The New Institutional Economics and its Contribution to Improving our Understanding of the Transition Problem.* 1st Annual Public Lecture, 7 March, United Nations University/World Institute for Development Economics Research (UNU/WIDER), Helsinki.

Novotny, V. & Olem, H. 1994. *Water Quality: Identification, Prevention, and Management of Diffuse Pollution*. Van Nostrand-Reinhold, New York.

Novotny, V. & Somlyódy, L. 1995. Water quality management: Western experiences and challenges for Central and Eastern European countries. In: Novotny, V. & Somlyódy, L. (Eds.): *Remediation and management of Degraded River Basins with Emphasis on Central and Eastern Europe*. NATO ASI Series. Springer, Berlin.

Peet, J. 1992. *Energy and the Ecological Economics of Sustainability.* Island Press, Washington D.C.

Pike, J.G. 1995. Some aspects of irrigation system management in India. *Agricultural Water Management* 27(2): 95-104.

Rahaman, M.M., Varis, O. & Kajander, T. 2004. EU Water Framework Directive vs. integrated water resources management: The seven mismatches. *International Journal of Water Resources Development* 20(4): 569-579.

Rahaman, M.M. & Varis, O. 2005. The ethical perspective of water: Dilemmas and future challenges. In: Afgan, N., Bogdan, Z., Duic, N. & Guzovic, Z. (Eds.): *Sustainable Development of Energy, Water and Environment Systems – Volume II.* University of Zagreb, Croatia.

Selborne, L. 2000. *The Ethics of Freshwater Use: A survey*. United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris.

Serageldin, I. 1994. *Water Supply, Sanitation, and Environmental Sustainability, the Financing Challenge*. The World Bank, Washington DC.

Serageldin, I. 1995. Strategic water resources management: themes for a new millennium. *Proceedings, 5th Stockholm Water Symposium,* 13-18 August 1995. Stockholm Water Company, Stockholm.

Somlyódy, L. 1995. Water quality management: can we improve integration to face future problems? *Water Science and Technology* 31(8): 249-259.

Somlyódy, L., Yates, D. & Varis, O. 2001. Challenges to freshwater management. *Ecohydrology and Hydrobiology* 1(1-2): 65-96.

Stiglitz, J.E. 1998. *More Instruments and Broader Goals: Moving towards the Post-Washington Consensus.* 2nd Annual Public Lecture, 7 January, United Nations University/World Institute for Development Economics Research (UNU/WIDER), Helsinki.

Thapa, P.J. 1997. Water-led development in Nepal: Myths, limitations and rational concerns. *Water Nepal* 5(1): 35-57.

Todaro, M. 1997. *Economic Development*. 6th Ed. Longman, London & New York.

UN 2004. *World Population Prospects: The 2004 Revision.Population Database*. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, New York. http://esa.un.org/unpp (3.5.2006).

UNDP 1995. *Human Development Report*. United Nations Development Program (UNDP)/Oxford University Press, New York.

UNDP 1996. *Human Development Report*. UNDP/Oxford University Press, New York.

Varis, O. 1998. *Water and Third World cities: the expanding puzzle*. Research in Progress 16. United Nations University/World Institute for Development Economics Research (UNU/WIDER), Helsinki.

Varis, O. 1999. Water resources management: Vicious and virtuous circles. *Ambio* 28(7): 599-603.

Varis, O. & Lahtela, V. 2002. Integrated water resources management along the Senegal River – Introducing an analytical framework. *International Journal of Water Resources Development* 18(4): 501-521.

Varis, O. & Somlyódy, L. 1997. Global urbanization and urban water: can sustainability be afforded? *Water Science and Technology* 35(9): 21-32.

Ward, W.A., Deren, B.J. & D'Silva, E.H. 1991. *The Economics of Project Analysis, A Practitioner's Guide.* The World Bank, Washington D.C.

WCED 1987. *Our Common Future: Report of the World Commission on Environment and Development (WCED).* Oxford University Press, Oxford.

Wolf, A.T., Yoffe, S.B. & Giordano, M. 2003. International waters: identifying basins at risk. *Water Policy* 5(1):29-60.

4 DRIVING FORCES

Due to the temporal scale of this study, one generation backwards and ahead, and the focus on the development of human societies and natural resources, the issues listed in Section 4 can be considered as external driving forces. They include population growth, urbanization and other patterns of migration, climatic change, economy, along with human capital, technology, and industrialization. Clearly, these issues are under a certain level of control by the societies. Crucial questions to development are how much these factors are controllable, how they can be controlled, and how much control would be needed. Their control is yet only marginally possible by the tools discussed in this study, and therefore, they are called here as driving forces to development.

In the year 2000 the limit of 6 billion people was passed. It is estimated that in 20 years the population will be almost 8 billions. Economic inequality is predicted to increase.

Today almost one billion people live in industrialized countries, most of them in urban areas. Population growth in these countries has been slow during the last few decades whereas economic growth has been fast. Most of the world's population, five billion people, live in developing countries where population growth is fast, i.e., almost two billion people over 25 years, and economic growth is slow. We can compare economic potentialities between these two groups of nations by comparing their GNI. In industrial countries the average GNI per person is about US$ 20,000 and in developing countries only about US$ 1,000. Developing countries have rather small chances to finance even the most necessary infrastructure projects.

Population will become increasingly urbanized; today rural population is about 50% and is predicted to decrease to about one third by the year 2025. One rural farmer will have to feed two city dwellers instead of one.

The key question number one is what will be the development of these driving forces; will population growth outpace economic growth, will the development in human capital and technology bring enough benefit to the mankind so as to allow more positive development signs than negative ones, or will the climatic variations and changes pose increasing risks to the mankind, its food security, health risks, and economic and social development? The key question number two is how these developments will affect the other issues vital to the mankind. Such issues are scrutinized in the Chapters to follow.

4.1 Population growth

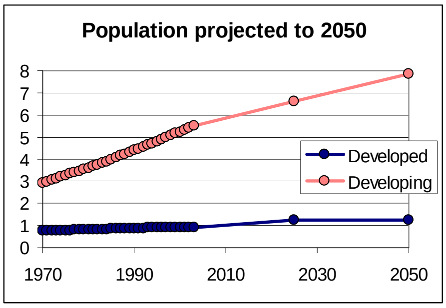
Olli Varis

The expansion of human population is expected to continue at least a couple of decades, or maybe one Century on. It occurs chiefly in the developing countries. The relative growth rates are gradually going down in most parts of the world, and this development is expected to continue. At present, the absolute growth is still linear, but is likely to start to decline within one generation from now. Still, the population growth is a heavy burden on the development possibilities of impacted countries, as well as on the planet's natural resources.

Overview

It was only around the first quarter of the 19th Century, that the size of human population first hit the one billion limit. One hundred years was needed to double its size, and break the second billion limit. The third one was reached around 1960 and the fourth by 1975. From those days on, it has been observed and estimated, that the next 3 billions require only around one dozen years each. After that, the absolute growth per year would start to go down, and approach zero during some decades from that time (Figure 4.1a). What that level of the population would be, is naturally highly obscure, but many of the recent population projections suggest it to be around 10 billion, in about one Century from now on.

Figure 4.1a
Population grows in developing countries
Data and projections by UN (2002a).



Such projections are based on numerous assumptions about population parameters such as fertility, mortality, and migration rates, on the assessment difficulties of the current and historical population structures, and many more.

Every two years, the United Nations Population Division produces its population projections. They change each time to some extent. Fortunately, most of the corrections have been downwards. For instance the 1994 forecast for 2050 was 9.8 billions, whereas the 2002 projection had gone down to 9.1 billions. This direction is a very positive thing, and declining projections has been a clear tendency in population studies during recent decades. But the "balanced" rate of growth in the global scale still far ahead.

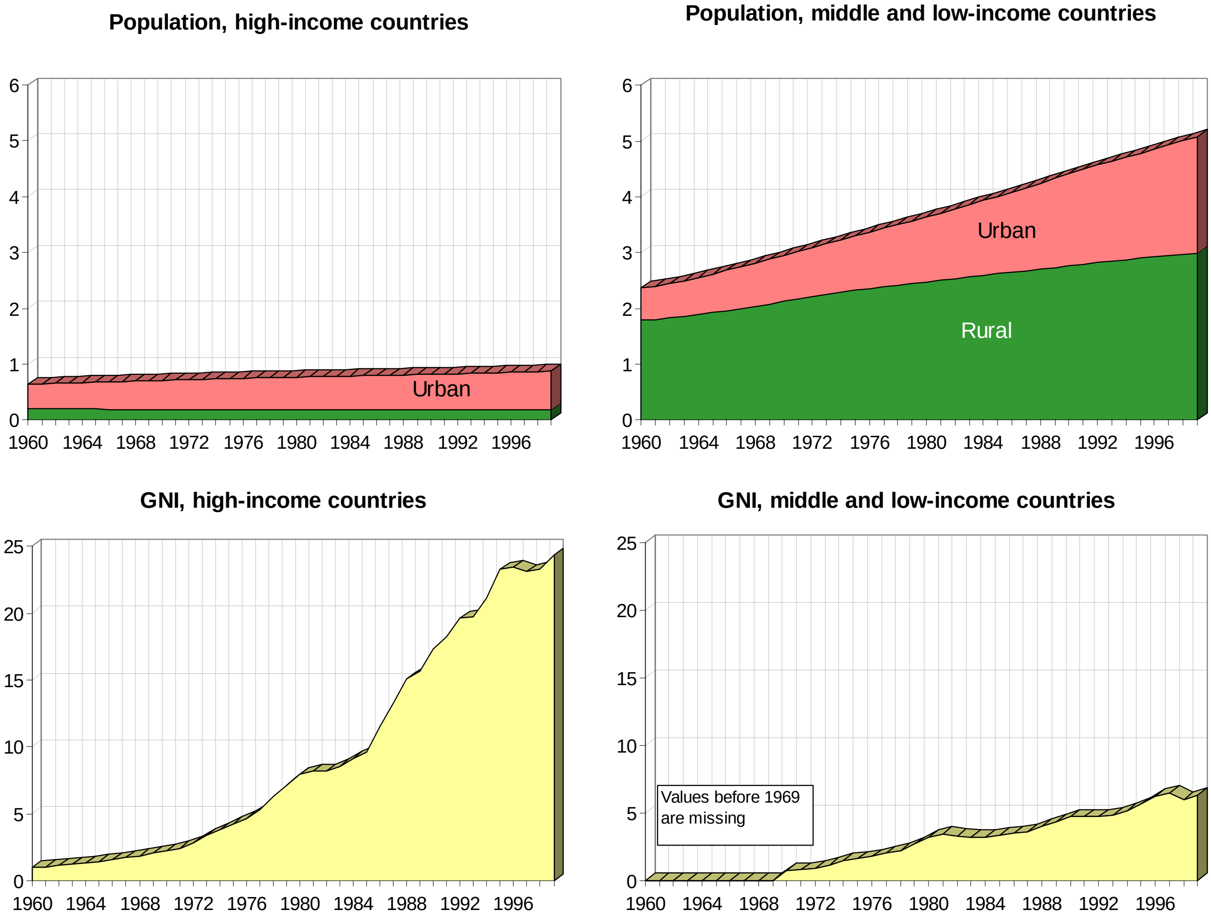
The growth is now linear and declining

The population grows now in a linear way. Each year, the population is added with around 80 million. This linear rate is expected to continue still for one generation ahead, and then the absolute growth rate would start to go down. This implies, that the relative rate has already shown notable decrease; from the all-time peak of 2.3% per year in the 1970s, it has already gone down to 1.7% of the 1990s.

The growth rates tend to be the higher the poorer the economy is. Therefore, most of the population growth takes place in developing countries (Figures 4.1a and b). Sub-Saharan Africa tops the world with around 3% a year—a rate that has continued for a few decades, and is projected not to slow down very dramatically. Near East and N Africa range around 2.5% and S Asia around 2%. However, they are on the way down with some 0.2-0.3% per decade. All the other regions of the world show notably lower growth rates, and their rates also show a clear declining tendency.

Population growth in a country is principally an indication of unbalance between fertility and mortality. For various means, the life expectancies are higher and mortality rates are lower than they used to be over a millennia, in most parts of the world. The problem is that fertility rates have not gone down as rapidly. This phenomenon is known as the demographic transition (see Chapter 7.1).

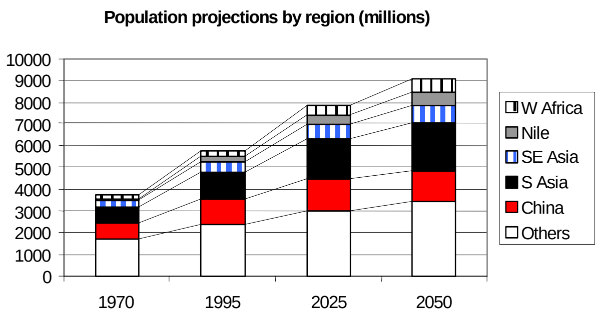
Figure 4.1b
The population vs. wealth disparity
Population (millions) and GNP (10^{12} US$ per year) in high-income countries, and in middle and low income countries (source: World Bank 2001).



Regional analysis

Two of the study regions scrutinized in Chapter 2 are remarkably more populated than the others (Figure 4.1c). They are China and S Asia, that both had around 1.3 billion inhabitants in 2000. They account together for around 40% of the world's population. The other study regions (SE Asia, Nile Region and W Africa) together approached 1 billion people by the turn of the millennium.

Figure 4.1c
Population by regions
Source: World Bank (2001).



African regions have clearly higher rates than the Asian ones (Figure 4.1f). Those of the Nile Region and the W Africa Region have varied around 2.6-2.8% over decades, and according to the UN projections, they are expected not to come down soon. The regions in Asia, in contrary, show remarkable decline in population growth rate since 1970. According to UN (2002a), this tendency is projected to continue.

The UN (2002a) projections for each country are summarized in Table 4.1a. Disregarding of the positive signs of growth rate decrease within the Asian regions, the population sizes projected for 2025 and 2050 are phenomenal, compared with the present situation. Only China, and to a lesser extent SE Asia appear to be able to stabilize their populations within a few decades. The other regions will be in steady and momentous growth over decades (Figure 4.1f).

This growth, which is faster than the world average, means that their proportion of the world total is in growth (Figure 4.1e). The share of the African regions together grows from 6.3% to 14.1% in 1970-2050, and that of S Asia from 18.6% to 24.3%. In the same period, the total proportion of the study regions grows from 54.6% to 62.4%, given the projections of UN (2002a).

China's share has decreased from 22.1% of 1970 to the present 21.0%, and is expected to decrease to 15.3% till 2050, while the Nile region's share grows from 3.2% to 6.6%. The number of people in China will grow 1.7-fold in 80 years (1970-2050). The corresponding figure for W Africa is 5.9-fold, for the Nile region 5.1, for S Asia 3.2, and for SE Asia 2.8-fold.

World's population is expected to grow 2.5-fold within the period of 1970-2050 (UN 2002a).

With these growth rates in recent past and at present, the African study countries almost double their population within one generation (Figure 4.1f). The rates are expected to decrease only after one generation from now.

Population density

The population size must be related to the size of the region. Figure 4.1d shows that S Asia has a far more dense population than the other regions. It has already passed the density of 300 people per km^2. China has less than half of that density, and the African regions not more than one-tenth. However, the African regions have large deserted areas and the average figure is somewhat misleading.

Particularly condensed countries by region are shown in Table 4.1b. This list is again biased because countries such as Egypt with a very uneven spatial distribution of population are left out, because their average figures remain relatively low.

Figure 4.1d
Projected population density by regions
People by km^2. Sources: World Bank (2001) and UN (2002a).

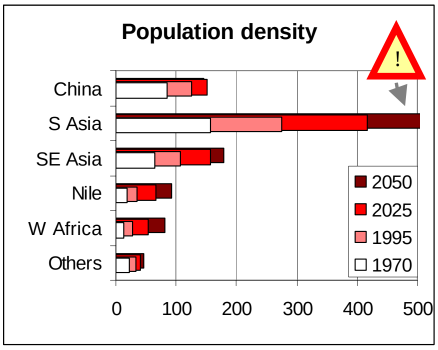


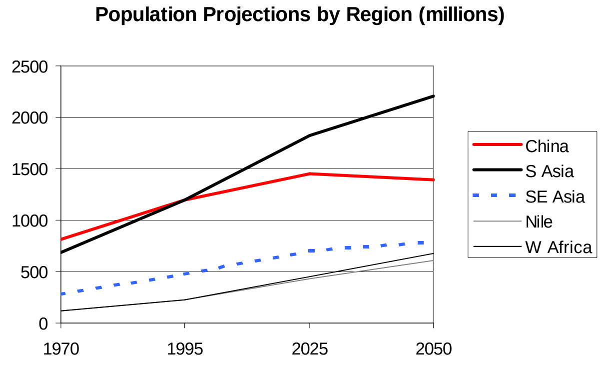
Table 4.1a
Population by country
UN (2002a) data and projections, in millions. The region totals are given in Figure 4.1f.

	1970	1995	2025	2050
China	**818**	**1200**	**1455**	**1394**
S Asia	**687**	**1200**	**1819**	**2208**
Bangladesh	67	120	178	205
India	548	929	1363	1628
Nepal	11	21	36	43
Pakistan	61	130	242	332
SE Asia	**285**	**476**	**705**	**799**
Cambodia	7	10	18	22
Indonesia	118	193	282	316
Lao PDR	3	5	9	11
Malaysia	11	20	36	46
Myanmar	27	45	60	69
Philippines	38	69	116	136
Singapore	2	3	8	10
Thailand	36	58	72	72
Vietnam	43	73	104	117
Nile region	**119**	**229**	**433**	**603**
Burundi	4	6	12	20
Egypt	33	58	96	115
Eritrea	29	56	8	13
Ethiopia			118	173
Kenya	11	27	33	37
Rwanda	4	6	8	9
Sudan	14	27	50	64
Tanzania	14	30	60	88
Uganda	10	19	48	84
W Africa	**115**	**228**	**454**	**679**
Benin	3	5	12	18
Burkina Faso	6	10	22	34
Cameroon	7	13	25	35
CAR	2	3	5	6
Chad	4	6	18	33
Cote d'Ivoire	6	14	26	36
The Gambia	0	1	3	4
Ghana	9	17	27	32
Guinea	4	7	14	21
Guinea-Bissau	1	1	2	3
Liberia	1	3	6	10
Mali	5	10	22	36
Mauritania	1	2	5	7
Niger	4	9	26	52
Nigeria	53	111	205	304
Senegal	4	8	17	23
Sierra Leone	3	4	11	15
Togo	2	4	8	10
Regions total	**2019**	**3337**	**4866**	**5683**
World total	**3697**	**5716**	**7859**	**9104**

Figure 4.1e

Population projections by regions

Population data and projections by UN (2002a).



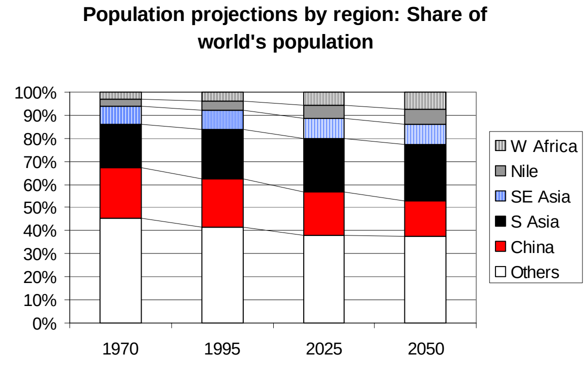


Figure 4.1f

The population doubles in one generation in many countries, particularly in Africa

The population growth rates adjusted for 25 years. Source: UN (2002a).

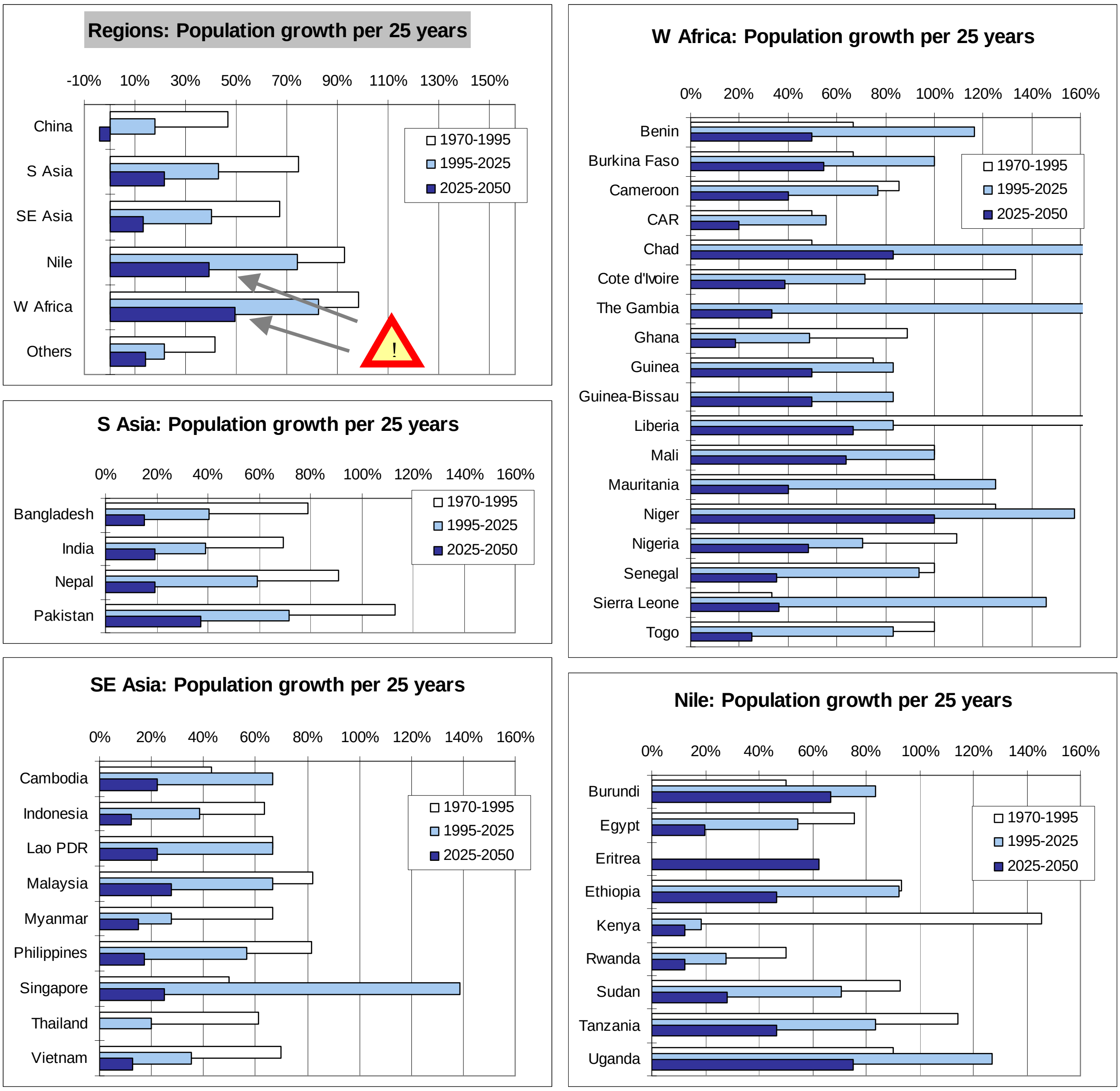


Table 4.1b

Densely populated study countries

All the study region countries with more than 100 people per km² in 2002 (Singapore excluded). Source: World Bank (2004).

Region	Country	Population density (people per km² in 2002)
China	China	137
S Asia	**Bangladesh**	**1042**
	India	353
	Nepal	169
	Pakistan	188
SE Asia	Indonesia	117
	Philippines	268
	Thailand	121
	Vietnam	247
Nile	Burundi	275
	Rwanda	331
	Uganda	125
W Africa	The Gambia	139
	Nigeria	146

China has a large territory, 9.6 million km², but most of it is very scarcely populated (Figure 4.1g). The average population density is 137 people per km². 90% of people are living in less than one third of the land area, with a density of 354 people per km². This is a higher density than in Japan or any European country except the Netherlands. 50% of Chinese live in a density as high as 740, and 30% (346 million) in 1,024. For comparison, the Bangladesh has 1042, island of Java has 870, and the Netherlands has 477 inhabitants per km² (World Bank 2004). Figure 4.1h relates the population density of selected Chinese provinces to some countries around the world.

Figure 4.1g

China's population is very concentrated

People are condensed in humid areas (source: Heilig 1999).

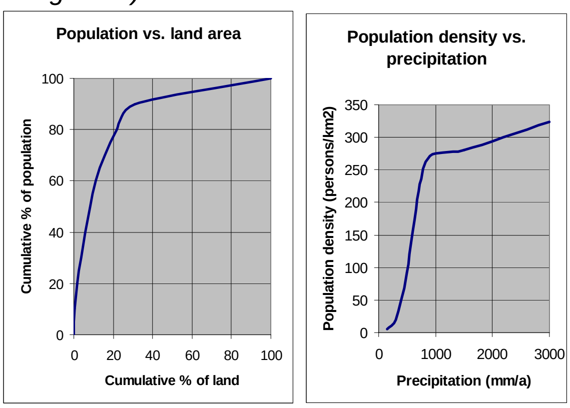


Figure 4.1i shows how dramatic the Chinese population growth has been in comparison to Europe. In 1950, the populations of those two areas were equal in size, but at present, Europe has only 60% of China's population size. In 2050, Europe is expected to have only 47% of China's population.

There are many reasons that explain the population concentration, but a very simple comparison of precipitation and cumulative population in China shows, that with precipitation higher than 900-1000 mm per year, the amount of rainfall does not have much effect on population density. This observation was drawn from the tables of Heilig (1999).

Figure 4.1h

China's population density in comparison

Population and its density in some Chinese provinces in comparison to selected countries of equal population size (source: Heilig 1999).

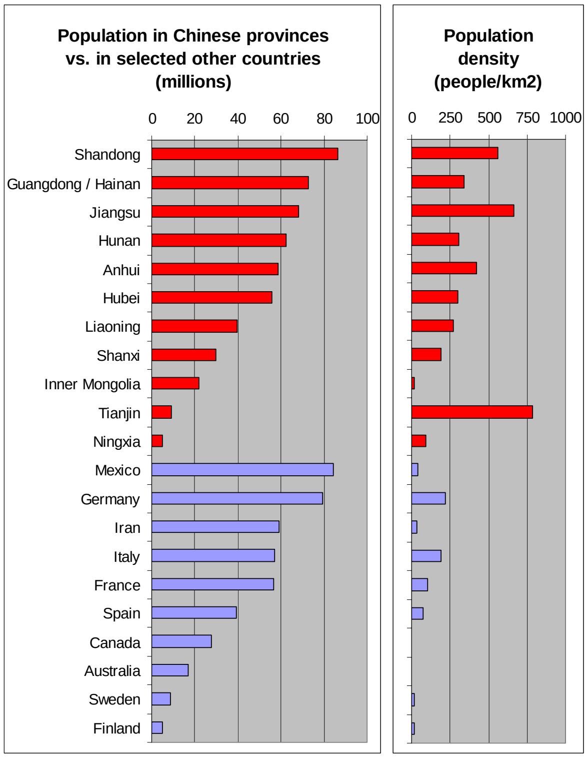
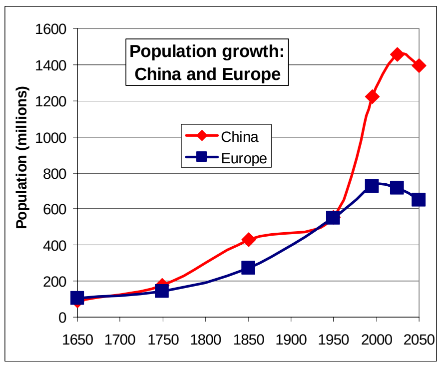


Figure 4.1i

China beats Europe in population growth

China's population growth has been rapid, but the growth rate is declining (sources: UN 2002a and Heilig 1999).



4.2 Urbanization

Olli Varis

Many say that urbanization will even be a more problematic and momentous issue than population growth. The fact that almost all of the world's population growth ends to cities implies that urbanization is among the major global changes. It is a big issue to most individuals in coming decades, as well as when considered as a driving force in any development of the societies, whether nature, environment, social issues or economics are in focus.

Cities absorb the population growth

The previous Chapter presented the outline of population growth on the world scale, as well as in the study regions. The growth in urban areas — due to both migration and natural growth — accounts for almost all of the total population growth.

At present, around one half of the earth's 6 billion people live in urban areas. Each year, the world population grows with around 80 millions. Practically all of this is urban growth, but merely due to migration; fertility rates are far smaller in urban areas than in rural ones.

Let us view the mankind just one generation ahead in time, which is the shortest possible time span for any consideration of sustainable development. World's urban population is expected to reach 5 billion by 2030. This would be 66% more than in 2000, and would mean that 60% of world's population lives in urban areas (UN 2002b).

Africa and Asia will urbanize massively

In Africa and in Asia, the proportion of urban population is around 1/3 while in all the other continents it is over 2/3. Therefore, the most massive urbanization development is to be expected in Asia and in Africa (Figure 4.2a).

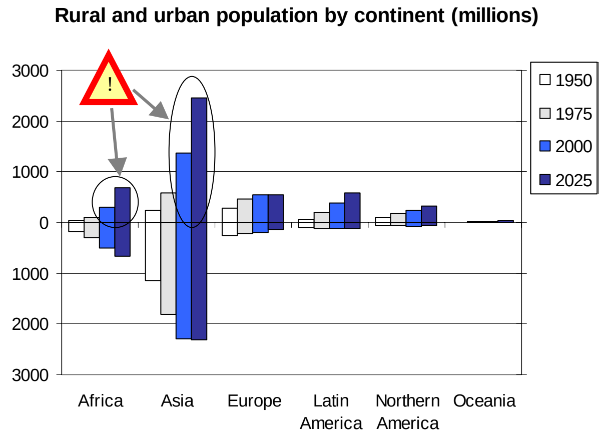
In many big cities of Africa, such as Addis Ababa, Kinshasa, and Lagos, the population more than doubles in a decade. In China, the urban population has been estimated to grow with 378 million by 2025. China's cities face severe environmental and resource degradation problems already now. The urban population, however, is 'only' 456 million today.

Urbanization of low-income countries

It seems that urbanization will touch most drastically the low-income countries, in most of which urbanization is very fast and will continue long (cf. Figure 4.2b). In terms of population share, India and China are in the key position; they have roughly 2/3 of the low-income category population.

In developing countries, much of the urban growth occurs in an uncontrolled fashion. Several, interlinked vicious circles feed the cities with people, and government controls are only partial. In many cities, up to 90% of the population are linked with the informal sector (Drakakis-Smith 1987), and much of the formal sector is at least partially controlled by foreign enterprises.

Figure 4.2a
Rural and urban population by continent
Rural below the line. Source: UN (2002b).

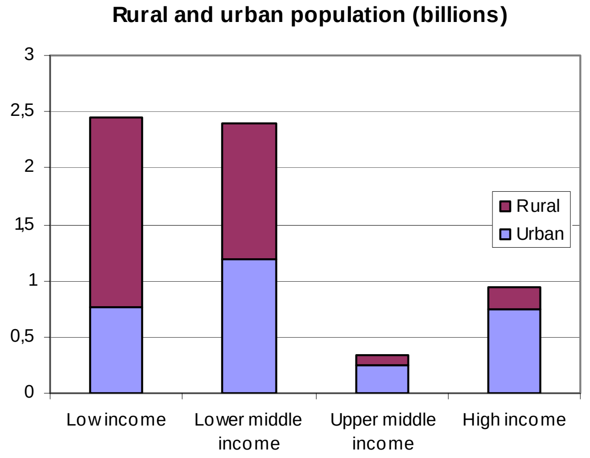


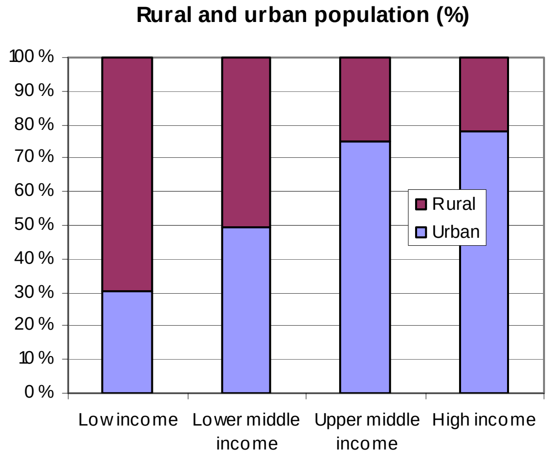
Urbanization – its causes, driving forces, and consequences – are not limited to urban areas. The marginally growing rural population must practically feed themselves and the rapidly growing urban areas. This will not be simple.

Why urbanization?

Why is there an alarming number of people leaving their rural settlements, with their sound social relations, and moving into hectic urban centers, where

Figure 4.2b
Urbanization and economic categories
Population in urban centers and rural areas. The urbanization rates in 1995-2002 were 3.3% for low-income, 2.4% for lower middle income, 1.6% for upper middle income, and 1.0% for high income economies. Source: World Bank (2004).



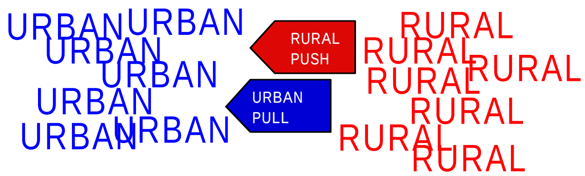


there is a high probability of living in very poor and overcrowded circumstances? Most migrants to many developing world cities build their homes on any available land without adequate infrastructure, and often live on a formally illegal basis.

In Ankara, Turkey, 2/3 of people live in squatter settlements, because former urban plans have proven incapable of meeting the demands of the population explosion (Drakakis-Smith 1987). The situation is not too different in many other cities; 2/3 of the population of Calcutta, India, and 3/4 of that of Ibadan, Nigeria, live in squatter conditions.

The fundamental reasons to urbanization are twofold (Figure 4.2c), called often the rural push and the urban pull (see Haggett 1979). Rural areas often have high birth rates, and they do not offer work for the growing number of young people. Even improving technology often reduces the need for labor.

Figure 4.2c
Rural push and urban pull forces
Water management and infrastructure decisions are among their many components.



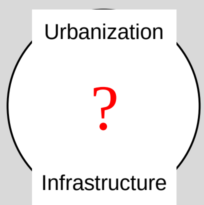
Urban pull factors are manifold. Discrepancies in living conditions between rural and urban areas are marked in many countries; In Brazil, Iran, and Argentina, the ratio of Gross Regional Product between the richest and poorest regions is one order of magnitude.

Box 4.2a
Vicious circles of urban growth

One should evidently make any attempts to try to cut the vicious circles in urban development, and to make the urbanization and infrastructure development more controlled processes (Figure 4.2d).

This, however, requires huge amounts of political and economic power and will, especially over the informal sector. These are often lacking. Recent developments in former centrally planned economies are vivid examples of collapsing formal sectors that tried to keep a strong control over the opening societies. How the success stories of today — e.g., Singapore, Western Europe — will develop further, remains to be seen.

Figure 4.2d
Vicious circle of infrastructure development
City growth appears to outpace infrastructure development in many fast growing cities.



Although the increased income level represents by no means the most likely scenario for a migrant who moves to a city, it shows the possibility of a better life, however tiny one. In reality, the differences between the economic elite and the migrant are typically huge.

Most cities of the developing world have a colonial background. Colonialism varied enormously from region to region, but some general features can be detected. Drakakis-Smith (1987) has a 7-step model

Box 4.2b

The Delhi case

An example of the history of urbanization (after Drakakis-Smith 1987).

Pre-contact phase (pre-1500). Small towns with organical pattern predominate.

Mercantile colonialism (1500-1800). Limited colonial presence in ports. Trade in natural products of the local region. At the end of the 18th Century, Delhi was the Mogul capital with 150 000 inhabitants. The center was dominated by the Royal Palace, the Jama Mosque and the Chadni Chowk, as political, religious, and commercial foci, respectively. The remainder consisted of narrow lanes and organically patterned mixed land uses.

Transitional phase (1800-1850). Reduced investments overseas. Industrial revolution facilitated greater profits. Between 1803 and 1857 Delhi was a district military post to Punjab — not a major administrational or commercial center — with a few hundred European inhabitants. The British were living in an area next to the Royal Palace, where the Mogul aristocracy used to live. Their living was very similar to that of the local elite. Very little conflict took place.

Industrial colonialism (1850-1920). Cheap raw materials from colonies. Territorial patterns, new settlements. In Delhi, the puppet emperor was dethroned in 1857. The British military control sharpened, and the indigenous people were forced to move out of the civil lines. Isolation increased. Many imposing buildings for symbolizing institutional power were constructed. Around 230,000 Indians were living in the old city of 4 km^2 while a few thousand British lived in the open spaces of their district.

Late colonialism (1920-1950). Growth of European influence. Extension to smaller towns in hierarchy. Delhi was chosen as the capital of India in 1911 due to good railway connections. A decade later, New Delhi was planned on a vast scale. Spatial categorization was very rigid. There was no manufacturing growth except some food industry. Old Delhi received some improvements to water supply and drainage, but major water infrastructure efforts were focused on the foreigners' districts. There was massive immigration to Old Delhi, which amplified the contrasts.

Early independence (1950-1970). Rapid population growth by immigration of indigenous people in search for jobs. Expansion of slum and squatter settlements. Delhi's population increased rapidly. It was an attractive opportunity, although most immigrants lived in very poor circumstances. Around 1960, Old Delhi contained 60% of the city's population in with a density of 41,300 per km^2.

New international division of labor (1970 onwards). Appearance of the factories of multinational corporations. Further migration. Since 1960, Delhi's population has grown fourfold, up to 6 million. Squatter settlements without proper water related infrastructure have expanded and multinational companies do not employ a notable part of Delhi's population, unlike in some other big cities in the developing world.

for colonial urbanization (see also King 1991). It relates primarily to Asia, but the succession is mostly likely to be valid across Africa and Latin America as well. The time scales may differ from city to city. A brief summary of the model with an example (Delhi, India) is given in Box 4.2b.

In many countries the biggest urban centers are the most attractive ones, and therefore grow faster than other cities. In Thailand, the growth rate of Bangkok greatly outpaces that of other Thai cities. The concentration of manufacturing centers within the capital is strong. Manila contains 79% of the Philippines manufacturing employment.

As a result, many capitals have become under direct government administration, almost to the point of being quasi-independent (e.g., Jakarta, Bangkok Metropolitan Area, Metro Manila, Federal Territory of Kuala Lumpur). These cities evidently want to be among the ones that raise from peripheral to semi-peripheral or even core socio-economic units in the global scale (cf. King 1991). Such centers are pressingly needed, especially in Sub-Saharan Africa and in many parts of Asia.

Developments of infrastructure and technology are among the key factors, which have contributed to the growth of present day cities. As mentioned above Delhi was chosen as the capital of Imperial India because of good railway connections. Its growth in area and population in the 1920s and 1930s was greatly enhanced by the spreading of cars, telephones, etc.

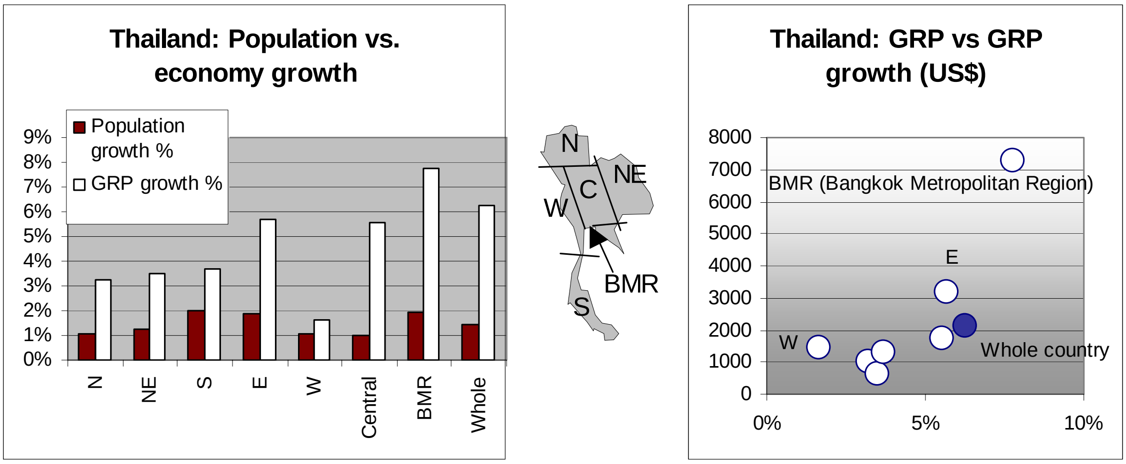
Other examples include Jakarta, Indonesia (Box 10.3b) and Bangkok, Thailand (Figure 4.2e). They both are subject to the typical dichotomy; the present infrastructure has not been able to respond to the growth of the city, but any improvement in infrastructure potentially speeds the growth of the city (Box 4.2a). Now, these cities are not among the poorest, nor the most problematic ones in the world.

A counterexample is China where many middle-sized cities grow now much faster than the biggest cities such as Shanghai, Beijing or Tianjin.

Figure 4.2e

Thailand's and Bangkok's economy

Bangkok's strong economy in comparison to the economy of the rest of Thailand. The period 1989-93 is under study; annual rates are shown. GRP means Gross Regional Product, shown in US$. BMR is Bangkok Metropolitan Region. Source: Pednekar (1997).



Todaro (1997) classifies five main, non-economic reasons that influence the decision of individuals to migrate from rural areas to urban ones. They are:

- *Social factors*: the will to break away from traditional constraints of traditional organizations.
- *Physical factors*: Disasters due to climate and weather, such as droughts and floods.
- *Demographic factors*: massive population growth rates in rural areas due to decreased mortality.
- *Cultural factors*: Security provided by extending the family relationships to urban areas and the allure of the urban lifestyle.
- *Communication factors*: improved transportation, educational systems, and the influence of mass media and telecommunications.

Todaro (1997) adds, that the primary factors tend to be economical in nature. The biggest group of migrants is young people between the ages of fifteen and twenty-four. The level of educational attainment correlates well with migration.

In former days, the majority of migrants tended to be landless, poor, and unskilled individuals, who had no opportunities to make their living in urban areas. Todaro (1997) argues, that the situation has changed due to the growth of stability in economies and industrial growth. Today, migrants come from all social strata. They are poorer than urban dwellers, because the rural income level is lower than the urban one.

After all, the situation must be very country-specific, and such generalizations may be too vague. Both the poor and unskilled, as well as the well-educated individuals seek better living from cities. Their proportion must be very different in different countries.

Study regions: overview

The study regions account at present for around 71% of the world's rural population. This share will grow slightly when viewing the world one generation ahead in time (Figure 4.2f). China's share will decrease, but that of the other regions will more than compensate that number.

Their share of urban population has grown markedly, and will continue to do so. One generation ago, in 1975, their urban population was 452 millions, which was 29% of world's urban population. In 2000 these figures were 1196 millions and 42%. In the UN (2002b) projections for 2025, the corresponding numbers are 2,362 millions and 51%.

In 1975-2000, the urban population grew 2.28-fold in S Asia and 3.5-fold in W Africa (Table 4.2a). The rates in the other regions were between those two. In countries outside the regions the rate was 1.59. Within the period 2000-2025, China's urban population is expected to grow 1.82-fold, and Nile's 2.39-fold.

In the statistics for the study regions, the urbanization rate correlates significantly, negatively, with the wealth of the nation. The poorer the country is, the faster the urban areas grow (Figure 4.2g).

Figure 4.2f

Urbanization forecasts

Rural and urban population in the study regions and in other countries. Source: UN (2002b).

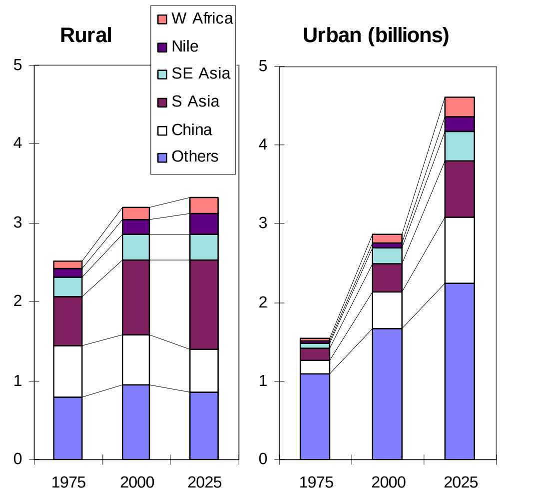


Table 4.2a

Rural and urban growth

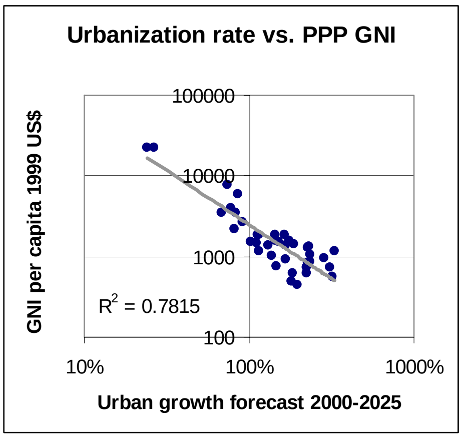
Growth rates adjusted for 25 years (source: UN 2002b).

Rural	1975-2000	2000-2025	**Urban**	1975-2000	2000-2025
China	0.97	0.86	*China*	2.80	1.82
S Asia	1.53	1.20	*S Asia*	2.28	1.98
SE Asia	1.31	0.98	*SE Asia*	2.74	1.90
Nile	1.73	1.38	*Nile*	2.74	2.39
W Africa	1.59	1.37	*W Africa*	3.50	2.52
Others	1.22	0.77	*Others*	1.59	1.56

Figure 4.2g

Poor countries urbanize most rapidly

A log-log correlation plot for urban growth forecast (UN 2002b) against Purchasing Power Parity adjusted GNI per capita in 1999 (World Bank 2001). All the study countries except Myanmar and Liberia are included.



Asian regions

China has by far the lowest expected population growth among the study regions (Figures 4.2h and i). The rural population is even expected to go down by 14% between 2000-2025. The number of urban people, however, will grow by 83%, which means not less than 378 million people (which exceeds the population of the European Union in 2003). In 2025, the UN (2002a) estimates for urban and rural population in China are 834 and 552 millions, respectively.

The other giant, India, has a different pattern than China in the sense that the rural population is expected to grow by 16%. Urban growth will be 82%, which is very close to the Chinese level. India will remain far more rural country than China with its urbanization level of 37.5% against China’s 60.2% in 2025.

Bangladesh and Pakistan will both have a far higher relative population growth than India. Their urban populations are expected to grow around 2.5-fold in mere twenty-five years. At the same time the number of rural people is also expected to grow 44% in the case of Pakistan, and 21% in Bangladesh. Their total population was 278 millions in 2000, and it is expected to grow up to 461 millions which is a massive number.

Nepal, however, will have proportionally the highest population and urbanization growth in the Asian regions. It shares the pole position with Cambodia. In these very poor countries, the urban population grows 3.3-fold between 2000 and 2025. This growth, accorded with the 50% growth in rural population, will challenge those resource-scarce societies—the poorest ones in Asian study regions—in a very big way. In addition, Lao PDR is almost in a same level of trouble with its urbanization and population growth as Cambodia and Nepal.

The other SE Asian countries all have an urbanization and population growth pattern, which is surprisingly homogeneous: the urban population will double, the rural one will change only little. In these countries there already are a number of very crowded and massive megacities which will grow further and new ones will emerge.

African regions

Whereas the poorest countries in the Asian study regions will have enormous challenges with their urbanization problems, there are several countries in African regions, which will have even superior challenges.

In W Africa, there are two groups of countries, which are particularly problematic in terms of urbanization. The first group consists of the landlocked, extremely poor countries in the Sahel zone: Chad, Niger, Burkina Faso and Mali. Their urban population will grow around 3.3 to 4.2-fold in 2000-2025. On the top, the rural population growth will be 1.5 to 2-fold. The second group is the violence-blocked countries Liberia and Sierra Leone. In fact, virtually all the W African study countries will face remarkable challenges with urbanization.

Figure 4.2h
Population grows fast and concentrates to urban areas
Growth rates of urban and rural population in the study region countries. Source: UN (2002b).

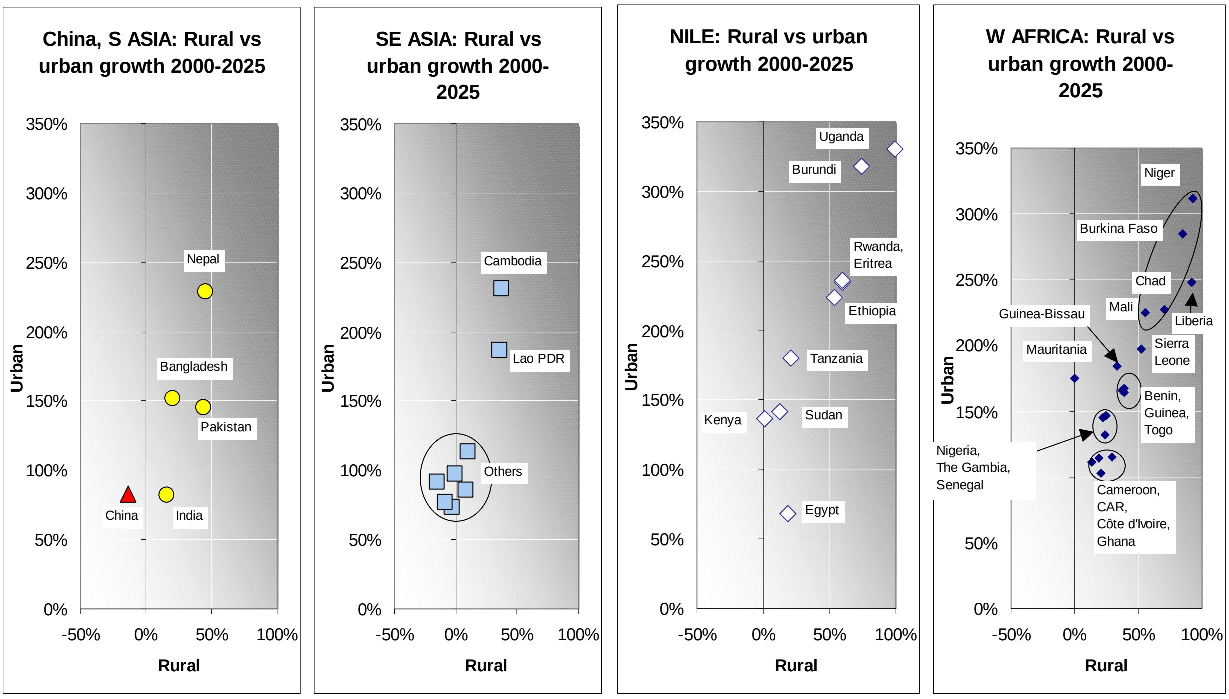
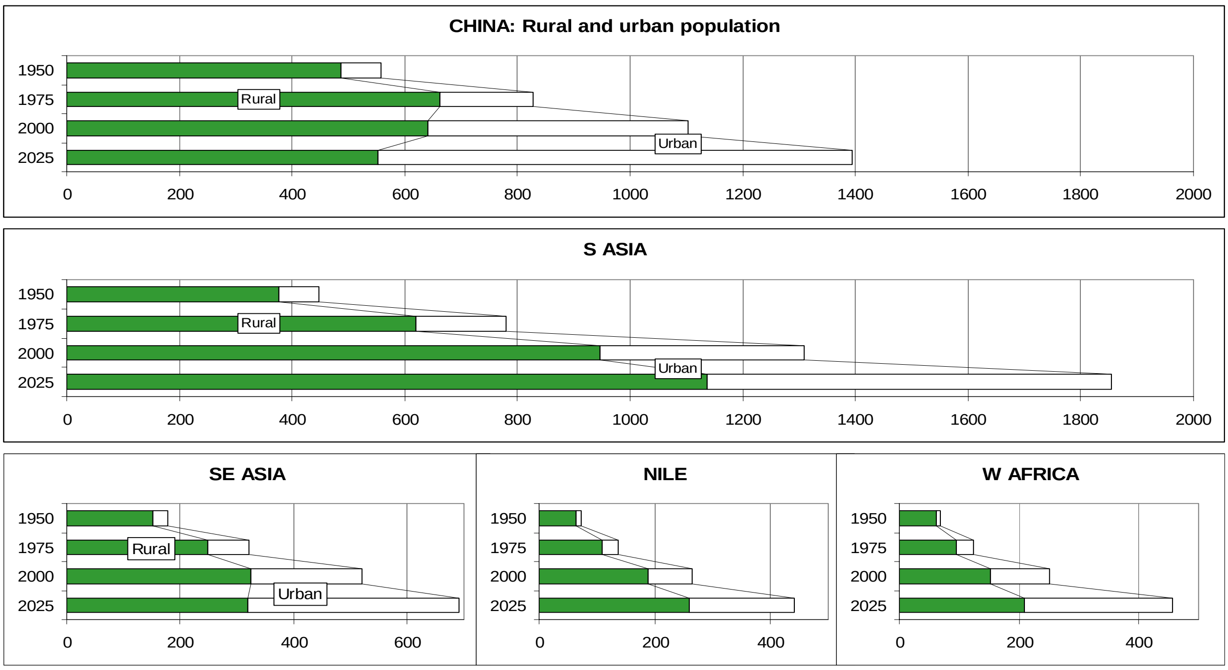


Figure 4.2i
Most of the population growth ends to urban areas
Rural (left) and urban (right) population by regions in 1950, 1975, 2000, and 2025. Source: UN (2002b).



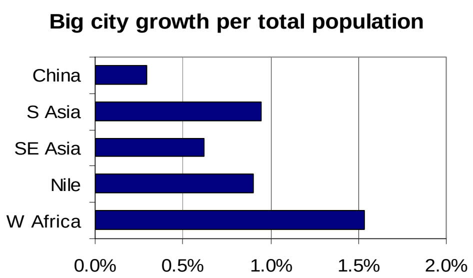
In the Nile region, Uganda and Burundi have extremely high urbanization forecasts. Their urban population is expected to grow over 4-fold in twenty-five years. Again, high rural growth is taking place at the same time. Egypt is very different from the other Nile region countries. Its urbanization rate is quite modest, urban areas are expected to have 68% more population in 2025 than they had in 2000. This number is small only in comparison to the other African countries but in reality it is an alarming growth rate.

Big cities

Urbanization is seen most dramatically as the growth of large urban agglomerations, which are expected to grow like mushrooms in all the study regions. This growth is bigger than in any other parts of the world. Whereas in 1985, only three study region countries were among the world's ten biggest cities, in 2000 there were four and in 2015 there will be six of them.

Astonishingly, W Africa is the most urbanized study region. Also it has by far the biggest share of migration to big cities (Figure 4.2j). China is equally clearly the last on that list.

Figure 4.2j
Relative growth of population in big cities
Source: UN (2002b).



The UN Population division publishes regularly statistics on the large urban agglomerations of the world. Those statistics include all cities with over 750,000 people in 1990. The study regions include altogether 125 such cities. Tables 4.2b and c include some basic data of those cities (see also Figures 4.2 k and l).

Table 4.2b
Summary data: big cities of study regions
For details see Table 4.2c and UN (2002b).

Region	Number of big cities	Population in big cities (million) and % of total	Average growth rate (in 25 years)
China	50	131 (10%)	0.73
S Asia	44	153 (12%)	2.00
SE Asia	15	59 (12%)	1.32
Nile	7	25 (10%)	2.29
W Africa	9	30 (12%)	3.22

Some cities are expected to grow more than 5 or 6-fold in 25 years. Such cities include Dhaka (Bangladesh) and Peshawar (Pakistan). Other cities that grow more than 4-fold, include Yaounde (Cameroon), Conakry (Guinea) and Gujranwala (Pakistan).

The massivity of the urbanization development is striking; whether considered from the standpoint of megacity growth, augmentation of the urbanization level, or from the growth rates of urban population.

Urbanization in developing countries is remarkably faster than in industrialized countries. Moreover, the biggest cities appear to grow at the highest rates with the exception of China. Much of this urban growth occurs uncontrolled, with only a minor impact felt from government controls.

Figure 4.2k
World's biggest cities in 2015
*With population data from 1985 and 2000. The study region countries are marked by *. Source: UN (2002b).*

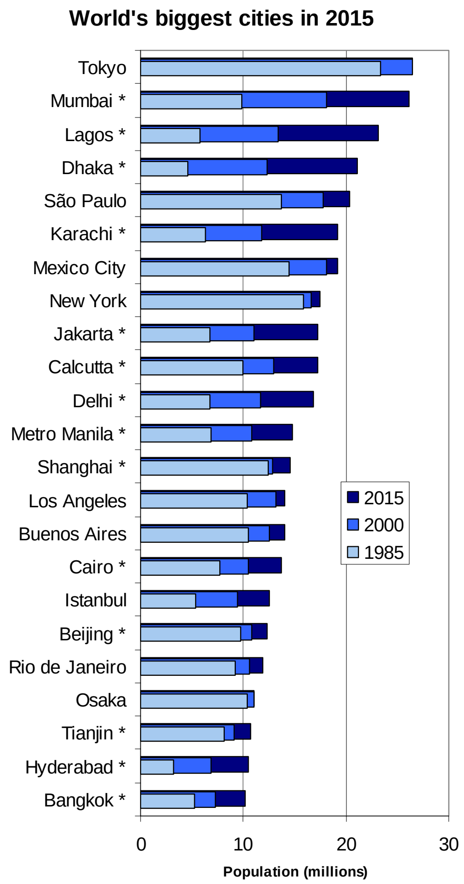


Figure 4.2l

Growth rates of world's biggest cities

Within the ten biggest cities in 2015, there are six cities inside the study regions. They grow much faster than the other ones. Source: UN (2002b).

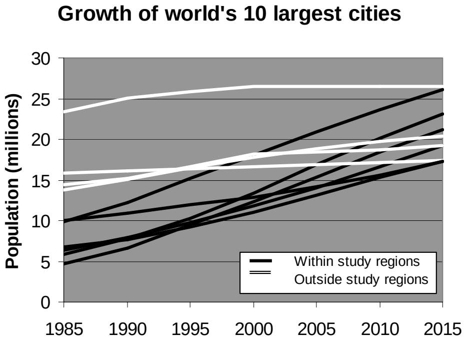


Table 4.2c

Cities of case study regions

Population of cities with at least 750,000 inhabitants in 1990 (millions). Growth rate (r) adjusted for 25 years is shown (source: UN 2002b).

Region	Country	City	1975	2000	2015	g/25a
S Asia	India	Mumbai	6.85	18.0	26.1	1.757
W Africa	Nigeria	Lagos	3.3	13.4	23.1	3.763
S Asia	India	Calcutta	7.88	12.9	17.2	0.741
China	China	Shanghai	11.4	12.8	14.5	0.171
S Asia	Bangladesh	Dacca	1.92	12.3	21.1	6.231
S Asia	Pakistan	Karachi	3.98	11.7	19.2	2.389
S Asia	India	Delhi	4.42	11.6	16.8	1.748
SE Asia	Indonesia	Jakarta	4.31	11.0	17.2	1.875
SE Asia	Philippines	Metro Manila	5	10.8	14.8	1.228
China	China	Beijing	8.54	10.8	12.2	0.274
Nile	Egypt	Cairo	6.07	10.5	13.7	0.788
China	China	Tianjin	6.16	9.15	10.7	0.461
SE Asia	Thailand	Bangkok	3.84	7.28	10.1	1.025
China	China	Hong Kong	3.94	6.92	7.68	0.593
S Asia	India	Hyderabad	2.08	6.84	10.4	2.508
S Asia	India	Madras	3.60	6.64	9.14	0.958
S Asia	Pakistan	Lahore	2.39	6.04	9.96	1.970
S Asia	India	Bangalore	2.11	5.56	7.98	1.737
China	China	Chongqing	2.43	5.31	8.94	1.668
China	China	Wuhan	2.92	5.16	7.35	0.944
China	China	Shenyang	3.69	4.82	5.66	0.333
SE Asia	Viet Nam	Ho Chi Minh	2.35	4.61	6.20	1.022
SE Asia	Myanmar	Yangon	1.76	4.19	6.04	1.523
S Asia	India	Ahmedabad	2.05	4.16	5.82	1.150
Nile	Egypt	Alexandria	2.24	4.11	5.52	0.915
China	China	Guangzhou	3.10	3.89	4.46	0.273
SE Asia	Viet Nam	Hanoi	0.81	3.73	5.10	3.282
S Asia	Bangladesh	Chittagong	1.01	3.58	5.87	2.985
SE Asia	Singapore	Singapore	2.26	3.56	3.99	0.478
S Asia	India	Pune (Poona)	1.34	3.48	5.12	1.757
SE Asia	Indonesia	Bandung	1.49	3.40	5.24	1.568
W Africa	Cote d'I-	Abidjan	0.96	3.30	5.06	2.674
China	China	Chengdu	2.07	3.29	4.09	0.607
China	China	Xian	1.93	3.12	3.81	0.604
China	China	Changchun	1.55	3.09	4.57	1.208
China	China	Harbin	2.28	2.92	3.36	0.294
China	China	Nanjing	1.93	2.74	3.26	0.427
Nile	Sudan	Khartoum	0.88	2.73	4.61	2.626
Nile	Ethiopia	Addis Ababa	0.92	2.63	5.09	2.802
China	China	Dalian	1.39	2.62	3.16	0.790
China	China	Jinan	1.23	2.56	3.10	0.943
S Asia	India	Lucknow	0.89	2.56	3.94	2.140
China	China	Guiyang	1.14	2.53	3.96	1.548
Region	Country	City	1975	2000	2015	g/25a
SE Asia	Indonesia	Surabaia	1.47	2.46	3.40	0.821
S Asia	India	Kanpur	1.42	2.45	3.40	0.872
China	China	Taiyuan	1.51	2.41	2.95	0.590
Nile	United	Dar es Salaam	0.63	2.34	4.25	3.539
S Asia	India	Surat	0.64	2.34	3.61	2.891
China	China	Qingdao	1.10	2.31	2.86	0.994
Nile	Kenya	Nairobi	0.67	2.31	3.77	2.858
S Asia	Pakistan	Faisalabad	0.90	2.23	3.75	1.964
S Asia	India	Jaipur	0.77	2.14	3.19	1.937
S Asia	Pakistan	Peshawar	0.34	2.09	3.57	5.806
W Africa	Senegal	Dakar	0.76	2.07	3.49	2.219
China	China	Zhengzhou	1.22	2.07	2.69	0.749
S Asia	India	Nagpur	1.07	2.06	2.90	1.062
S Asia	Pakistan	Gujranwala	0.43	2.05	3.48	4.335
China	China	Handan	0.76	1.99	2.51	1.430
W Africa	Ghana	Accra	0.85	1.97	3.41	1.879
SE Asia	Indonesia	Medan	1.03	1.87	2.65	0.983
China	China	Xuzhou	0.66	1.87	3.57	2.722
W Africa	Guinea	Conakry	0.37	1.82	3.15	4.658
China	China	Hangzhou	1.09	1.78	2.36	0.719
China	China	Changsha	0.94	1.77	2.53	1.056
S Asia	India	Kochi (Cochin)	0.53	1.76	2.72	2.579
W Africa	Nigeria	Ibadan	0.64	1.73	2.79	2.071
China	China	Lanzhou	1.17	1.73	2.1	0.492
China	China	Nanchang	0.89	1.72	2.50	1.119
S Asia	India	Visakhapatnam	0.45	1.70	2.69	3.094
China	China	Kunming	1.22	1.70	2.04	0.420
China	China	Tangshan	1.19	1.67	2.10	0.474
W Africa	Cameroon	Douala	0.38	1.67	2.77	3.940
S Asia	India	Ludhiana	0.47	1.65	2.59	2.759
S Asia	India	Ulhasnagar	0.49	1.63	2.51	2.585
S Asia	India	Vadodara	0.57	1.60	2.41	2.015
China	China	Shijiazhuang	0.94	1.60	2.07	0.757
S Asia	India	Bhopal	0.48	1.57	2.40	2.453
S Asia	Pakistan	Rawalpindi	0.67	1.53	2.59	1.796
S Asia	Pakistan	Multan	0.59	1.5	2.54	2.032
China	China	Anshan	1.08	1.45	1.69	0.352
China	China	Luoyang	0.79	1.45	1.92	0.887
W Africa	Cameroon	Yaounde	0.27	1.44	2.42	4.875
China	China	Qiqihar	1.09	1.43	1.69	0.345
China	China	Jilin	0.95	1.43	1.76	0.535
S Asia	India	Indore	0.66	1.42	2.05	1.313
S Asia	Bangladesh	Khulna	0.47	1.42	2.30	2.427
SE Asia	Indonesia	Palembang	0.59	1.42	2.19	1.677
China	China	Wulumuqi	0.71	1.41	1.89	1.026
China	China	Fushun	1.08	1.41	1.65	0.332
China	China	Fuzhou	1.01	1.39	1.62	0.375
SE Asia	Malaysia	Kuala Lumpur	0.64	1.37	1.85	1.174
China	China	Baotou	0.91	1.31	1.61	0.474
China	China	Nanning	0.67	1.31	1.66	0.922
S Asia	Pakistan	Hyderabad	0.66	1.30	2.21	1.449
S Asia	India	Coimbatore	0.81	1.29	1.79	0.756
S Asia	India	Patna	0.64	1.29	1.79	1.114
S Asia	India	Varanasi	0.68	1.29	1.83	1.060
S Asia	India	Madurai	0.79	1.27	1.76	0.772
S Asia	India	Meerut	0.43	1.26	1.92	2.165
China	China	Hefei	0.71	1.24	1.57	0.749
S Asia	India	Vijayawada	0.41	1.23	1.88	2.183
S Asia	India	Thiruvanan-	0.45	1.22	1.88	1.968
Nile	Uganda	Kampala	0.39	1.21	2.59	3.446
SE Asia	Philippines	Davao	0.48	1.20	1.71	1.576
China	China	Suzhou	0.61	1.18	1.71	1.104
China	China	Shantou	0.64	1.17	1.68	1.012
S Asia	India	Agra	0.68	1.16	1.65	0.895
China	China	Datong	0.87	1.16	1.35	0.339
China	China	Wuxi	0.73	1.12	1.42	0.591
S Asia	India	Kozhikode	0.41	1.11	1.66	1.900
China	China	Daqing	0.62	1.07	1.32	0.692
S Asia	India	Allahabad	0.56	1.06	1.52	1.063
SE Asia	Indonesia	Ujung Pandang	0.50	1.05	1.55	1.306

Table 4.2c (continued)

Cities of case study regions

Population of cities with at least 750,000 inhabitants in 1990 (millions). Growth rate (r) adjusted for 25 years is shown (source: UN 2002b).

Region	Country	City	1975	2000	2015	g/25a
Nile	Egypt	Shubra El-	0.35	1.03	1.43	1.906
S Asia	India	Jabalpur	0.62	1.02	1.42	0.804
S Asia	India	Jamshedpur	0.53	1.00	1.41	1.015
China	China	Huhehaote	0.61	0.97	1.17	0.562
S Asia	India	Dhanbad	0.52	0.96	1.34	0.967
China	China	Benxi	0.71	0.95	1.13	0.365
China	China	Jixi	0.65	0.94	1.21	0.530
China	China	Liuzhou	0.46	0.92	1.26	1.072
China	China	Yichun	0.66	0.90	1.07	0.384
China	China	Jinzhou	0.53	0.83	1.06	0.632
SE Asia	Indonesia	Semarang	0.66	0.78	0.96	0.291
China	China	Fuxin	0.57	0.78	0.95	0.416

4.3 Global climate change

Olli Varis

The globe's climate is subjected to variations due to many reasons all the way from astronomy to rhythmic oscillations in sea and air currents. The hot questions today are whether the human activities have changed global climate, how this has happened and will happen, what will the most important consequences be, and how the future changes should be mitigated?

Overview

Human activities have changed the concentrations of many components in the atmosphere, particularly during the last one hundred years. The concentrations of the so-called greenhouse gases have increased; CO_2 (carbon dioxide) by 30%, NH_4 (methane) by 145% and NOx (nitrogen oxides) by 15%. Their increase has been caused by the burning of fossil fuels, land-use changes, and agriculture. Greenhouse gases have a warming effect on the globe's surface temperatures.

Burning of fossil fuels and biomass result also in the increase of aerosols in the troposphere. These aerosols, in contrary, have a cooling effect on climate. Their balancing effect is believed to be smaller than the warming effect of the greenhouse gases. Present-day scenarios suggest warming of the world's surface temperature by 1.4 to 5.8°C on average, over the period 1990 to 2100 (IPCC 2001).

Such changes, however, are anticipated to vary much with respect to local and regional weather conditions. Many suggest that the changes in variations are much more significant than those in the mean behavior of the climate (Katz and Brown 1992). In fact, extremes such as floods, droughts, storms and their frequency are often critical to water resources management, and changes in their pattern or frequency can be very influential to the economy and society.

Adaptation strategies

In the management of water and land, the knowledge and ability to adapt to the effects of climate variability has been traditionally recognized as one of the bases of proper management and operation (e.g. Schaake and Kaczmarek 1979). The climatic and hydrologic time series were assumed to be stationary, periodic-stochastic processes. Although paleoclimatologists have reported large changes in climate variables over diverse time scales, these changes were assumed to be slow enough to be neglected in natural resources management.

The reasonability of this stationarity concept in natural resources management has been increasingly questioned due to the uncertainties caused by climate changes. The following approaches have been advocated for studies of non-stationary climate impacts (Kaczmarek et al. 1996, Kuikka and Varis 1997):

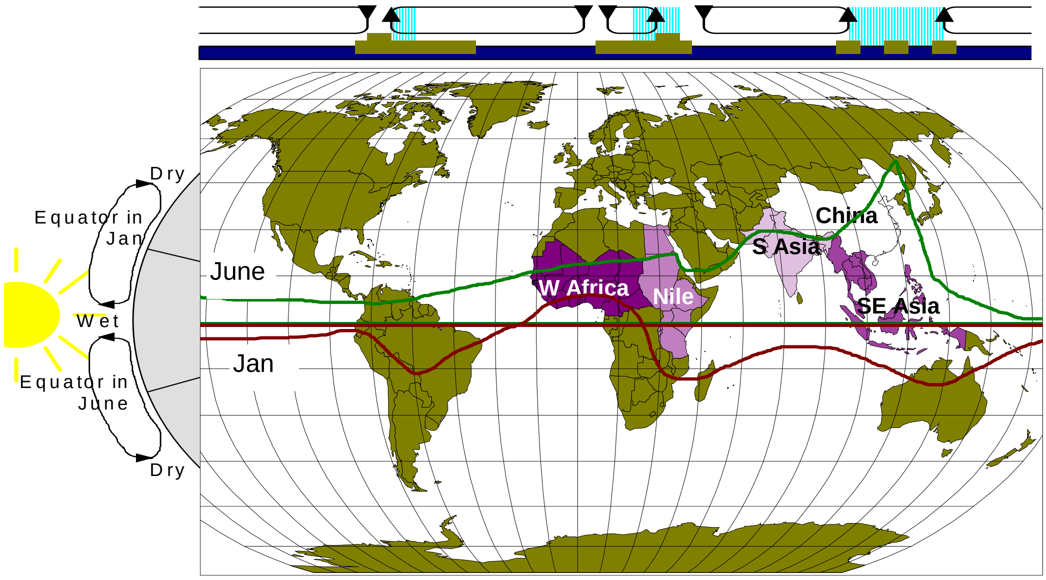
- Scenarios and sensitivity analyses are based on some *prescribed changes* in climatic elements.
- Temporal and/or spatial *climatic analogues* are used. For instance, a historical data on a particular climatic period (dry period, warm period etc.) or data from another location are used so as to correspond the assumed, changed climate.
- Scenarios can be based on *paleoclimatic* data or *extrapolation of observed time series*.
- Scenarios are based on *atmospheric models* such as global circulation models.
- Comprehensive *elicitation of judgments of a panel of experts* on heir anticipations concerning climate changes and their impacts.

None of these can in essence reduce the underlying uncertainty of the phenomenon, they only provide analytical approaches to detect a reasonable risk level to be considered in policy making. As suggested by Fiering and Rodgers (1989), "*stationary-climate-policy statements should be periodically checked and updated by responsible experts as to the rationality of the assumption of an unchanging climate*".

The study regions lie in the equatorial belt

It was a surprise to realize, that the study regions, which were selected on the basis of the six criteria defined in Section 2.1, coincide with the area called

Figure 4.3a
The study areas lie in the equatorial belt
The map shows the geographic definition of the selected regions, and the ITCZ in January and in June, and the schematic description of air circulation.



the equatorial belt (Figure 4.3a, see Varis 1998). It covers the range of the seasonal movement of the intertropical convergence zone (ITCZ). In this zone, the trade winds from the both hemispheres confront, causing rainfall. Its location varies seasonally, being in extreme north during the northern hemisphere summer, and in extreme south in the southern hemisphere summer.

This belt is subjected to highest uncertainties in the climate change projections (IPCC 1996, 2001), and a few decades ahead, it will be affected more by other global changes—population growth, urbanization, industrialization, and political-economic transitions—than other parts of the world. This makes the economies particularly sensitive; they are prone to social unrests, dislocations of people, disease outbreaks, uncontrolled urbanization, malnutrition and famines, ecological disasters, and environmental degradation.

The *intertropical convergence zone* (ITCZ), known also as the equatorial-trough disturbance, consists of the region near the equator in which the trade winds from the two hemispheres meet. When these humid air masses encounter, they rise up, and the humidity is condensed to clouds and rainfall. The location of ITCZ varies seasonally; in January, it reaches its southernmost position which is located mainly in the southern hemisphere, while in June, it reaches the northern extreme in the northern hemisphere (Figure 4.3a). This range is here called the *equatorial belt*. The trade winds are driven by the earth's rotation. The Coriolis force turns the northern hemisphere winds to southwest, and those of the southern hemisphere northwest. These easterly winds tend to be strongest in the E Pacific. The trade winds convey relatively cool air, and together with the rainy summer seasons related to the geographical movement of the ITCZ make the climate exceptionally comfortable to humans. Consequently, many regions of the belt have been development sites of ancient civilizations, e.g., the river valleys of the Nile, the Indus, the Ganges-Brahmaputra, the Huang He, the Yangtze, the Mekong, and the Niger. Today, around 60% of the human population dwell within the belt and the population densities are high in large areas.

Observed trends

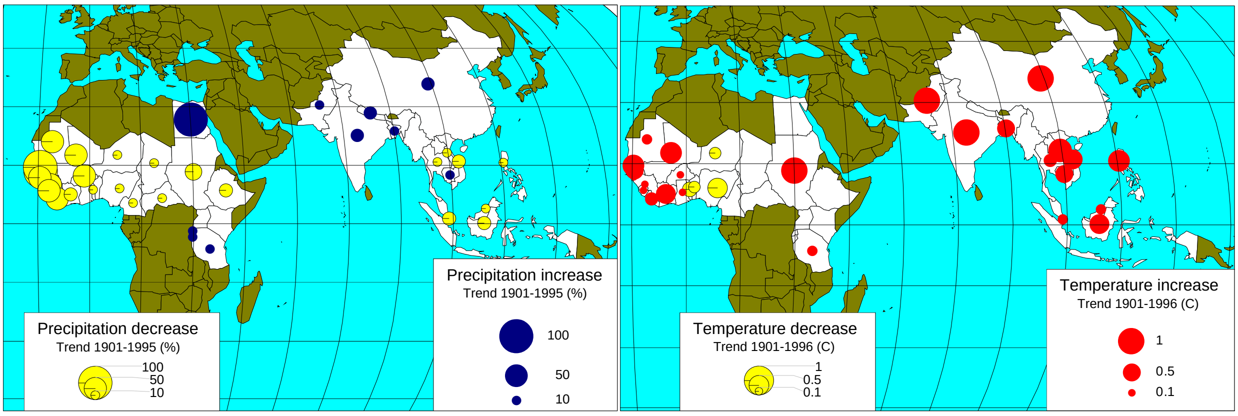
The changes in the atmosphere's composition have various influences in its heat budget, and consequently in transfer processes such as winds. The human-introduced changes in the recent centuries have been observed in many ways. They have changed the radiative forcing of the atmosphere; growing concentrations of CO_2, NH_4, N_2O, halocarbons, and tropospheric ozone increase, while aerosols such as sulfates and smog from biomass burning decrease the amount of radiative forcing, i.e. the heat accumulated to the lower layers of the atmosphere (IPCC 2001).

The belt has witnessed some clear trends in the measured temperatures and precipitations in the 20th Century (Figure 4.3b). The most remarkable climate changes have been in W Africa where the temperatures have grown with around 1^{o}C, while the precipitation has decreased markedly. These trends cease when moving eastwards, around the Greenwich Meridian. The other trends in Africa are much smaller, except the temperature increase in the Sudan, and the

Figure 4.3b

Observed climate changes

Trends in precipitation and temperature as calculated by each country from the 5°x5° grid cell data (IPCC 1998; see also Hulme 1992, Hulme et al. 1994, Nicholson et al. 1996). For countries within study regions, which have no mark have no trend in the respective variable.



precipitation growth in Egypt. Almost all the study countries in Asia have become warmer. S Asia and China have become wetter, while SE Asia has turned somewhat dryer. It has not been shown unambiguously that the observed trends are consequences of human-enhanced greenhouse effect, but it is highly possible.

El Niño—Southern Oscillation (ENSO)

The ITCZ system, in particular the trade winds, are subjected to various factors that cause large annual weather variations. One of the crucial determinants of the year-to-year variation is the ENSO, which has been followed over centuries as a natural feature of the regional climate patterns. It has even been globally recognized as the most important determinant in this respect (Whetton and Rutherford 1994, IPCC 1996, 2001). According to Sandweiss (1986), there is evidence based on sand ridges of Peru that ENSO has been active at least for 6000 years. For the last 500 years, there are various, relatively accurate data sets that can be used for the analysis of ENSO. It occurs at irregular intervals of 2-10 years, consisting of a series of phenomena that form a consequence.

The strong trade winds of the E Pacific transport the warm, solar-heated surface waters of the equatorial Pacific, and induce a vast warm water accumulation to the W Pacific, around Indonesia. Due to the air pressure differences in the E and W Pacific, the sea surface is about 50 cm higher in the west than in the east. The warm water with the trade winds and the equatorial front cause a plenty of evaporation and consequently much precipitation. This rain keeps most of SE Asia very humid; throughout the year close to the equator, and elsewhere during the rainy monsoons. On the eastern end of the ocean, the warm water transferred westwards by the winds is replaced by nutrient-rich, cool water from deeper water layers. This causes a dry climate to western S American coast, and also feeds the world's commercially most important fish stocks along the Peruvian coast.

The El Niño—the warm phase of the Southern Oscillation (cf. Trenberth 1997)—commences with weakening trade winds. The warm surface waters start to return to the east, because the pressure gradient weakens. Thereby, the coasts of Peru experience increased water temperatures, reduced fish catches, and growing precipitation with heavy storms that can be devastating. The rainfall that usually benefits SE Asia, precipitates earlier on its way to the west, falling mostly straight to the ocean. Therefore, Indonesia and several other countries (Figure 4.3c) experience droughts.

There are some interesting and important connections of regional climates around the equator. The monsoon patterns and, consequently, the wetness of rainy seasons are affected also elsewhere, not just in SE Asia. For instance, the rainfall anomalies in the source area of the Nile—the Ethiopia-Sudan region—are very closely related to the Indian summer monsoon, i.e. the rainy season (Camberlin 1997). The Asian summer monsoons in different regions have similar, high correlations (Kitoh et al. 1997, Ose et al. 1997, Tanaka et al. 1997). Table 4.3a summarizes some of such teleconnections related to ENSO. Another example is the effect of the strength of trade winds to the jet streams that transfer the air back to mid-latitudes: they are also weakened along with trade winds. This causes changes even in N America and Europe (Figure 4.3c).

Even though ENSO appears to be known today well enough to allow short and medium term forecasts that are accurate enough to be used in seasonal weather

Table 4.3a

Teleconnections of El Niño

Examples of teleconnections between ENSO and climate-related time series in the Nile Basin, SE Asia, S Asia, and China (after Whetton and Rutherford 1994, 1996).

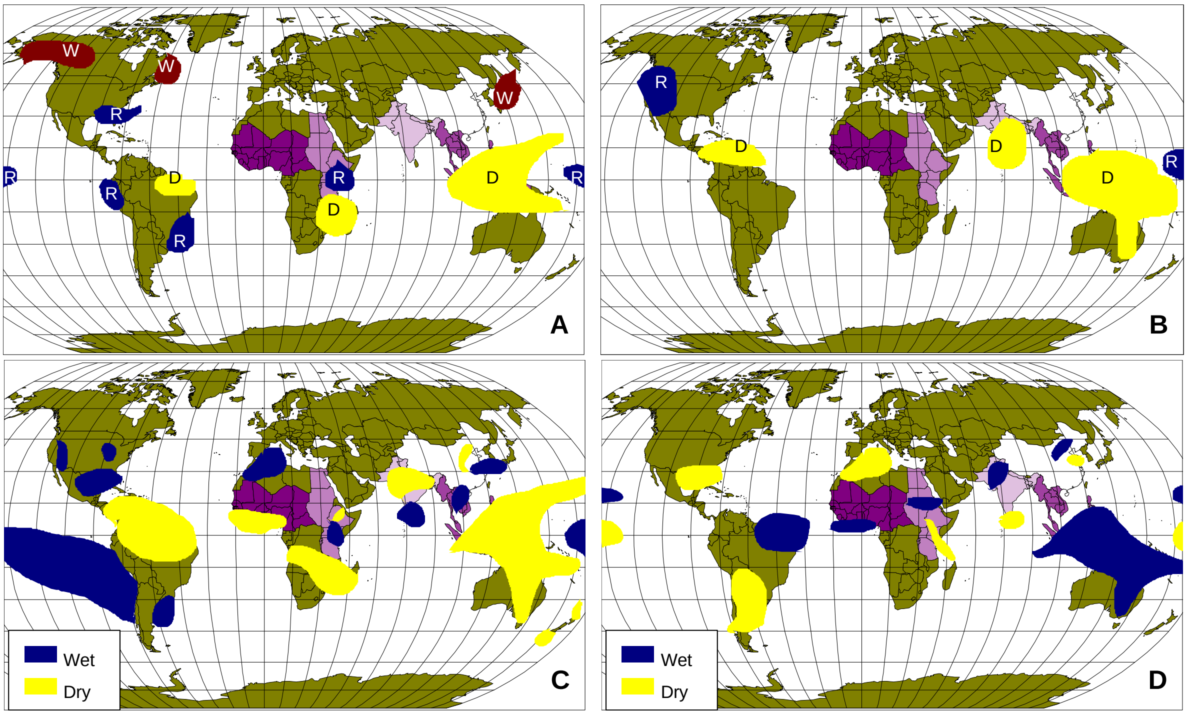
Event	*Description and relation with ENSO*	*By El Niño**
Nile floods	Related to many issues. Important ones include sea surface temperatures and ENSO. Flood records cover 1300 years. The statistical relation between ENSO and floods was very significant. The most important El Niño impact on the basin is the reduced rainfall in the Blue Nile Basin, particularly in Ethiopia.	Low Nile discharges
Javanese tree rings	ENSO affects strongly Indonesia by decreasing precipitation during El Niño. A record of 1514-1929 showed a significant statistical relation between ENSO and teak growth.	Narrow tree rings
Rainfall in N China	The rainfall records cover over 500 years. They have a significant statistical relation with the Southern Oscillation Index in June to August, i.e., the wet summer monsoon.	Low rainfall in N China
Chrono-logy of Indian droughts	Drought has been the immediate cause of all the peacetime famines in India. El Niño tends to weaken the wet monsoon. The drought and famine records start around 1500, being very unreliable till 1769, improving gradually and being reliable from 1870. Most famines could be associated with droughts and most droughts with El Niño, although there are other important causes of monsoon variation in the Indian subcontinent.	Low summer rainfalls

** El Niño years, N hemisphere summers*

Figure 4.3c

Typically affected areas by El Niño.

Exceptional events after Gommes et al. (1998): October to March (A), April to September (B). D = drought, R = unusually high rainfall, W = exceptionally warm. Rainfall anomalies associated with El Niño events (C) and La Niña events (anti-El Niño, D) synthesized from Ropelewski and Halpert (1987), and Whetton and Rutherford (1994).



forecasts several months ahead (Stockdale 1998), the relation between the enhanced greenhouse effect and ENSO are highly unclear. There is a heavy debate whether the greenhouse effect affects El Niño or not (IPCC 2001, Trenberth and Hoar 1996, 1997, Harrison and Larkin 1997, Rajagopalan 1997). The recent El Niño events have been exceptionally strong and long-lasting, even more frequent than before (Cole et al. 1993), and there is a wide concern that the oscillation pattern has already changed, and will continue to change. According to Trenberth and Hoar (1996), the recent events represent such extremity which could statistically occur only once in a few thousand years. The hypotheses under argumentation are:

- Greenhouse warming and El Niño are *unrelated*.

- El Niño will become *more frequent*.
- El Niño will *last longer*.
- El Niño will even become *permanent*.

With any of these, there are good arguments to back them and to turn them down. Whatever the truth is, the importance of El Niño and its connection to the greenhouse effect is a highly important issue.

Projected future impacts

The most widely used and accepted approach in making future projections of the climate is to use global and regional circulation models. This approach dominates, e.g., within the IPCC, which enjoys the leading status of climate change assessment within the UN system. The projections are used for driving scenarios on climate change impacts on hydrology, water resources, agriculture, vegetation, diseases, sea level rise, economic impacts, etc. (e.g. IPCC 1998, 2001).

The magnitude and the impacts of the climate changes have been subjected to intensive research over the last decades, but due to the complexity of the system and the long time span of the changes in comparison to the observation records (O'Neill et al. 1997), there are many important processes not adequately known so far. For instance the heavy investments in Global Circulation Models (GCMs) has yielded in a high number of hypothetical patterns that appear logical, yet often stay in conflict with one another, but much more so with present observations (Figure 4.3d).

The error bounds in temperature simulations for historical data are typically as broad as 10^0C. When precipitation is examined, the inaccuracy of the models is much higher. Special attention is mandatory when interpreting and using the projections in impact analyses of any sort. The rather good agreement of the projections with one another does not imply any reliability, because they cannot reproduce the climate's current situation. When talking about the equatorial belt and ITCZ, the IPCC (1996) observation, that *the El Niño related variability is generally underestimated in the models, and the largest differences among the model outcomes are found over the tropical oceans* casts still more doubt to the practical applicability of the projections within the world's regions that are subjected to largest stresses of other global changes during coming few decades.

Figure 4.3d

The diagnosis and the forecast: the former should be good before the latter is credible

The ability of GCMs to reproduce the present situation (left columns) and what do they project for the future (data from IPCC 1996).

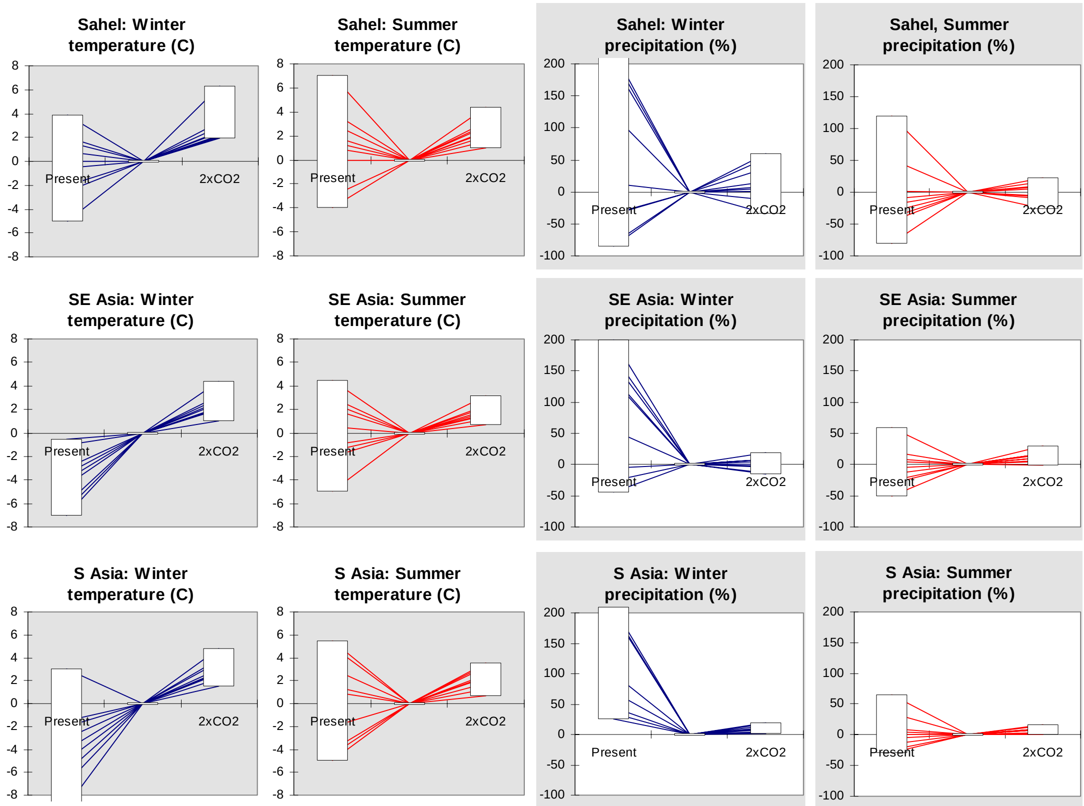


Figure 4.3e includes grain projection scenarios as collected by IPCC (1996, 1998). Table 4.3b and Figure 4.3f include further climate and water projections for the study regions. Knowing the above, such studies indicate only the relative uncertainties among different parts of the world, and perhaps to some degree, also the most likely development trends in future. Taking a view to the observed trends in temperature and precipitation, one can see, that many projected changes appear logical. However, *de facto*, the projections tell that *next to anything may happen*. This is discouraging, but inevitable, when knowing the present state of the knowledge on the future climate.

So what?

In societies subjected to stresses from various directions, global and regional changes tend to accelerate the complicated, mutually *interconnected vicious circles that tend to feed each other* (Chapter 3.2; Varis 1999). Societies that suffer from the vicious circle malaise are vulnerable to even slight external changes, or extremes in the natural climatic variability, political stability, or economical conditions.

To break the vicious circles, a society must have capacity to take a control over its own development.

Figure 4.3e
Climate change effects on grain production
Selected projections for grain projection after climate change (2xCO_2). Data from IPCC (1996, 1998).

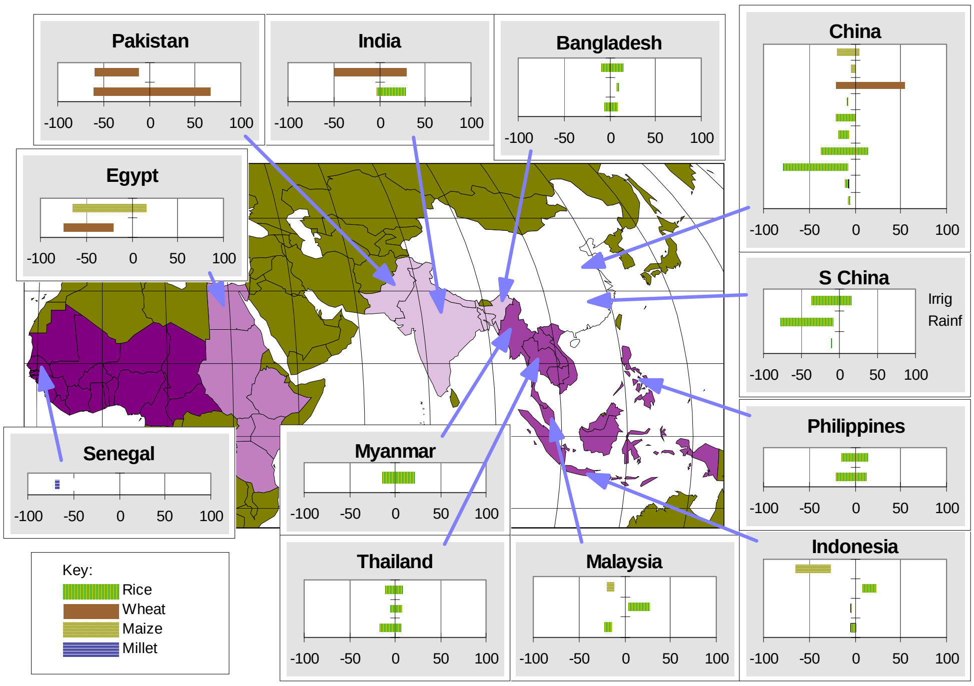
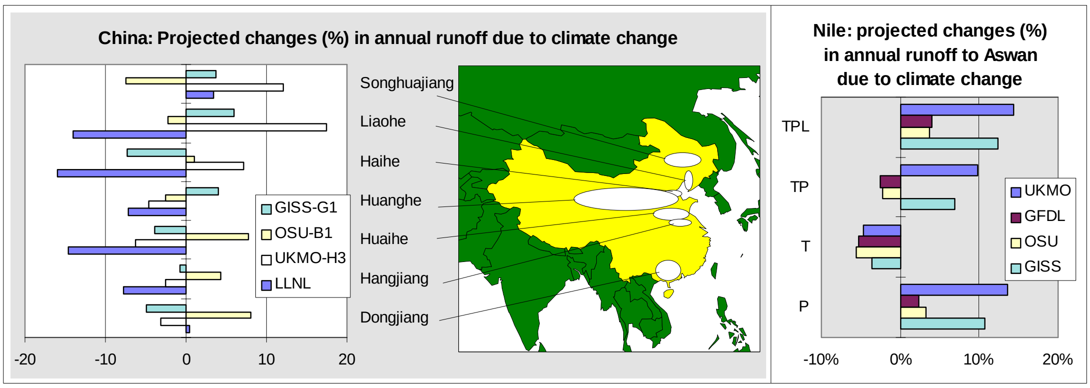


Figure 4.3f
Runoff projections for Chinese rivers
GCM projections of annual runoff in Chinese rivers (Liu 1997) and in the Nile (Conway et al. 1996). Issues considered in Nile scenarios: T = temperature, P = precipitation, and L = land cover impacts.



Such capacity consists of human, technological, institutional, and economic components. Once there is a capacity to allow conscious choices, those should be made wisely, so that the living conditions of the people directly in question, or others (those of the next generation, or those in other parts of the world) are not degraded or spoiled.

The study regions appear to own various levels of capacity. China is the extreme as a command-and-control society, with a tradition of a strong, big government. It has now a rapidly growing economy, plus many other imperatives for making conscious development choices. With respect to the concern about water and climate-related issues, however, the picture is not too optimistic; the price of the economic development in terms of emissions and environmental degradation, not to talk about vast urbanization-related problems, are huge. The future is likely to increase N China's water problems in particular. It already lies at the razor's edge with its water resources, having less than half of the water per capita compared to Egypt (Smil 1992, Zhang et al. 1992, Box 4.3).

The policy choices in S Asian countries appear to follow many of the same paths, but in a less controllable fashion. These two *Asian regions* alone *grow are growing rapidly to the greatest polluters of the globe*, and they are accorded by SE Asia. *The African regions*—with exceptions of a few middle-income countries, Egypt above all—appear to have far less capacity at present. However, their *struggle out from the Malthusian era* seems to have advanced many

Table 4.3b

Future projections for temperature, precipitation, and river runoff by region (IPCC 1998)

Area	*Temperature*	*Precipitation*	*Runoff*
Uncertainty	High	Very high	Extreme
China			
N China	Small increase suggested, decrease is also possible. Sensitivity of coastal monsoon areas smaller than dry continental areas	Summer rains will increase towards S and winter rains towards N. Substantial decrease throughout is also possible but less likely	Very sensitive to any change. More likely to decrease than increase (except Manchuria). Special attention to summer flows.
S China			Grows rather than decreases
S Asia			
Pakistan	Modest increase, yet slight decrease in winter has also been suggested, sensitivity grows towards inland, less effect during summer (wet season)	Wet season (summer monsoon) prone to become more rainy, intensities grow, yet the opposite has also been proposed. Dry season projections are inconsistent, but show great potential changes. Tropical cyclone effects are unknown.	Decrease or unchanged
India, Nepal			Decrease
Bangladesh			Decrease or unchanged
SE Asia			
Myanmar	Modest increase, sensitivity grows towards inland	*As above*	Prone to decrease
Indochina			Highly inconsistent
Indonesia, Philippines	Small increase	*As above*, plus extreme sensitivity to El Niño which decreases precipitation	Inconsistent, depends very much on El Niño
Nile			
Tanzania, Rwanda, Burundi	Modest increase, sensitivity grows towards inland	Rainfall changes are proposed to be small in comparison to present-day variation, yet slight increase is expected. Projections are inconsistent.	Slight increase
Uganda, Kenya, Ethiopia			Highly inconsistent
The Sudan, Egypt			Highly inconsistent, more prone to decrease
W Africa			
Guinean coast	*As above*	*As above,* but decrease is more likely	Increase
Niger basin		*As above,* but increase appears more likely. Inconsistency is extreme.	Inconsistent
Senegal basin		*As Guinean coast*	Decrease

steps during recent years. Still, the headlines are rich with political conflicts and other disasters taking place in many countries in the African study regions. Such development keeps those countries weak and blocks them from making wise future choices.

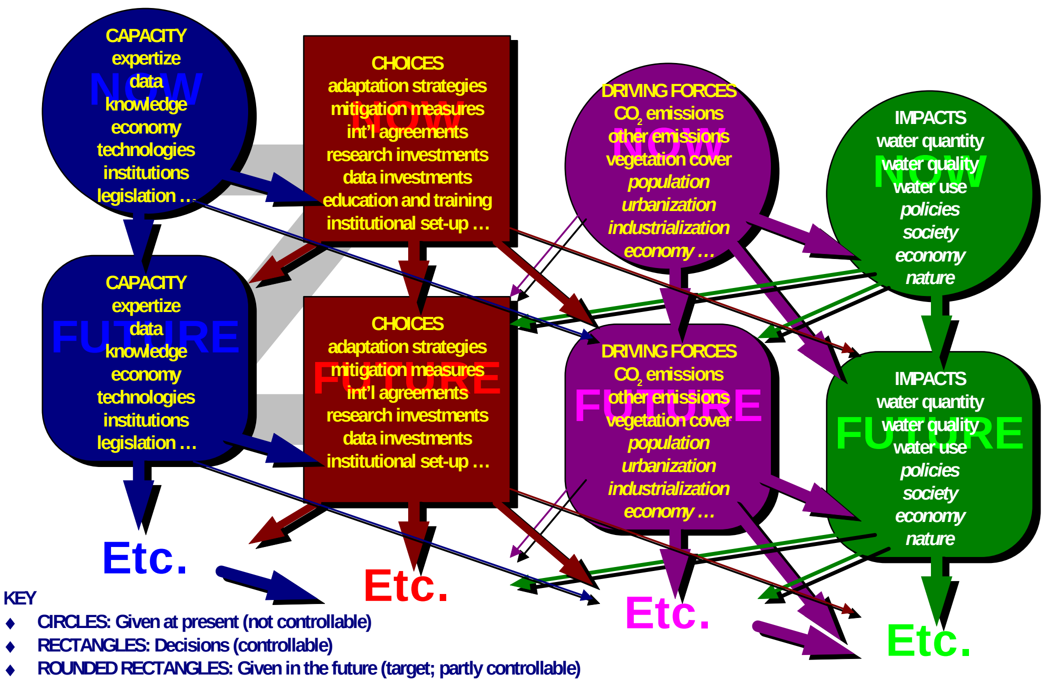
The capacity is needed for both the mitigation of problems that occur in the future, and the adaptation to such climatic changes, which—as was shown above—are extremely uncertain but can be very severe. The Asian regions are gradually entering the global spotlight when greenhouse gas mitigation—as well as the control over other pollutants—is considered. The African regions, in contrary, appear to be forced principally to adapt their strategies to the coming changes.
For mitigation and adaptation, if considered in the framework of sustainable development; the underlying importance of human capacity—education and training at all levels in the first place—cannot be over-emphasized. In many ways, they are the prerequisite of the construction of other capabilities, plus in making good policy choices. In this respect, the regions have recently shown positive signs, with the exception of a number of countries that suffer from internal conflicts, wars, or have not yet recovered from the burdens of the cold war. Inevitably, there is a big role for the international community and the high-income countries in supporting the process of capacity building in the most vulnerable societies.

Climate issue remains uncertain

The study regions are exceptionally vulnerable to climatic variations and changes. They depend vitally on the summer rains of ITCZ, and are stressed by other global changes and transitions, and lack the ability to take the development in their own hands in a sustainable way. Likewise, some of their policy choices appear too one-sided, paying too little attention to environmental degradation, growing emissions, and resistance of societies to various risks such as the climate.

The present status of climate projections does not allow a concrete basis for building up other policies besides making societies less sensitive and vulnerable to any foreseeable event. It is very doubtful to base any real-world policy choices in present climate change projections. The very basic needs of the billions that are potentially affected by the changes—water, food, housing, social fabric—are in question. The models give an overly optimistic view of the adequacy of the knowledge, despite of their consistent development (Varis et al. 2004). It is important to split the climate issue into more accessible components such as El Niño and its potential impacts. Such problem settings become closer to policy makers throughout the world.

Figure 4.3g
Running with time
Capacity of various types is needed to make clever choices when dealing with global changes—such as the climate change—both in mitigation of coming problems in advance, and adapting societies to them.



Box 4.3

Climate change in China

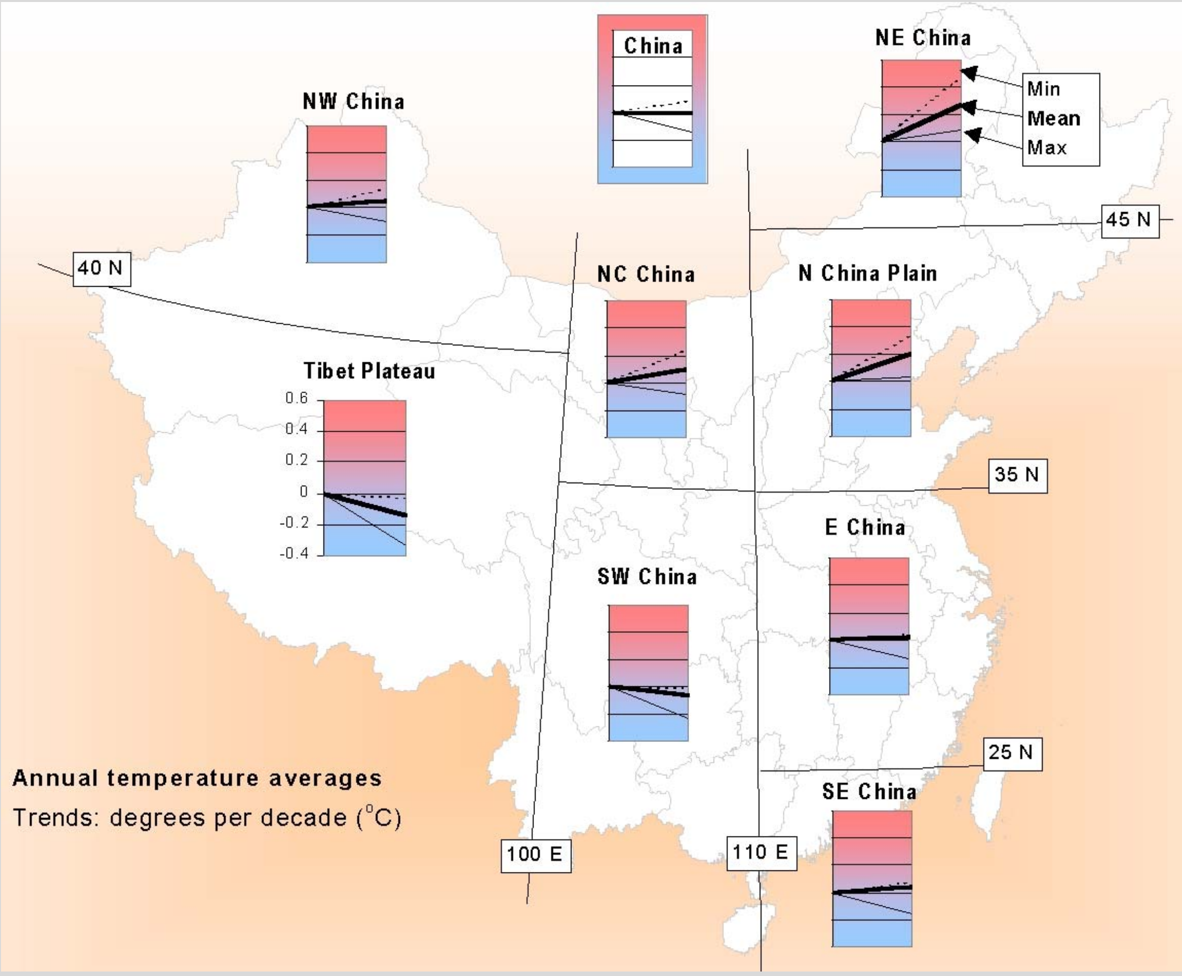
After Shen and Varis (2001)

In the past 40 years, China has been passing a mildly changing climate period. This result is based on the analyses of 1955-1997 time series data of monthly maximum, mean and minimum temperatures from 400 stations all over China. The minimum temperatures have increased markedly, particularly in winter. The populated North China Plain together with NE provinces became warmer, whereas the Tibetan Plateau and other SW parts became cooler. China's most water-scarce regions—taking the population density into account—are in the North China Plain. The observed climatic trend has obviously been an important contributor to the augmented water problems in that region.

Figure 4.3h

Annual temperature trends in China from 1955 to 1997.

North China Plain and Northeastern China get warmer whereas Tibet and Southeastern China cool down. Thick solid line is the annual mean temperature, thin solid line is annual mean maximum temperature and dotted line is annual mean minimum temperature. The trends are the slopes of the linear trendlines. The data is from China Meteorological Bureau and it includes 400 stations.



China seems to have become more temperate (Figure 4.3h). The crowded North China Plain (5) has had a clear warming trend. Particularly, the minimums, as well as, winter temperatures are on the way up. In contrast, Tibet and the subtropical SW China are cooling down.

This leaves us with a series of open questions. The global climatic system is so complex that from these results, we cannot so far find the reasons that cause to these changes. Are they due to anthropogenic activities, such as increasing the concentration of greenhouse gases and aerosols, increased irrigation and other changes in vegetation and land cover or what? Or are they dominated by natural processes and variations? Are they a consequence of the global climatic change or regional activities, such as urbanization because the urbanization rate in China has increased from 12.5% in 1952 to 29.9% in 1997? Is this warming unusual relative to low-frequency variations in temperature? If it is, then how much of it has been caused by anthropogenic changes in the composition of the atmosphere? Such basic questions call for answers with empirical support. Without such answers, any future projections of China's climate lack a solid base.

The policy strategies to cope with climate changes are traditionally classified under mitigation and adaptation. Regions such as China, S Asia, and SE Asia are rapidly entering the group of key actors in the global scene, when cutting down their rapidly growing greenhouse gas emissions. The same applies to other pollutants to air, water, and land. Those countries should not use their growing capacity in a too short-sighted manner. Regions such as W Africa and the Nile countries largely lack the capacity to take proactive caution to possible future risks. They have both two big steps to take; building a balanced capacity, and using it in a wise way. Otherwise, they will remain highly vulnerable in almost any respect including climate changes and variations. The capacity that is needed, particularly human resources, would allow them robustness to other global changes as well. The countries lying in the equatorial belt suffer from severe shortcomings in both these respects, and it is of international concern to elaborate these shortcomings. The time is running fast, and in many ways, its unit is the number of human beings.

4.4 Economy and globalization

Olli Varis

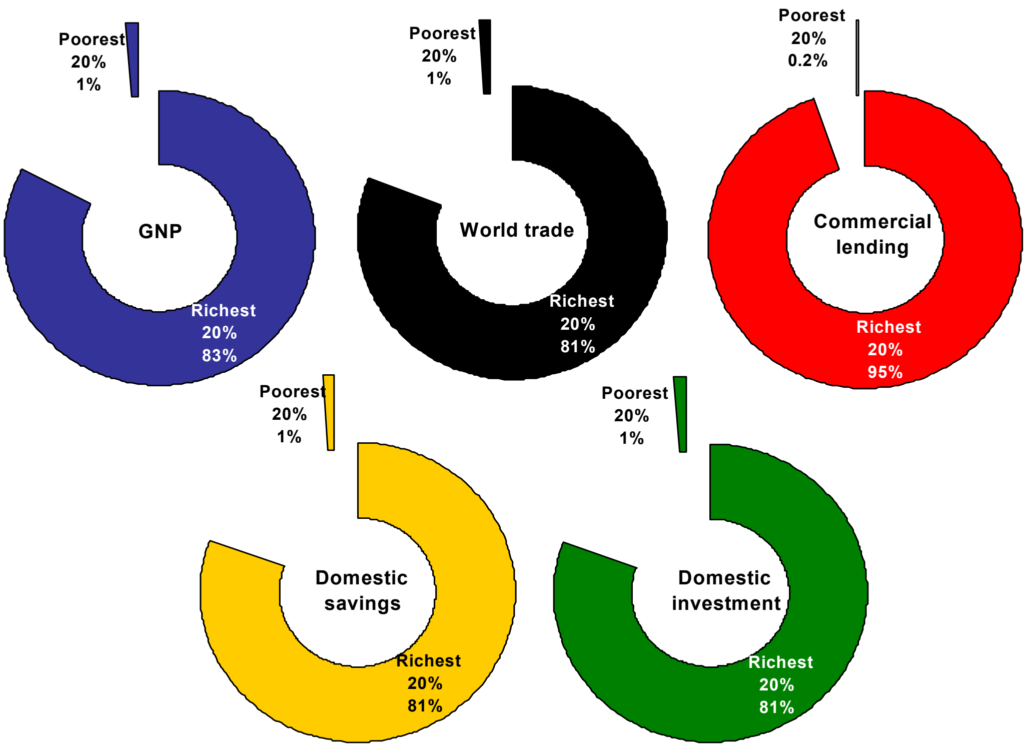
In the last quarter of the 20th Century, world economy has grown tenfold. Per capita, the growth was over six-fold. Things should be getting better. The problem is that wealth accumulates dramatically to rich countries, and disparities grow sharply. Among the study countries, only Singapore and Chinese Hong Kong grow faster than world's average rate. Thailand and Malaysia keep pace with that rate. The poorest economies have the lowest growth. The wealthiest core economies perform much better than the periphery.

Global overview

The world economies represent a high variety of economic potential. The richest 20% of the mankind dominate the global economy (Figure 4.4a). Depending on the indicator used, their share is between 80 and 95%. Accordingly, the proportion of the poorest 20% of all people ranges from 0.2 to 1% of the world's economy. This is the starting point in any discussion of world's economy and its globalization.

Figure 4.4b shows the GNP (Gross National Product, called since 2001 Gross National Income, GNI) per capita and population of 133 countries with over 95% of the world's population as a cumulative plot of country averages. Note, that the vertical axis is logarithmic, smoothing remarkably out the disparities. See also Box 4.4 and the discussion of purchasing power parity which adjusts GNI to local prices. The income level classification used by the World Bank (1996) is also shown:

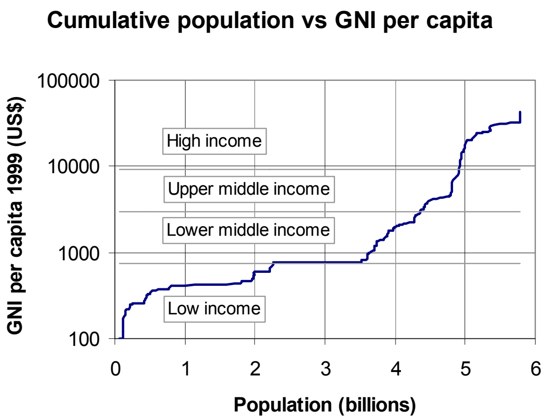
Figure 4.4a
The starting point in the global economic competition is not equal for the rich and the poor
Distribution of economic activity in 1989. Sources: UNDP (1992) and Nafziger (1997).



- Low-income economies (most of Sub-Saharan Africa, S Asia, China, some SE Asian countries),
- low-middle-income economies (some of the Latin America, most of the former USSR, some African countries),
- high-middle-income economies (most former centrally planned countries in Europe, most of Latin America, some SE/E Asian and a few African countries), and
- high-income economies (OECD countries and a few others).

In these four categories, the numbers of inhabitants were 2.4, 2.1, 0.6, and 0.9 billions in 1999, respectively.

Figure 4.4b
Economic potential of the mankind
World's population against GNI per capita. Source: World Bank (2001).



Study regions in global comparison

The GNI statistics (Figure 4.4c) indicate that in the wealthiest regions, SE Asia and China, GNI per capita has remained an order of magnitude below the average for the rest of the world (outside the areas studied) during the last 25 years in spite of fast economical growth. The rates of growth for the other areas have been remarkably slower. The African areas have had virtually no growth during the last decades (Table 4.4a). The most alarming is the situation in W Africa.

The proportion of the African regions of the world's total GNI has fallen from 1.0% to 0.7% during the period 1970-1999, even though the population has grown from 6.4% to 8.6%. The share of all study regions together of the global GNI has grown only slightly at the same time from 7.9 to 8.2% although their proportion of the population has gone up from 54% to 60% (Figure 4.4c). It should be noticed that about 16% of China's GNI comes from Hong Kong

Figure 4.4c
Gross national income of the regions
GNI per capita shown in absolute and relative scales, and the share of the regions of world's total GNI for the period 1971-1999. Source: World Bank (2001).

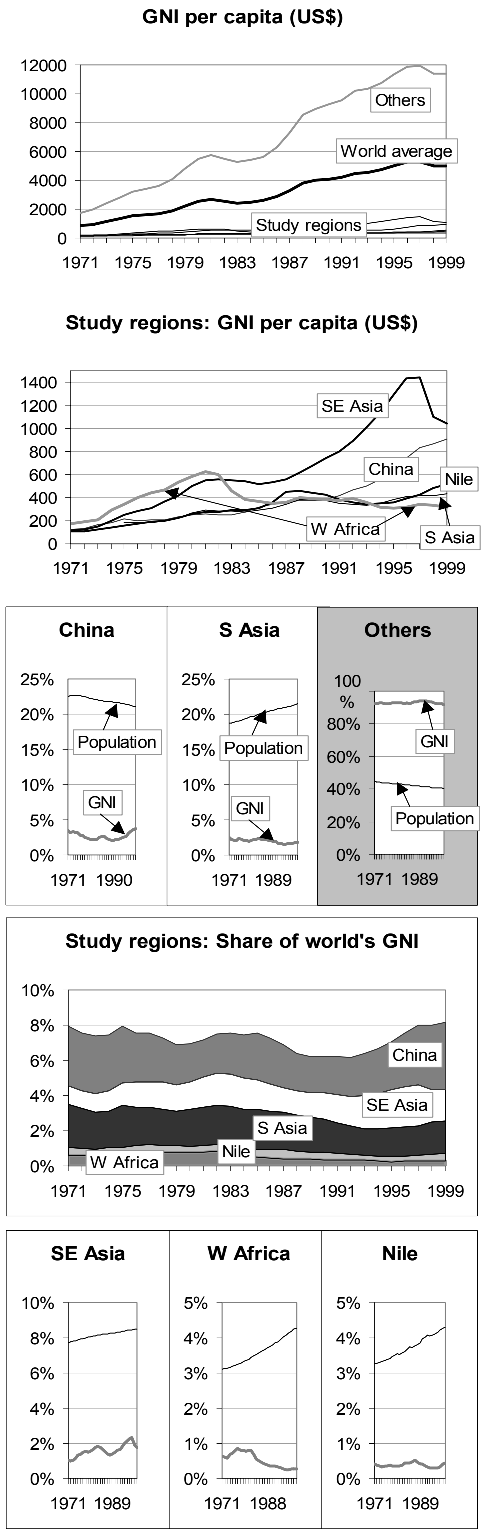
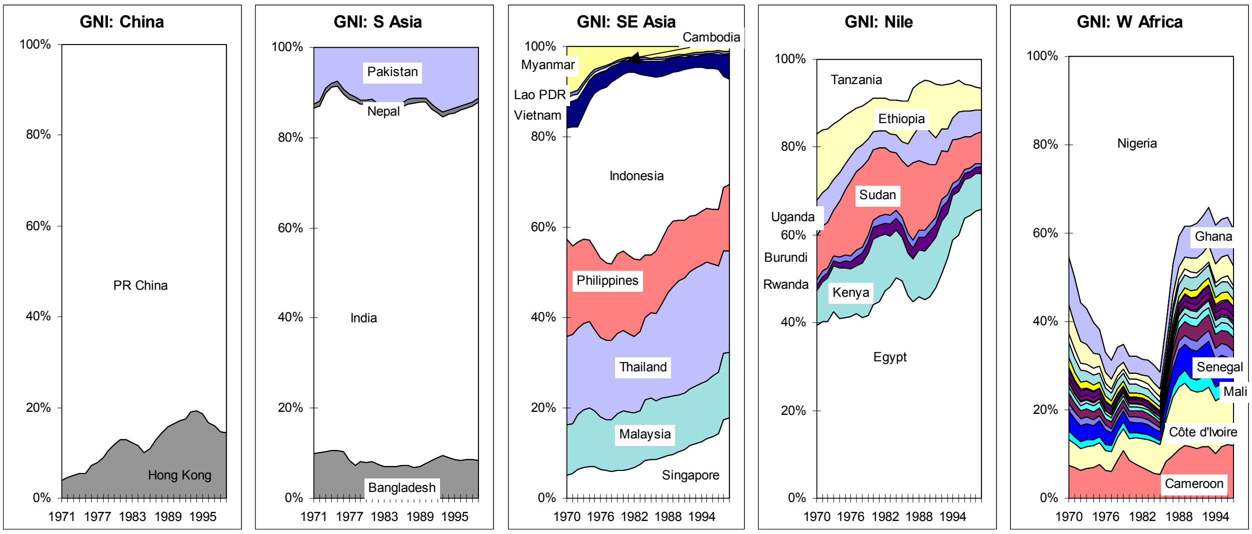


Figure 4.4d

Development of GNI within each region by country

The period between 1970 and 1999. The figure shows the shares of each country of the total regional GNI. The countries of W Africa are from bottom (winners) to top (losers): Cameroon, Côte d'Ivoire, Mali, Senegal, Benin, Burkina Faso, Togo, CAR, the Gambia, Mauritania, Chad, Guinea-Bissau, Liberia, Niger, Sierra Leone, Guinea, Ghana, and Nigeria. Source: World Bank (2001).



area although just 0.5% of the chinese population live in Hong Kong. (Figure 4.4d). Similarly, a significant part of SE Asia's GNI is consisted of some metropolises like Singapore, Bangkok, Manila, Jakarta and Kuala Lumpur.

Hong Kong is not the only economic core of China. The other coastal mega-cities—wealthiest of them being Shanghai—grow rapidly in importance, as well as the numerous special economic zones, while the large, landlocked agriculture-dominated provinces are losing their economic share. The regional income differences are notable in China (Figure 4.4e). Shanghai's GNI per capita is four times the national average (Hong Kong excluded), whereas most of the landlocked provinces can provide their dwellers only 10% to 20% of Shanghai's GNI. Shanghai's province rates as upper-middle income economy, with a GNI per capita close to Mexico and Poland.
After Heilig (1999), China's urban to rural income ratio has remained almost constant during the last twenty years. It is about 2.5, implying that a rural dweller has on average 40% of the income of an urban person.

The four countries of S Asia have developed with very much the same tempo between 1970 and 1999 (Figure 4.4d). The relative proportions fluctuate somewhat, but no marked changes in the shares of the countries of the total regional GNI can be seen. The regional GNI per capita is around US$ 400.

In contrary, SE Asian economies have developed with highly uneven rates. Singapore's share has more than doubled, and Myanmar's share has shrunk drastically. Indonesia had good times till early 1980s, but after that, the development has not kept intact with the rest of SE Asia. The Philippines has also some trouble in following the others. A great split of the regional economy is clear:

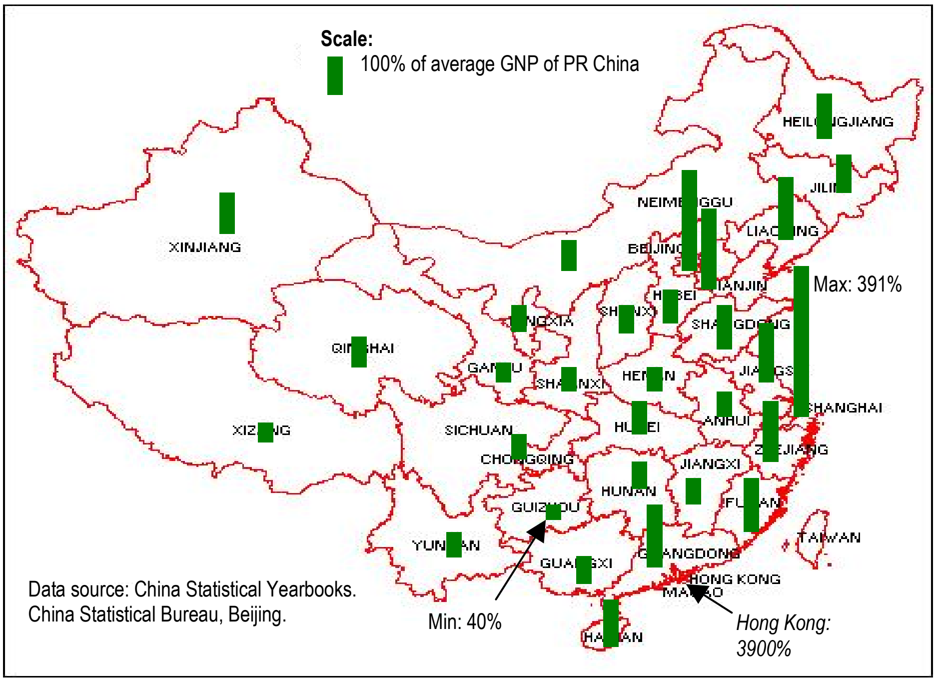
Table 4.4a

African economies have stagnated while Asian regions have shown economic progress

Evolution of GNI per capita in the study regions (thousand US$; source: World Bank 2001).

Region	1971	Change 1971-85	1986	Change 1986-99	1999	Change 1971-99
China	.13	2.4 x	.34	2.7 x	.91	7.1 x
S Asia	.11	2.6 x	.31	1.4 x	.43	3.9 x
SE Asia	.12	4.4 x	.53	2.0 x	1.0	9.0 x
Nile basin	.10	2.9 x	.36	1.4 x	.51	4.9 x
W Africa	.17	2.1 x	.35	0.9 x	.32	1.9 x
Other countries	1.8	3.8 x	6.2	1.8 x	11	6.5 x
World total	.85	3.0 x	2.8	1.8 x	5.0	5.9 x

Figure 4.4e
GNI per capita in Chinese provinces
Presented as a percentage of China's national average in 1994. Hong Kong is excluded from the average.



- *The losers:* The poor, communist and post-communist economies of Lao PDR, Cambodia, Vietnam and Myanmar, with 140 million people with GNI per capita around US$ 300. Their share has dropped from 20% to 4% of the regional GNI between 1970 and 1997, although some positive signs can be seen in the context of Vietnam and Lao PDR. Their proportion of regional population is 28%.

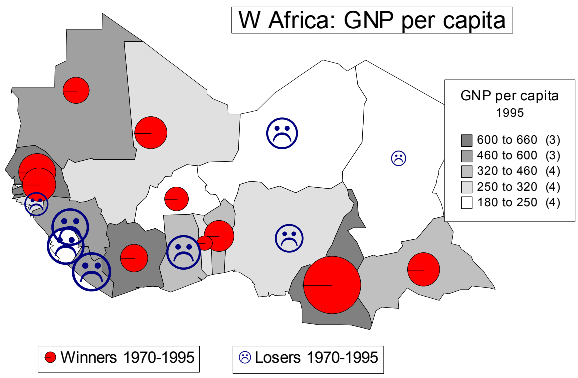
- *The in-betweens:* The lower-middle income isles, Indonesia and the Philippines. They have 281 million people with a GNI per capita approaching US$ 600-1000. Their share of the regional GNI has been around 40 to 45%. They have 55% of the regional population.

- *The winners:* The emerging economies: Singapore, Malaysia, and Thailand, with GNIs per capita US$ 24,000, 3,400, and 2,000, respectively. Their share of regional economy has grown from 37 to 51%. Population in these three countries accounts for 17% of the regional total.

Equally, the Nile region has seen a re-distribution of wealth: the richer economies have become richer, whereas the poorest—particularly centrally planned countries—have become poorer. Egypt's share has grown rapidly from 40% to 65% of the regional GNI. Egypt has 25% of the region's population. Its GNI per capita is around US$ 1,400. The rest of the region has a GNI per capita of 7 to 26% of that of Egypt. Egypt is the only winner of this region.

What comes to W Africa, the regional economic development is characterized by the collapse of Nigerian economy in 1985. Ghana, Niger, and the small W Guinean coast countries Liberia, Guinea, and Sierra Leone belong also to the greatest losers of the region, in terms of their contribution to the regional economy Figure 4.4f). The most successful economies have been the wealthiest ones—as in the other regions. They are Cameroon, Côte d'Ivoire and Senegal. Their GNI per capita approaches 45% of that of Egypt, and is higher than in the countries of S Asia. The poorest and economically declining countries Sierra Leone, Liberia, Guinea-Bissau, Chad and Niger have only US$ 150-210 per capita of GNI.

Figure 4.4f
Development of GNI in W Africa
The period from 1970 to 1995. Each country is related to the average economic development within the region (source: World Bank 1997).



Throughout the study regions some general features apply throughout. They are:

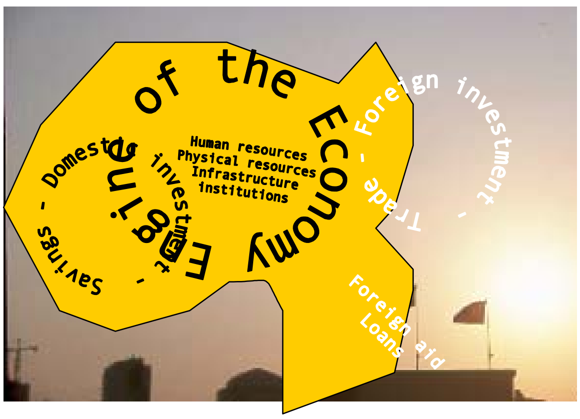
- The Poorest economies seem to be outcompeted.
- Centrally planned economies have collapsed economically, unless thorough reforms have been performed successfully.
- Core economies have been the more successful the smaller the population is and the bigger is the wealth gradient to the rest of the region.

This all means, that the wealth disparities have grown strongly among the economies of the regions. Only the small core economies of Asia, Singapore and Hong Kong, have exceeded the world average economic growth rate in the period 1970-1999. Thailand and Malaysia have kept in pace with the global average. The most successful core economies of Africa—within the study countries—have been Egypt, Cameroon, Côte d'Ivoire and Senegal. Their economic growth rates, as measured by GNI per capita, have been 20 to 40% below the world average.

Savings, trade, and investments

In order to see the reality behind the patterns of economic development outlined above, it is necessary to break up the concept into smaller components. The main connections of a low and middle-income economy to abroad are foreign investments and aid, trade, and loans. Domestic investments and savings form another cornerstone of the economic development (Figure 4.4g).

Figure 4.4g
National economy: wheels must roll on
Main components of the "engine of an economy". Foreign aid and investments must put the economy in operation, not to corrupt the institutions, waste the resources and feed inflation.



The latter must yield some added value, which can be used for investments. These savings from domestic sources are the base for the growth of the economy. If the savings are not enough to allow investments for future well-being, the economy must have cash from external sources. This may happen either by taking loans, attracting foreign investments, or by means of foreign aid.

It is typical to a low-income country where the economic wheels are not running well enough, that domestic savings are far too low to allow enough investments to human resources and increased production, in order to make the economy grow. Such "young economies" typically must borrow money to balance out the situation. Another source is foreign aid from industrialized countries. Loans are coming closer and closer to foreign aid, due to the fact that the debt burden of low-income countries has exceeded in most cases the carrying capacity of those economies, and the tendency seems to be to relieve problematic debts.

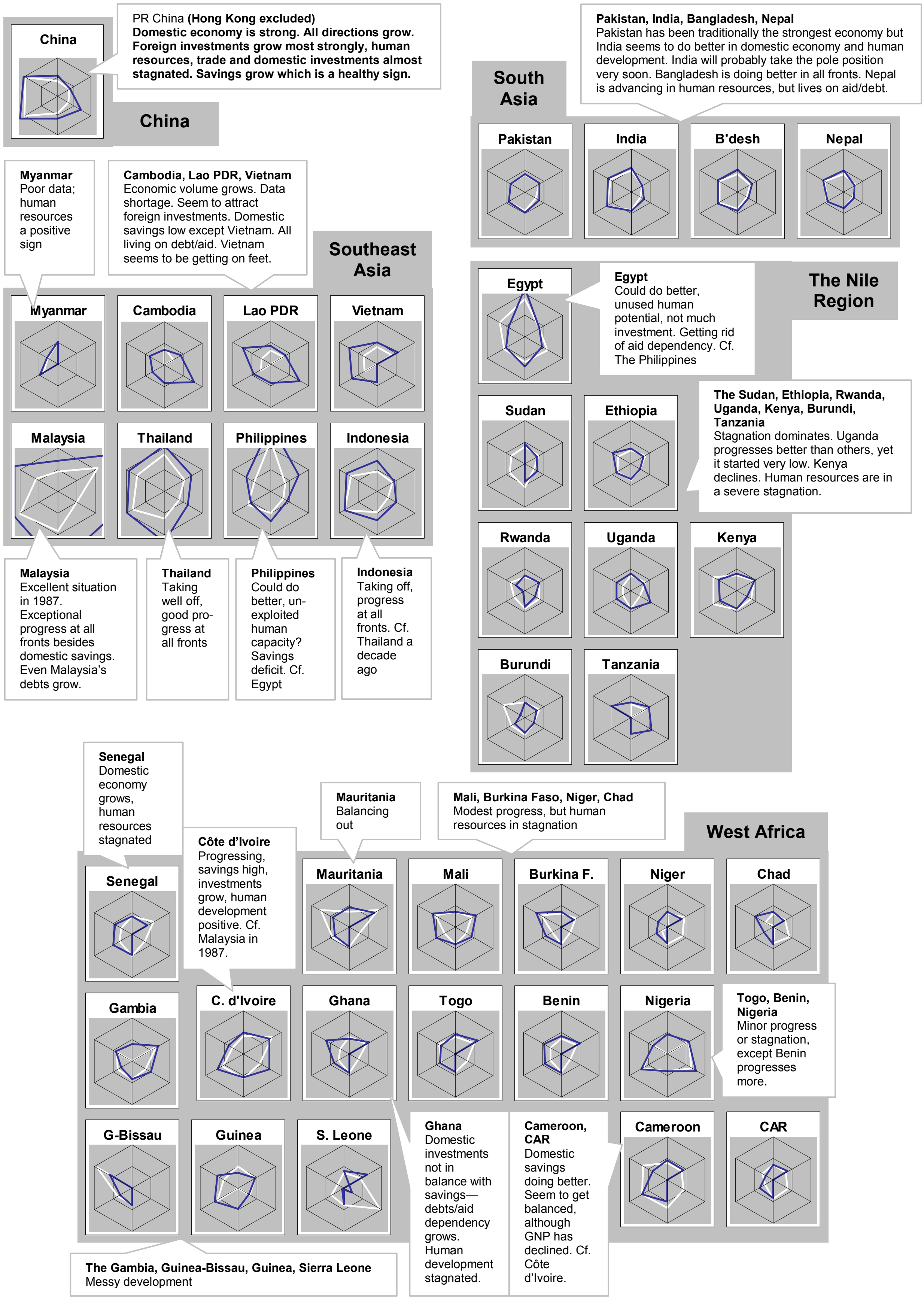
This input of finance should be used to develop capacity to allow better international balance of payments—the balance of imports and exports.

Yet, even the emerging economies such as Thailand and Malaysia were not able to balance their international payments in the 1990s. They had to borrow still from abroad with a rate that exceeded markedly their capacity to pay back old loans. For middle-income countries, there is a more important and attractive source of finance, namely private direct investments from abroad. Low-income countries, particularly in Asia, are increasingly receiving foreign investments and many of them compete strongly with emerging, middle-income economies.

Figure 4.4h shows the complex relation of six indicators that are revealing in this context. They are

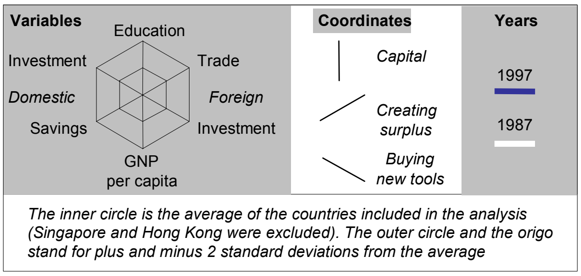
- *Education* (% enrolled in tertiary education). This measures the society's capacity to actively steer its economy and industry.
- *Trade* (% of GNI) indicates the extent of the economic activity that is connected to abroad.
- *Foreign investment* (% of GNI) is an indicator for the input of foreign capital to the economy. It also indicates the competitiveness of the economy in the world economy.
- *GNI per capita* (1,000 US$ per year) measures the volume of income within a country.
- *Savings* (% of GNI) is used to show the amount of money that is put aside, to allow investments for the future.

Figure 4.4h
Structure of economy by country
Relation of education, investments, savings, trade and GNP in each study country excluding Liberia, Singapore, and Hong Kong. For legends, see figure 4.4i. Data: World Bank (1999).



- *Domestic investment* (% of GNI) shows how much "new tools" of production are bought.

Figure 4.4i
Structure of economy by country
Legends and scales of charts of Figure 4.4h.



	1	2	3	4	5	6
Average	5.2	16.0	0.69	0.59	13.3	19.9
Standard deviation	7.1	15.0	0.68	0.81	11.6	8.8

1 *Education (% enrolled in tertiary education)*
2 *Trade (% of GNI)*
3 *Foreign investment (% of GNI)*
4 *GNI per capita (1,000 US$ per year)*
5 *Savings (% of GNI)*
6 *Domestic investment (% of GNI)*

The legends to the Figure are presented in Figure 4.4i.

It is important to realize that the diagrams are scaled with the means and standard deviations of the data from the countries included in the analysis. For instance, the average rate of domestic investments exceeds the rate of domestic –savings by 19.9% - 13.3% = 6.6%. Therefore, a completely vertical line between these indicators shows that the unbalance between these indicators is 6.6%, and the country either takes loans or receives aid from abroad with that rate.

Singapore and Hong Kong were excluded, since their indicator values deviate too much from those of the rest of the economies. Liberia was excluded because of the lack of data. From several other countries, some of the data is missing. In the graphs, those points are shown with lines drawn to the origo.

Foreign aid and assistance

The study regions received US$ 22.6 billion official development assistance (ODA) in 2002 (Table 4.4b). It can be related to the following sums: 1/5 of Singapore's, 0.88% of Germany's, and 0.42% of Japan's GNI; or 1/3 of world's total ODA. Singaporeans use 1/3 of that amount and Germans spend 2.2 times the sum for their holidays abroad. Whereas the per capita aid to S Asia is US$ 4 per year, the ODA from USA to Israel is US$ 115, nearly 30 times the S Asian aid. Israel's GNI per capita is 34 times that of S Asia.

The aid relates poorly to the economic progress of a country (Figures 4.4j, k). This is clear; the poorest economies receive on average far more aid than the better-off countries. China receives very little aid in comparison to its economic volume (see Figure 4.4l). However, its economic development has been favorable in the past decades. In S Asia, the aid received by Nepal and Bangladesh exceeds the economic growth of the respective countries (Figure 4.4j).

In SE Asia, the greatest aid recipients, Lao PDR, Cambodia, and Vietnam, show good economic growth rates. The share of aid of the GNI of the other countries is very low.

Table 4.4b
Aid dependency varies between regions
African regions depend more on foreign aid than the Asian regions by an order of magnitude. As comparison, the foreign aid from the USA to Israel is shown (source: World Bank 2004).

	Aid			GNI
	Billion US$	% of GNI	Per capita US$	Per capita US$
China	1.5	0.1%	1	1100
S Asia	4.9	0.8%	4	460
SE Asia	4.4	0.8%	8	1110
Nile	5.7	4.1%	21	508
W Africa	6.1	6.5%	22	336
US aid to Israel	*0.8*	*0.7%*	*115*	*15400*

Figure 4.4j
The richer the economy is, the faster it grows
If foreign aid is distracted from GNI growth, all African countries show negative rates in 1975-2002. Most Asian countries. in contrary, have positive net growth, and enjoy improving economic conditions. Source: World Bank (2004).

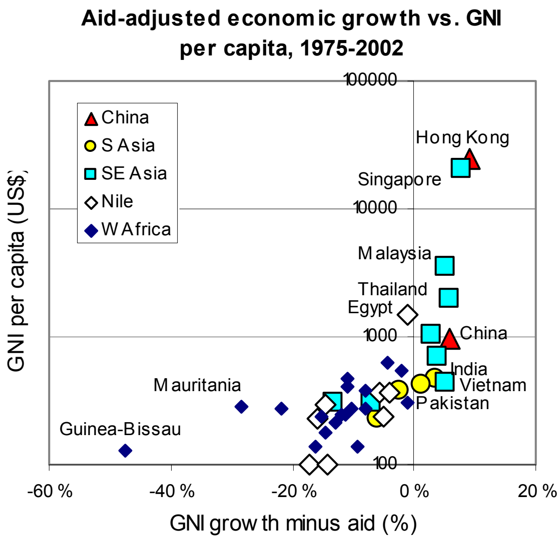
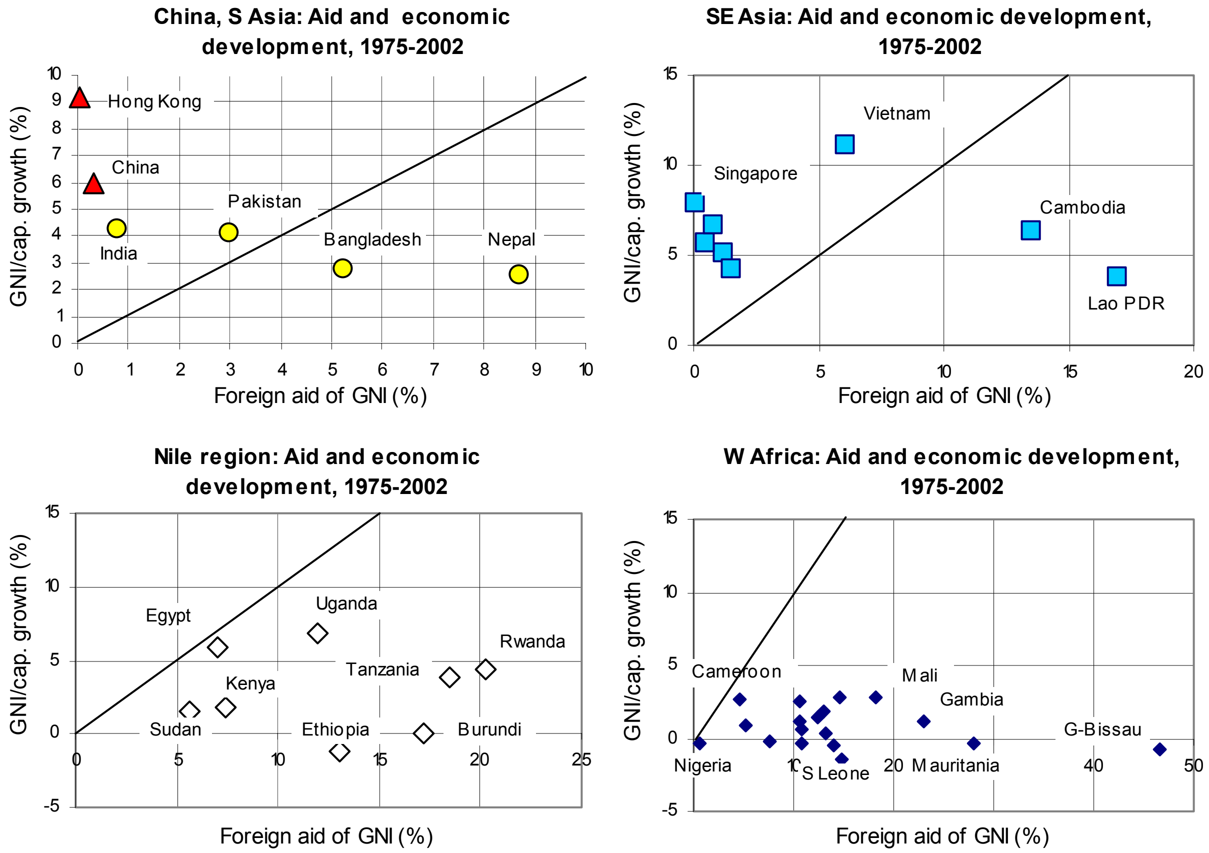


Figure 4.4k
Official development assistance relates poorly to economic progress
GNI per capita growth vs. share of foreign aid of GNI. Annual averages of the period 1975-2002 (source: World Bank 2004).



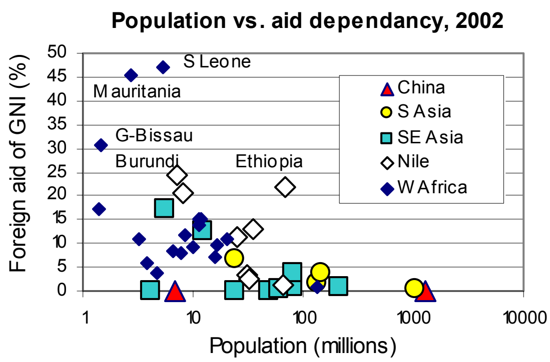
In the African regions, there is not a single country to score a higher average GNI growth rate in 1975-2002 than their ODA. In these terms, their net growth has been negative.

The picture would be still darker if all debts were included. Their inclusion, however, is problematic due to the fact that most of the debts are never paid back, for good reasons. The debt relief programs are extensive these days. Despite of that, the debt burden of Latin America consumes 20 to 25% of all earnings, and still somewhat more in Africa.

If a country gets tens of percents of its GNI as ODA over decades without showing economic progress, there must be something wrong with both the aid programs and recipients, or in the whole economic setting (see in this context Policy Tools sections).

World Bank has proposed in several reports that US$ 10 billion a year is needed to lift 25 million people out of poverty in the poor countries that *manage their economy well*. The population within the study regions, which lives permanently below the poverty line is around 1 billion (cf. Chapter 5.5).

Figure 4.4l
Small is beautiful in development aid
Small countries are more attractive aid targets than big ones (source: World Bank 2004).



This means that if the regions operated their economies that way—whatever it means—the foreign aid needed to remove poverty from the regions would be around US$ 400 billion a year, which is 20 times the actual foreign aid. Poverty reduction cannot hence be done dominantly by foreign aid.

Agriculture, industry, and services

A widely used classification of economical sectors divides a society into agricultural, industrial, and service sectors. Along with economic development, a traditional, agricultural society tends to lose its share to services and industry. In very loose terms, services can be associated with *transaction*, whereas industry and agriculture associate with *production*, in the terminology of institutional economics (Figure 3.2g).

Figure 4.4n shows fairly distinguishable relations between GDP per capita and the shares of the three sectors in the study regions. The share of manufacturing industry grows almost linearly with increasing GDP per capita. Clearly, the scatter is also notable, but still, the relation is clear. In the African economies still less than 20% of GDP comes from manufacturing industry. Same applies to S Asia. In SE Asian countries more than 20% of their GDP is produced by manufacturing.

Among the world's top five countries in terms of manufacturing industry—as measured as a proportion of GDP—are China and Thailand. Their manufacturing industry contributes around 35% of the GDP. In countries with GDP above 10,000 US$ per capita, the share of manufacturing declines, and very rarely exceeds 25%.

The decline of the share of agriculture does not mean, though, that the agriculture value added per capita would go down. Quite in contrary, as Figure 4.4m reveals.

Figure 4.4m
Manufacturing industry by region
Source: World Bank (2004).

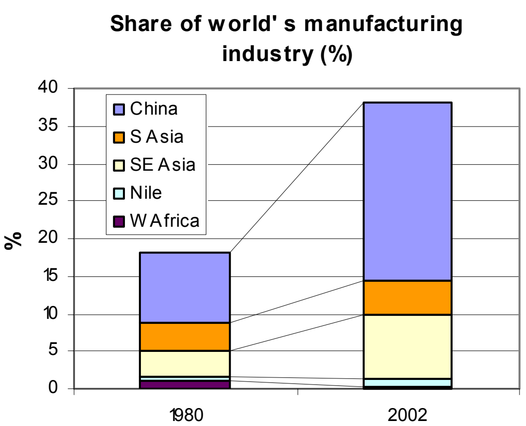
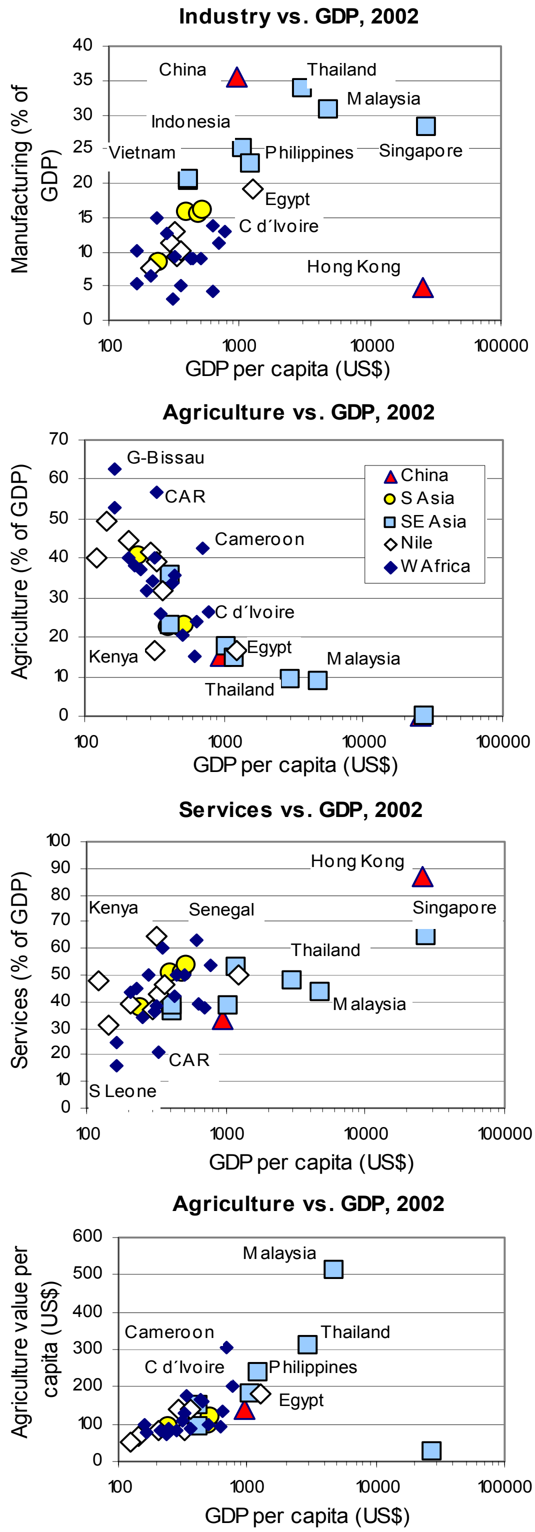


Figure 4.4n
Agriculture vs. services vs. industry
The share but not the volume of agriculture declines, services and industry grow in importance with growing economy. Note the logarithmic scale on the horizontal axis. Source: World Bank (2004).



As proportion of the world's manufacturing industry, the African regions have declined markedly in the last decades (Figure 4.4m). The decline has been strongest in W Africa. SE Asia and China, in contrary, have increased their share. S Asia has kept more or less in tact with the world's average industrialization rate.

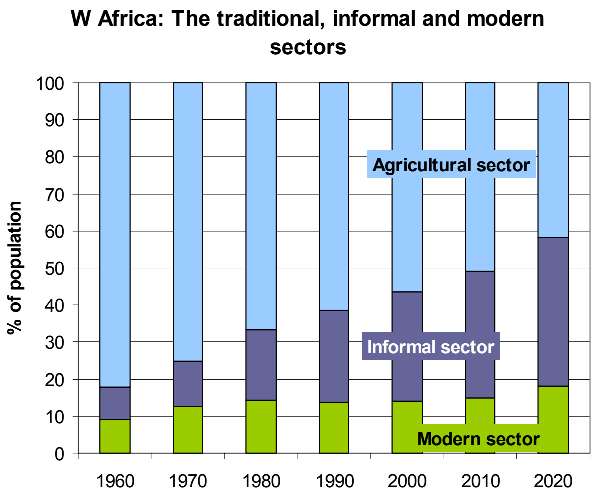
Traditional, informal and modern

Another broadly used three-class clustering of an economy is based on the structuralist theories (Chapter 3.2). In this approach, the classes include the traditional, informal, and modern sectors.

By now, it is very difficult to obtain reliable data to allow comparisons between different parts of the world. This is due to the lack of commonly used quantitative indicators. Some regional data exists, though. Figure 4.4o provides an insight into the development of these three sectors in W Africa. The trend is clear: the informal sector grows in importance (see Chapters 3.2 and 8.2).

The informal sector is not properly included in national account statistics, and therefore, it causes remarkable errors to the macroeconomic indicators such as GNI, the role of different sectors, and so forth.

Figure 4.4o
Changes of economic structure in W Africa
The informal sector is excluded from most of the official statistics, but its volume is important in W Africa. Source: OECD (1999).



Writes OECD: *"... contrary to conventional wisdom, the people of West Africa are actively producing, consuming, trading and accumulating capital in a way that is significantly underestimated by national accounts"* (Cour and Snrech 1998). This underestimation of national economies as a consequence of ignoring the role of informal sectors is perhaps greater in W Africa than in any other parts of the world.

Two examples illustrate the situation. The second most important growth center of Côte d'Ivoire, San Pedro, has 150,000 people. The modern sector contributes to 65% of its Gross Local Product, and the informal sector produces the rest. Yet, the distribution of employment is inverse; 67% are with the informal sector and 33% on the modern sector. Traditional sector is absent from the town (Nshimyumuremyi 1998).

In the delta region of Senegal river, including the town of Saint-Louis, the informal sector accounts for 1/4 of the regional economy, and employs 1/3 of the labor force (Niang et al. 1998).

Chapter 8.2 provides more details on the interconnections of the informal sector and water.

Role of water investments

Briscoe (1999) estimates, that the total level of investment in the water-related infrastructure is around US$ 65 billion annually, in developing countries. This sum breaks down in the following way between different subsectors: US$ 15 billion is invested for hydropower, US$ 25 billion for irrigation and drainage, and US$ 25 billion for water supply and sanitation. Around 90% comes from domestic sources, chiefly from the public sector. According to Briscoe, the proportion of water-related infrastructure amounts 15% of all government spending in developing countries.

Chapters 10.1 to 10.3 scrutinize these issues, but an example is given also in this context on the affordability of urban water infrastructure (Box 4.4).

Box 4.4
Affordability of urban water infrastructure
After Varis and Somlyódy (1997)

The high variety in the costs of urban water infrastructure does not allow the use of exact figures, but Varis and Somlyódy (1997) produced an exemplary cost envelope of US$ 150 to 300 as a minimum level of western type of solutions (capital costs per year per person) (cf. Serageldin 1994). When these figures are related to the GNI data, the situation appears hopeless; there seems to be no economic realism in attempting to provide proper water and sanitation services (WSS) for the majority of humans, at least when considering western solutions (Figure 4.4p).

Now, let us take the other view: How much would economies be capable of spending on water infrastructure? The World Bank (Serageldin 1994) gives a percentage of 0.4% of GNI as an investment rate typically used in WSS. This estimate is based on the examination of over 120 urban water projects realized 1967-89, in 29 developing countries. Again, a hopeless view: what the sum of US$ 1 to 3 per year for most people would make when improving WSS? The study revealed, that the rate of total public investment of the GNI has declined somewhat over the study period, being around 8.7% in 1987. That makes US$ 10 to 65 per capita. Taking even the world average GNI per capita, US$ 4470 in mid-1994, the above percentages would yield US$ 18 for water and sanitation, and US$ 390 for total public investment. The level of investments on environmental protection ranges globally between 0.5% and 3% of GNI, being typically higher in countries with higher GNI. In a low-income country with GNI per capita around US$ 80 to 725, the spending to environmental protection is bound to be below US$ 10 or even US$ 1 a year.

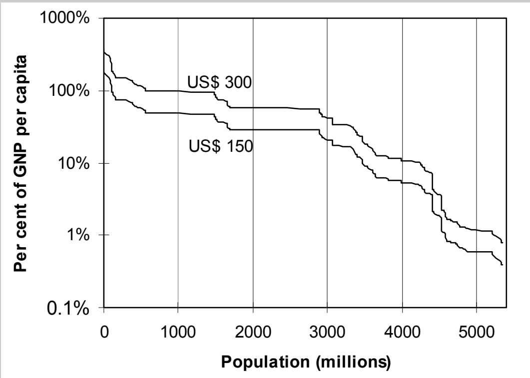
The situation is not that hopeless due to at least the following reasons.

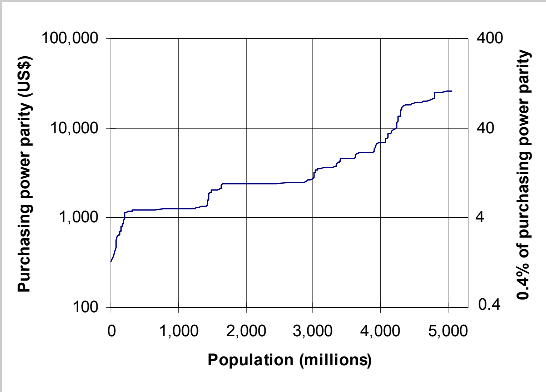
- It is well known that in many big urban centers in the developing countries, the Gross Regional Product per capita is much above the country average (up to 10 times, Drakakis-Smith 1987).
- The income distribution is often very wide; even the middle class may be pretty well off if measured with any economic criteria. The income inequality is highest in middle-income countries (Nafziger 1997); not in the poorest ones as one could think.
- The poor and the informal sector are a big question mark and an enormous diversity exists. GNI data do not cover the economic activity of the informal sector. Besides an economic issue, it is typically a political question of priority setting how to provide services for those very poor and those living on an illegal basis.

Figure 4.4p

Costs and affordability of urban water infrastructure

The exemplary share of urban water infrastructure costs of GNP in different economies (left). World's population against PPP and the sum of 0.4% of PPP used typically to WSS in developing countries (right).





Perhaps most importantly though, many local expenses in low-income countries are much lower than in high-income economies. The GNI generally overestimates the difference between rich and poor countries (e.g. Nafziger 1997). A number of alternative indices, such as purchasing power parity adjusted GNI (PPP), have been proposed to allow more realistic comparisons. It exceeds the GNI per capita typically 5 to 10 fold in low-income and lower-middle-income economies. Recalling the investment rate in WSS of about 0.4% of the GDP, we again face an excessively low economic capability of most humans this respect: about 4/5 of the mankind lie in the range of being able to spend between US$ 4 and 40 per person in a year in WSS. Recalling that the Gross Regional Product in many cities exceeds up to tenfold the country average helps us to get rid of much of the excess pessimism.

In the light of the recent development of the low-income economies (World Bank 1996), it would be overoptimistic to expect rapid economic growth in their near future; a notable economic growth is a rarity, whereas a notable economic decline is much more frequent. Moreover, many poor countries are heavily indebted and aid-dependent, and therefore very averse to invest on foreign technology. The observation that the disparities between economies are growing rather than diminishing suggests that the poorest economies will face the affordability question in a sharply increasing way, because the unit costs of WSS grows rapidly with congestion. Urban water infrastructure is typically far more expensive to construct and maintain than a rural one. The World Bank (1992a, b) estimated, that the difference is typically one order of magnitude. As a city grows, the unit costs tend to grow sharply: traditional low-cost systems become infeasible in congested areas; water has to be transferred from larger distances, and waste accumulation and pollution problems emerge; and aspirations due to urban lifestyle tend to increase water demand per capita.

It seems that much can be done even in lower-middle income economies, but what to do with the low-income ones, in most of which urbanization is very fast and will continue long? In terms of population share, India and China are in the key position; they have roughly 2/3 of the low-income category population, and both have showed positive economic indicators over many years. But still, for many of the remaining 1.1 billion people, such a cautious economic (and social) optimism appears unjustified.

4.5 Human development

Olli Varis

Although the basic economical indicators such as gross national income (GNI), gross domestic product (GDP), and purchasing power parity adjusted GNI (PPP GNI) per capita are powerful indicators of a country's development, they miss ignore many crucial issues what comes to the livelihood of human beings, and possibilities for improving living conditions. UNDP's human development approach is the most popular alternative concept. It combines economic performance with social indicators such as longevity and education. It is now widely used in comparative analyses for human development.

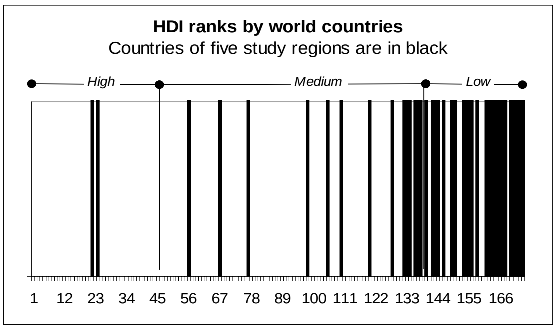
Human Development Index

UNDP's work on the analysis and quantification of human development is widely appreciated. The annual Human Development Reports attract plenty of notice even in the public media. The key advocate of the approach, professor Amartya Sen—originally from India—was nominated the Nobel Prize laureate in Economics in 1998.

The most used quantification for human development is the Human Development Index (HDI). It combines

- *standard of living*, measured with PPP GNI
- *longevity*, measured with life expectancy at birth
- *education*, measured as adult literacy and gross school enrolment.

Figure 4.5a
The study region countries score low in HDI
Human Development Index ranking by world countries after UNDP (1999).



The UNDP approach includes a number of other indices, such as Gender Related Development Index and Human Poverty Index. For their distribution over the study regions, see the analysis of Lahtela (2000).

In a global comparison, the study region countries cover a wide range of human development levels. Yet, almost all countries ranked low in 1999 are located in the regions (Figure 4.5a,b).

Human development wall

It is not a surprise that HDI is strongly correlated with economic indicators such as PPP GNI (Figure 4.5b) and GDP (Figure 4.5c). Owing to this strong relation, the analysis that follows is not done exclusively by country. The results would be fairly similar to those of the previous Chapter (see Figure 5.4h in particular).

Figure 4.5b
HDI correlates well with PPP GNI
Correlation between Human Development Index and PPP GNI (Purchasing Power Parity adjusted Gross National Income) per capita in 2002 in study region countries. Sources: UNDP (2004) and World Bank (2004).

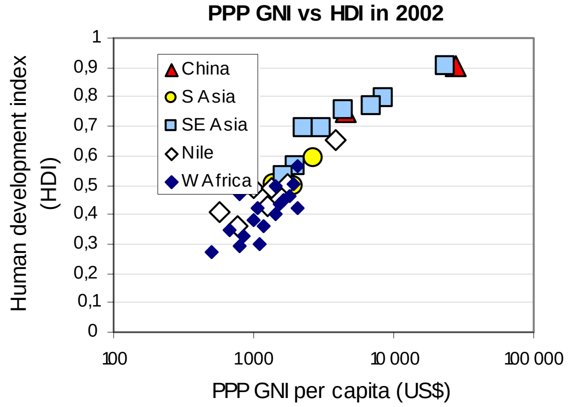
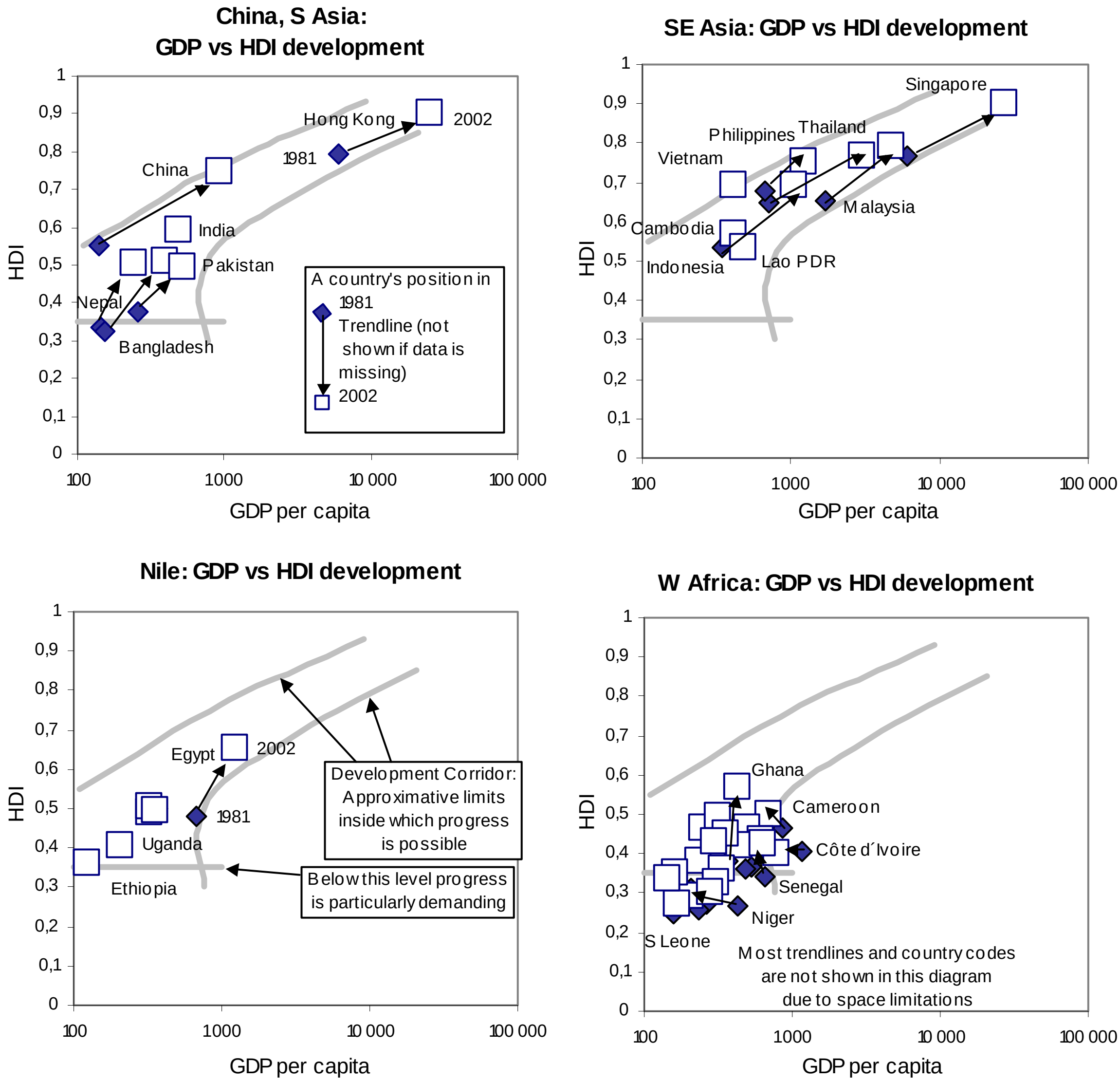


Figure 4.5c

The way to go: Human vs. economic development between 1981 and 2002

Human Development Index (HDI) and GDP per capita (in 1995 US$). Source: World Bank and UNDP (2004)



A closer look reveals, that within the PPP GNI range between US$ 1,000 and 5,000 per capita, most countries have relatively speaking a higher human development than economic development. This holds particularly to many SE Asian countries and China, that fall into this PPP GNI range.

Does this mean that those countries are in the process of building human capacity for economic progress, or the opposite: other constraints besides human development block economic growth?

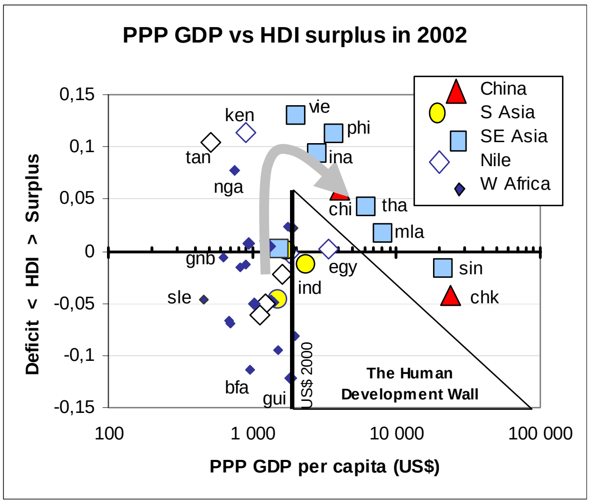
This question is very interesting, and it can be studied more in detail by the help of Figure 4.5d. The vertical axis in the two plots, HDI "Deficit" or "Surplus", is obtained by substracting the HDI value of each country from the correlation equation of Figure 4.5b. This scaling makes the analysis of the deviations of the data points of individual countries from the correlation line more implicit, and allows the detection of a distinct pattern of development. There is a well distinguishable wall which starts from around PPP GNP of US$ ~2,000.

It seems clear on the basis of these plots and Figure 5.4h, that for instance the Philippines should do better in economic terms. With its human resources, it should double its economic growth rate.

On the other hand, almost all African study countries have been unable to generate economic growth, and how to break the zero growth wall seems to be a common problem to the countries, independently from the HDI value.

Anyhow, seemingly the sole way to pass this wall is through increased human development. The diagram of Figure 4.5d indicates that there is no other way to climb and pass the PPP GNP per capita "wall" of US$ 2,000 than "surplus" human development. Egypt is an exception, for a reason which will be scrutinized later.

Figure 4.5d
Human development wall
HDI minus the correlation line of Figure 4.5b plotted against GDP per capita in study region countries. Sources: UNDP (2004) and World Bank (2004).



The development corridor

Plotting the countries in a similar way as in Figure 4.5b, but with GDP as the horizontal axis (Figure 4.5c) shows still more clearly that there exists a certain pattern of sequence for human and economic development. The temporal evolution between the years 1981 and 2002 is also included in the diagram.

There has not been a single case among the forty-one study countries in which the GNP wall of 1,000 US$ per capita would have been crossed with a HDI below 0.6. Some among the economically most advanced countries of W Africa—Cameroon, Côte d'Ivoire and Senegal—have made attempts but with no success.

The historical data shows, that the growth of GDP per capita has only taken place within a certain region of the crossplot of HDI and GDP per capita named here the "Development Corridor". Countries are drawn into this corridor by various reasons. From the lower-right hand side direction, severe shortcomings in education are the dominating reason, and from the upper-left hand side direction, other issues than education block the development; political and institutional reasons are dominating constraints.

Obviously, below the HDI level of ~0.35, several factors interact and contribute to the very slow progress, and it is consequently difficult to enrol into the development drive of the corridor.

In the 1996 World Development Report (UNDP 1996), a thorough analysis was made of the relation of human development and economic progress (Figure 4.5e). In both respects, the countries were ranked in low and high growth classes. It was concluded, that high human development is necessary in order to raise a country to a sustainable economic growth path. Most SE Asian countries were found in the high growth category in both respects, and so was China. Most African study countries, in contrary, were in the low human development category. UNDP approach provides at least a partial explanation to the complicated relation of human development and economic progress.

Figure 4.5e
Human development vs. economic progress
Selected countries from UNDP's (1996) analysis of the relation between growth rates of human development index (HDI) and GDP per capita. The section Low HDI/High GDP growth was found to be a trap with a difficult access to the High HDI/High GDP growth section. The analysis included eighty-seven countries.

HDI growth	GDP growth Low	High
High	24 countries incl. *Switzerland, France, Jamaica, Nicaragua, Sri Lanka*	14 countries incl. *Rep. of Korea, China, Hong Kong, Japan, Singapore, Malaysia, Indonesia, Thailand, Spain*
Low	42 countries incl. *Niger, Haiti, Ghana, Zimbabwe, India, Tanzania, Congo, Sudan, Rwanda*	7 countries incl. *Pakistan, Hungary, Egypt, Lesotho*

Analyses such as the one by UNDP (1996) are, however, not unambiguous. This can be demonstrated simply by plotting the GDP and particularly the GDP growth against the HDI as was done earlier. Compare, for instance, the location of Egypt, Malaysia, and S Asian countries in Figure 4.5c. This comparison leads to a feeling, that UNDP's study is extremely interesting, but the conclusions may be somewhat too simplistic.

China

In the HDI ranking, seventy-nine countries have been evaluated constantly since 1975. Between the years 1975 and 1997, fifty-one of them have improved more than 20%, thirty-one more than 30%, nineteen over 40% and six have exceeded 50% increase. China's index grew with 34%, which is well above the average (UNDP 1999). With its ranking, ninety-eight, among the 174 countries evaluated in 1999, it is in the middle category (Figure 4.5f). Chinese Hong Kong has been evaluated separately, and it ranks among the high HDI countries.

Akder (1994) analyzed the Chinese human development by province (Table 4.5a). According to his results, Shanghai—the most advanced province—would rank on the top class of the world countries, even above Hong Kong. Beijing, the second, comes slightly after Hong Kong, which is number twenty-five in the country ranking. Tianjin follows, with the human development level of Brazil and Libya (rank ~ 65).

Table 4.5a
HDI in Chinese provinces
Disaggregated Human Development Index for China after Zhizhou (1994, see Akder 1994)

Province	Share of Population	HDI 1990	HDI 1982
Shanghai	1.18%	.985	.99
Beijing	0.96%	.896	.824
Tianjing	0.78%	.799	.759
Guangdong	5.56%	.698	.609
Liaoning	3.49%	.682	.674
Zhejiang	3.67%	.621	.53
Jiangsu	5.93%	.618	.517
Hainan	0.58%	.586	-
Hebei	5.40%	.571	.548
Heilongjiang	3.12%	.565	.567
Shandong	7.47%	.564	.501
Shanxi	2.54%	.556	.516
Jilin	2.18%	.554	.564
Fujian	2.66%	.544	.449
Guangxi	3.74%	.511	.532
Henan	7.57%	.511	.469
Hunan	5.37%	.49	.451
Hubei	4.77%	.488	.423
Inner Mongolia	1.90%	.464	.446
Shaanxi	2.91%	.461	.381
Sichuan	9.48%	.454	.357
Xinjiang	1.34%	.448	.310
Jiangxi	3.34%	.445	.414
Anhui	4.97%	.442	.406
Ningxia	0.41%	.425	.337
Gansu	1.98%	.364	.318
Guizhou	2.87%	.312	.199
Yunnan	3.27%	.304	.180
Quinghai	0.39%	.261	.209
Tibet	0.19%	.023	.029

Tibet has the lowest ranking, falling below all the 174 countries analyzed by UNDP (1999). The last ones on this list are from W Africa: Mali, Burkina Faso, Niger, and Sierra Leone. The second Chinese province from the bottom is Qinghai, ranking slightly better than the above-mentioned W African countries. Yunnan comes next. It would rank 164, close to Guinea-Bissau, Chad and Gambia.

The top is very sharp, but the bottom goes very deep in the regional spectrum of Chinese human development. Akder (1994) notes, that the range of Chinese provinces is broader than that of world's nations. Going along the Yangtze, from Tibet, Qinghai and Yunnan down to Shanghai, this whole range is represented.

After all, China's economic and human development seem to go very much hand in hand (Figure 4.5f).

S Asia

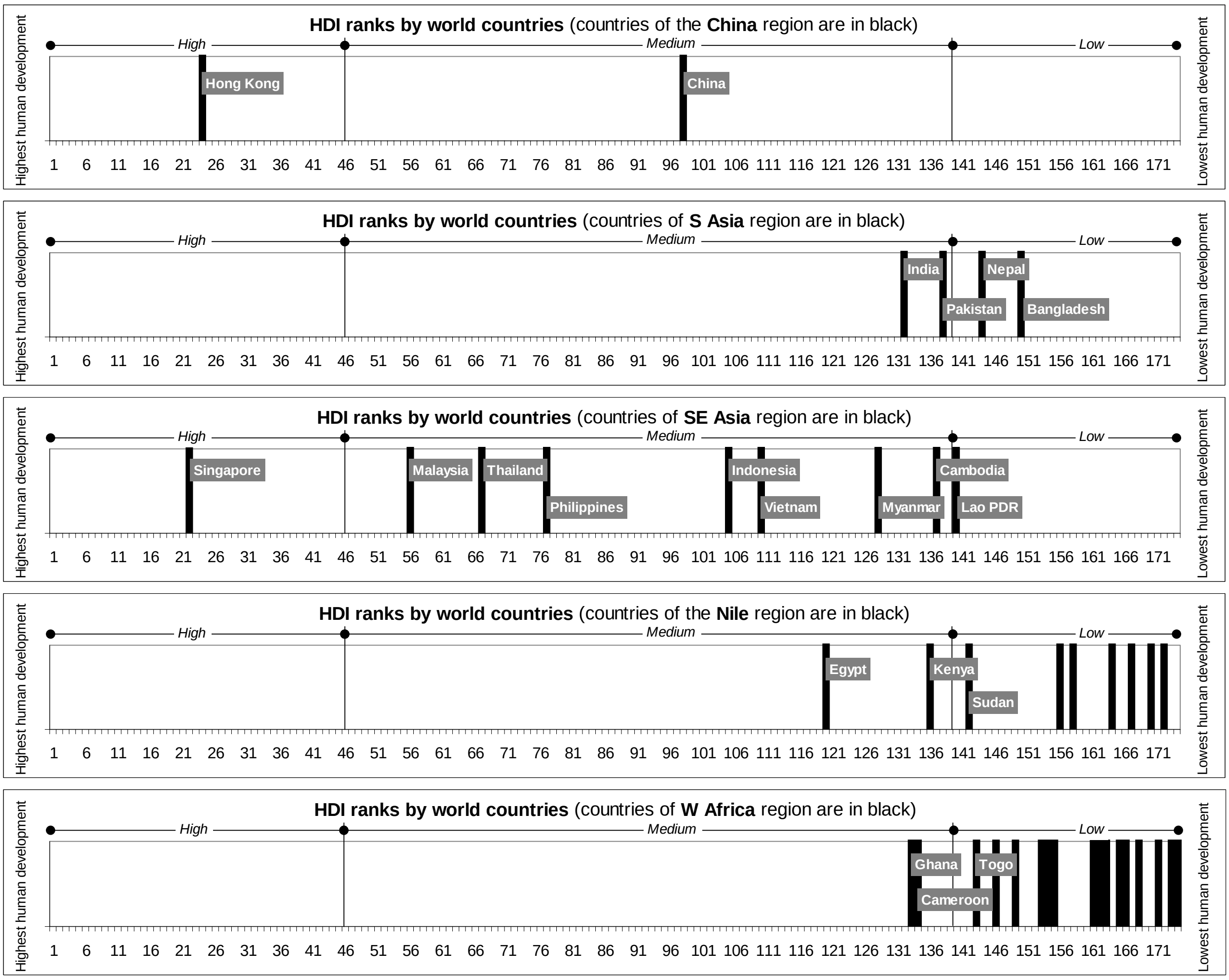
As in many statistics, the S Asian countries India, Pakistan, Bangladesh and Nepal are relatively close to one another in terms of HDI. They all rank between 132 and 150, among the lowest of medium HDI and highest of the low HDI countries.

The small differences in the country rankings in S Asia do not mean that the region is homogeneous, though. In the case of India, for instance, the differences between states are remarkable (Table 4.5b). Kerala—the state with the highest HDI—would rank much higher than the country average. Depending on the source—there are great differences between the HDIs calculated by different authors—Kerala would be close to Indonesia or even Thailand and Malaysia.

Table 4.5b
HDI in Indian states: a wide scatter
Disaggregated Human Development Index for India after Akder (1994). Results of four unpublished UNDP studies are shown. They have an enormous scatter.

States	HDI[1]	HDI[2]	HDI[3]	HDI[4]	Share of pop.
Uttar Pradesh	.244	.292	.11	.53	16,88%
Bihar	.258	.306	.147	.503	10.48%
Madhya Pradesh	.297	.344	.196	.543	8.03%
Rajasthan	.299	.347	.246	.565	5.34%
Orissa	.3	.348	.224	.529	3.84%
Assam	.324	.372	.256	.608	2.72%
Jammu & Kashmir	.333				0.94%
Andhra Pradesh	.349	.397	.361	.589	8.07%
Himachal Pradesh	.413				0.63%
Gujarat	.417	.465	.566	.678	5.01%
West Bengal	.418	.467	.436	.641	8.26%
Karnataka	.427	.475	.502	.639	5.46%
Tamil Nadu	.436	.483	.508	.652	6.78%
Haryana	.467	.514	.624	.724	2.00%
Maharasthra	.484	.532	.655	.711	9.58%
Punjab	.538	.586	.744	.793	2.46%
Kerala	.603	.651	.775	.769	3.53%

Figure 4.5f
SE Asia and China score better in human development than the other study regions
Human Development Index ranking by world countries after UNDP (1999)



The mid-northern states Uttar Pradesh, Bihar, Madhya Pradesh and Rajastan, in contrary, fall among or even below the low HDI countries.

Again, the enormous scatter among the HDIs evaluated by different authors gives a reason to be cautious in deriving too far-reaching conclusions on the basis of the disaggregated HDIs presented in this chapter. Same caution is justified to the whole HDI approach.

The HDI development has been very positive in S Asia, and hopefully, it will allow enhanced economic development in coming decades. However, the education component of the HDI is strikingly low, and as can be seen in the SE Asian data (Figure 4.5g), a typical order of progress among the different components of the HDI is

1. *Education*

2. *Longevity*

3. *Economy*

Therefore, S Asia is perhaps more constrained by the low level of education than the other regions, given its contemporary level of development.

SE Asia

SE Asia is a region with a wide spectrum of stages of HDI (Figures 4.5f, g). Singapore belongs to the High HDI category, Lao PDR to the Low, and the seven other countries scatter in the Medium HDI category.

SE Asia has been a region with remarkable positive development in both economic and human development in the past few decades (Figure 4.5f). Despite of very different conditions and development levels in the countries, the patterns of development may have certain similarities.

Figure 4.5g

Components of human development: start from education

Human Development Index (HDI) consists of three components which are economy, longevity and education. For each component, an index is calculated, and the HDI is their arithmetic mean. Source: UNDP (2004).

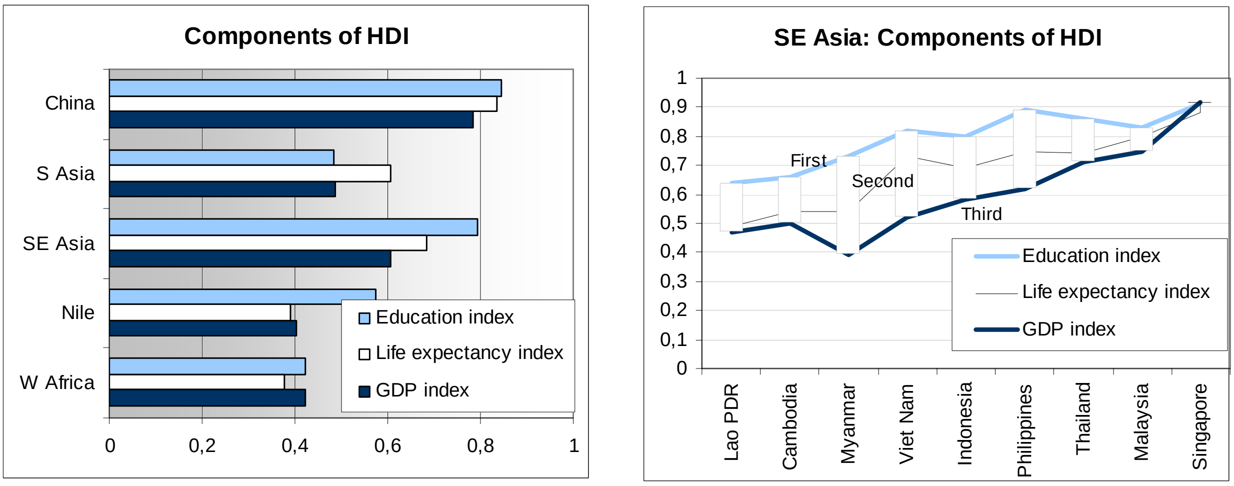
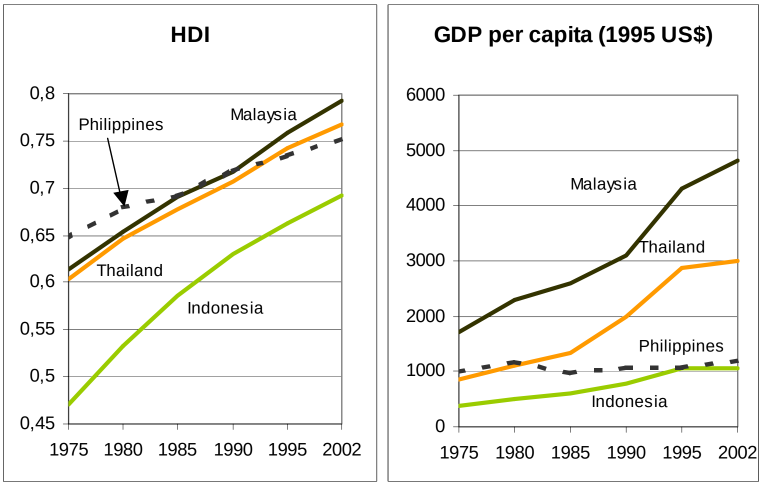


Figure 4.5h

What goes wrong on the Philippines?

HDI and GDP development in Indonesia, Thailand, malaysia and the Philippines between 1975 and 2002. Source: UNDP (2004) and World Bank (2004)



The most distinctive exception is the Philippines, which has stagnated in economic terms during the past decades. Given the human development level of its population, it should be much more successful than it has been. Figure 4.5h illustrates the stagnation of the Philippine economy in comparison to Indonesia, Thailand, and Malaysia. The reasons for that stagnation may lie partly in the stagnation of human development in the 1980s, but the main causes are elsewhere, obviously in politics.

Many SE Asian countries are ethnically non-homogeneous, and the human development of different ethnic groupings tends to differ from one another.

An example is Malaysia (Table 4.5c). The HDI for the Chinese population is 12.9% higher than the national average, while the Malayans and Indians are below the average by 8.0% and 5.8%. According to Akder (1994), however, the inter-ethnical disparities are narrowing due to successful policies in this respect. The bigger problems are the widening disparities between rural and urban populations, as well as between the males and females.

Table 4.5c

Adjusted HDIs for Malaysia

After Leng and Aziz (1993, see Akder 1994).

Unadjusted HDI (1994)		.845
Ethnicity-Adjusted HDI	*-Malays*	*.777*
	-Chinese	*.954*
	-Indians	*.796*

Nile and W Africa

The urban-rural disparities are important in Egypt as well (Table 4.5d). Upper Egypt is more backward than lower Egypt, as measured with HDI. The HDI of upper Egypt's rural governorates is only 67% of those in lower Egypt. The wealthy provinces of the Nile Delta (Port Said, Alexandria, Damitta, Sharkia…) have about a double HDI in comparison to the poorest rural provinces (Menia, Beni-Suef, Assuit, Sohaq…).

Nigeria's HDI has also a clear geographic pattern (Table 4.5e, Figure 4.5i). The index has its highest values in the southern parts of the country, and decreases towards the north.

What comes to the trends in the African study regions, a sad thing is that their human and economic development stay far below those of the Asian regions.

Egypt scores higher than the other countries, yet it cannot be proud in all respects of HDI. Whereas it is economically by far the most advanced African study country, it is only in the same level in terms of education as Tanzania, Uganda, Rwanda, and Kenya. Its economic progress is partly due to the substantial volume of foreign aid (Figure 4.4k), which is far bigger than in most Asian study countries. For these reasons, its way to pass the "human development wall" as defined in Figure 4.5c is very different from that of Asians. Vietnam receives the same proportion of foreign aid of its GNP as Egypt (8%). Yet, Vietnam's economy grows with more than double rate in comparison with Egypt.

What was observed about the sequence of development of the three components of the HDI within the context of SE Asia (Figure 4.5g), is difficult to import to Africa (Figure 4.5j). There are countries that have the same sequence of sub-indicator values (education highest, GNP lowest), and many of those countries tend to be better-off than the others. However, several among them have had a backward development in the last decades (Cameroon, Tanzania, Nigeria, Kenya, Rwanda…). Anyhow, those countries might have the best potential for sustainable economic and human progress, once their political and social environment is favorable enough.

Summary

UNDP's human development approach has become the major challenger for economic indicators such as GNP to characterize the development of nations. The most used UNDP index HDI (Human Development Index) combines economy with education and longevity.

HDI as a combined index is very powerful. However, for any policy implications it must be split back to its original components in order to see the weak and strong points of human development in countries or regions under study.

It appears that the achievement of sustainable economic development from the approximate PPP GNI level of ~2000 US$ per capita cannot be realized without a "surplus" human development.

The same goes with the GDP per capita level of US$ ~1,000: it is very hard to cross if the HDI level is below ~0.55-0.6.

The far most important issue to concentrate on when creating such "surplus" human develoment is education. The share of the education index should exceed notably the share of the other HDI components in all developing countries.

Development attempts and policies that ignore the human development wall and the way to pass it through education are ultimately bound to fail sooner or later.

Table 4.5d

HDI in Egyptian governorates and regions

R = rural governorate. After El-Laithy (1993, see Akder 1994).

	Share of population	HDI 1991
Port Said	0.86%	.671
Damitta	0.39%	.67
Sharkia	1.51%	.582
Cairo	12.31%	.581
Ismailia	0.57%	.577
Dakhlia	1.92%	.577
Garbia	1.95%	.57
Alexandria	6.02%	.549
Suez	0.73%	.548
Giza	4.75%	.544
Menofia	0.94%	.509
Qalubia	2.42%	.496
Menia	1.14%	.496
Assuit	1.28%	.484
Damitta (R)	1.16%	.484
Qena	1.10%	.479
Beni-Suef	0.76%	.472
Aswan	0.66%	.471
Garbia (R)	4.01%	.471
Kafr Elsh	0.86%	.468
Ismailia (R)	0.60%	.467
Dakhlia (R)	5.38%	.467
Fayoum	0.76%	.447
Menofia (R)	3.72%	.443
Sohag	1.11%	.441
Behera	1.62%	.435
Sharkia (R)	5.66%	.422
Qalubia (R)	3.10%	.411
Kafr Elsh	2.89%	.402
Giza (R)	3.52%	.399
Aswan (R)	0.99%	.393
Behera (R)	5.25%	.366
Qena (R)	3.62%	.348
Fayoum (R)	2.51%	.323
Sohag (R)	3.97%	.32
Assuit (R)	3.34%	.315
Beni-Suef (R)	2.26%	.311
Menia (R)	4.38%	.3
Urban Governorate	19.91%	.573
Urban Lower Egypt	12.18%	.524
Urban Upper Egypt	11.57%	.501
Rural Lower Egypt	31.76%	.429
Rural Upper Egypt	24.57%	.337

Table 4.5e

HDI in Nigerian regions

Disaggregated Human Development Index for Nigeria after Adamu (1993, see Akder 1994).

Region	Share of Population	HDI 1990	HDI 1970
Bendel	5.43%	.559	.432
Rivers	4.58%	.506	.313
Cross Rivers	4.85%	.482	.381
Lagos	6.39%	.441	.744
Imo	5.49%	.438	.301
Ogun	2.69%	.235	.216
Ondo	4.46%	.223	.176
Oyo	6.54%	.204	.167
Gongola	4.14%	.201	.143
Plateau	3.77%	.197	.106
Niger	3.32%	.179	.152
Benue	4.68%	.177	.080
Kwara	2.77%	.172	.135
Anambra	6.81%	.163	.164
Kano	9.72%	.151	.122
Bauchi	4.93%	.133	.037
Sokoto	7.42%	.106	.132
Kaduna	9.01%	.097	.070
Borno	2.98%	.053	.040

Figure 4.5i

HDI zones of Nigeria

For regional data, see Table 4.5e.

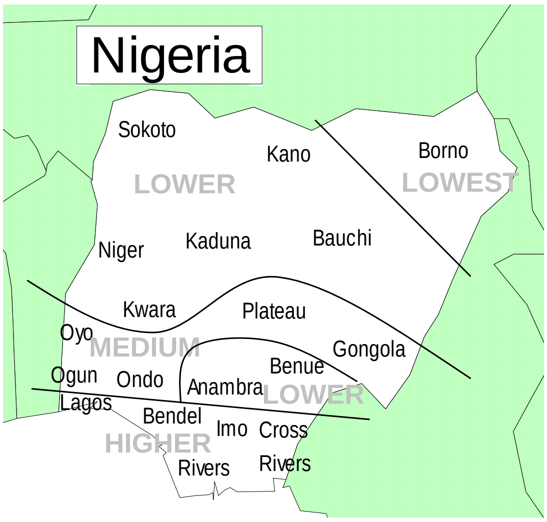
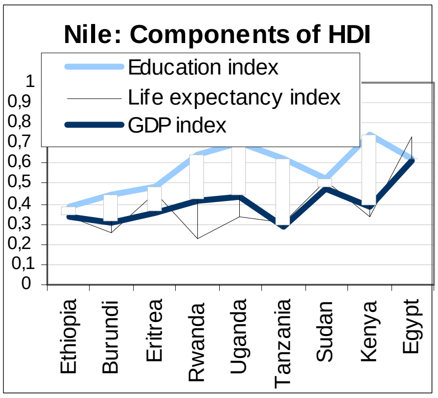
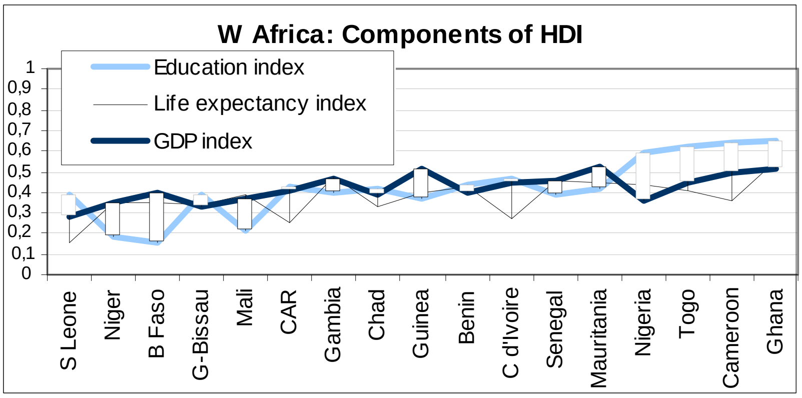


Figure 4.5j

Components of human development for African regions (UNDP 2004)





References to Section 4

Adamu, S. 1993. *Disaggregated Human Development Index within Nigeria.* Unpublished study for United Nations Development Programme (UNDP).

Akder, A.H., 1994. *A means of closing gaps: Disaggregated Human Development Index. Occasional Paper 18,* UNDP, New York.

Briscoe, J. 1999. The financing of hydropower, irrigation and water supply infrastructure in developing countries. *Water Resources Development* 15(4): 459-491.

Camberlin, P. 1997. Rainfall anomalies in the source region of the Nile and their connection with the Indian summer monsoon. *Journal of Climate* 10(6): 1380-1392.

Cole, J.E., Fairbanks, R.G. & Shen, G.T. 1993. Recent variability of the Southern Oscillation: Isotopic results from a Tarawa Atoll coral. *Science* 260(5115): 1790-1793.

Conway, D., Krol, M., Alcamo, J. & Hulme, M. 1996. Future availability of water in Egypt: the interaction of global, regional, and basin scale driving forces in the Nile Basin. *Ambio* 25(5): 336-342.

Cour, J.-M. & Snrech, S. 1998. *Preparing for the Future - A Vision of West Africa in the Year 2020: West Africa Long-Term Perspective Study*. Organisation for Economic Co-operation and Development (OECD), Paris.

Drakakis-Smith, D. 1987. *The Third World City*. Routledge, London.

El-Laithy, H. 1993. *The Disaggregation of Human Development Index for Egypt.* Unpublished study for United Nations Development Programme (UNDP).

Fiering, M.B. & Rogers, P. 1989. *Climate change and water resources planning under uncertainty*. Report for US Army Institute for Water Resources. U.S. Army Corps of Engineers, Fort Belvoir.

Gommes, R., Bakun, A. & Farmer, G. 1998, *An El Niño Primer,* SDdimensions. Food and Agriculture Organization of the United Nations (FAO), Rome. www.fao.org/sd/eidirect/eian0008.htm (30.5.2006).

Haggett, P. 1979. *Geography, A Modern Synthesis.* Harper and Row, New York.

Harrison, D.E. & Larkin, N.K. 1997. Darwin sea level pressure, 1876-1996: Evidence for climate change? *Geophysical Research Letters* 24(14): 1779-1782.

Heilig, G.K. 1999. *ChinaFood: Can China Feed Itself?* IIASA LUC Project CD, Version 1.1. International Institute for Applied Systems Analysis (IIASA), Laxenburg.

Hulme, M. 1992. Rainfall changes in Africa: 1931-1960 to 1961-1990. *International Journal of Climatology* 12: 685-699.

Hulme, M., Zhao, Z.-C. & Jiang, T. 1994. Recent and future climate change in East Asia. *International Journal of Climatology* 14(6): 637-658.

IPCC (Intergovernmental Panel on Climate Change) 1996. *Climate Change 1995: The Science of Climate Change.* Cambridge University Press, Cambridge.

IPCC 1998. *The Regional Impacts of Climate Change: An Assessment of Vulnerability.* A Special report of IPCC Working Group II. Cambridge University Press, Cambridge.

IPCC 2001. *Climate Change 2001: The Scientific Basis.* Cambridge University Press, Cambridge.

Kaczmarek, Z., Arnell, N.W. & Starkel, L. 1996. Climate, hydrology, and water resources. In: Kaczmarek, Z., Strzepek, K., Somlyódy, L. & Priazhinskaya, V. (Eds.): *Water Resources Management in the Face of Climatic/Hydrologic Uncertainties*. Kluwer, Dordrecht / International Institute for Applied Systems Analysis (IIASA), Laxenburg.

Katz, R.W. & Brown, B.G. 1992. Extreme events in a changing climate: variability is more important than averages. *Climatic Change* 21(3): 289-302.

King, A.D. 1991. *Urbanism, Colonialism and the World Economy: Cultural and Spatial Foundations of the World Urban System.* Routledge, London.

Kitoh, A., Yukimoto, S., Noda, A. & Motoi, T. 1997. Simulated changes in the Asian summer monsoon at the times of increased atmospheric CO_2. *Journal of the Meteorological Society of Japan* 75(6): 1019-1031.

Kuikka, S. & Varis, O. 1997. Uncertainties of climatic change impacts in Finnish watersheds: a Bayesian network analysis of expert knowledge. *Boreal Environment Research* 2(1): 109-128.

Lahtela, V. 2000. *Poverty and Water.* Helsinki University of Technology, Water Resources Laboratory, Espoo. www.water.tkk.fi/wr/tutkimus/glob/publications/Lahtela/alku_v.html (3.5.2006).

Leng, Y.K. & Aziz, T. 1993. *Disaggregated Human Development Index (HDI) of Malaysia.* Unpublished study for United Nations Development Programme (UNDP).

Liu, C. 1997. The potential impact of climate change on hydrology and water resources in China. *Advances in Water Sciences* 8(2): 21-32.

Nafziger, E.W. 1997. *The Economics of Developing Countries.* 3rd Ed. Prentice-Hall, Upper Saddle River.

Niang, D., Warr, B., Bossard, L. & Cour, J.-M. 1998. *L'économie locale de Saint-Louis et du delta du fleuve Sénégal.* Programme de Développement (PDM) & Club du Sahel, Organisation for Economic Co-operation and Development (OECD), Paris.

Nicholson, S.E., Ba, M.B. & Kim, J.Y. 1996. Rainfall in Sahel during 1994. *Journal of Climate* 9(7): 1673-1676.

Nshimyumuremyi, A. 1998. *San Pedro: Dynamics and Synergy in the Local Economy*. Programme de Développement (PDM) & Club du Sahel, Organisation for Economic Co-operation and Development (OECD), Paris.

OECD 1999. *Preparing for the Future - A Vision of West Africa in the Year 2020: West Africa Long-Term Perspective Study.* OECD, Paris.

O'Neill, B.C., Oppenheimer, M. & Goffin, S.R. 1997. Measuring time in the greenhouse. *Climatic Change* 37(3): 491-503.

Ose, T., Song, Y. & Kitoh, A. 1997. Sea surface temperature in the South China Sea—an index for the Asian monsoon and ENSO system. *Journal of the Meteorological Society of Japan* 75(6): 1091-1107.

Pednekar, S.S. 1997. *Resource management in the Thai Mekong basin*. Mekong Working Papers 71. Asia Research Centre, Murdoch University, Perth.

Rajagopalan, B., Lall, U. & Cane, M.A. 1997. Anomalous ENSO occurrences: An alternative view. *Journal of Climate* 10(9): 2351-2357.

Ropelewski, C.F. & Halpert, M.S. 1987. Global and regional scale precipitation patterns associated with the El Niño/Southern Oscillation. *Monthly Weather Review* 115(8): 1606-1626.

Sandweiss, D.H. 1986. The beach ridges at Santa, Peru: El Niño, uplift and prehistory. *Geoarcheology* 1(1): 17-28.

Schaake, J.C. & Kaczmarek, Z. 1979. Climate variability and the design and operation of water resources systems. In: *Proceedings of the World Climate Conference*. World Meteorological Organization (WMO), Geneva.

Shen, D. & Varis, O. 2001. Climate change in China. *Ambio* 30(6): 381-383.

Serageldin, I. 1994. *Water Supply, Sanitation, and Environmental Sustainability, the Financing Challenge*. The World Bank, Washington DC.

Smil, V. 1992. China's environment in the 1980s: some critical changes. *Ambio* 21(6): 431-436.

Stockdale, T.N., Anderson, D.L.T., Alves, J.O.S. & Balmaseda, M.A. 1998. Global seasonal rainfall forecasts using a coupled ocean-atmosphere model. *Nature* 392(6674): 370-373.

Tanaka, M. 1997. Interannual and interdecadal variations of the Western North Pacific monsoon and the Baiu rainfall and the relatioships with the ENSO cycles. *Journal of the Meteorological Society of Japan* 75(6): 1109-1123.

Todaro, M. 1997. *Economic Development*. 6th Ed. Longman, London and New York.

Trenberth, K.E. 1997. The definition of El Niño. *Bulletin of the American Meteorological Society* 78(12): 2771-2777.

Trenberth, K.E. & Hoar, T.J. 1996. The 1990-1995 El Niño—Southern Oscillation event: longest on record. *Geophysical Research Letters* 23(1): 57-60.

Trenberth, K.E. & Hoar, T.J. 1997. El Niño and climate change. *Geophysical Research Letters* 24(23): 3057-3060.

UN 2002a. *World Population Prospects: the 2001 Revision.* United Nations, New York. http://esa.un.org/unpp/ (3.5.2006)

UN 2002b. *World Urbanization Prospects: the 2001 Revision.* United Nations, New York. www.un.org/esa/population/publications/wup2001/WUP2001report.htm (3.5.2006).

UNDP 1992-2000. *Human Development Report.* United Nations Development Program (UNDP)/Oxford University Press, New York. *(published annually)*

UNDP 2004. *Human Development Report 2004: Cultural liberty in today's diverse world.* UNDP, New York.

Varis, O. 1998. What if the trade winds and monsoons change? In: Lemmelä, R. & Helenius, N. (Eds.): *Proceedings of the 2nd Conference on Climate and Water:* 1293-1302, 17—20 August, 1998, Helsinki, Finland. Edita, Helsinki.

Varis, O. 1999. Water resources management: Vicious and virtuous circles. *Ambio* 28(7): 599-603.

Varis, O., Kajander, T. & Lemmelä, R. 2004. Climate and Water: On the search for improved links from climate models to water resources management and vice versa. *Climatic Change* 66(3): 321-344.

Varis, O. & Somlyódy, L. 1997. Global urbanization and urban water: can sustainability be afforded? *Water Science and Technology* 35(9): 21-32.

Whetton, P. & Rutherford, I. 1994. Historical ENSO teleconnections in the eastern hemisphere. *Climatic Change* 28(3): 221-253.

Whetton, P. & Rutherford, I. 1996. Historical ENSO teleconnections in the eastern hemisphere: comparison with the latest El Niño series of Quinn. *Climatic Change* 32(1): 103-109.

World Bank 1992a. *FY92 Sector Review – Water Supply and Sanitation.* World Bank, Washington D.C.

World Bank 1992b. *World Development Report 1992: Development and Environment*. Oxford University Press, New York.

World Bank 1996. *World Development Report 1996: From Plan to Market*. Oxford University Press, New York.

World Bank 1999. *World Development Indicators 1999 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2001. *World Development Indicators 2001 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2004. *World Development Indicators 2004 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

Zhang, Z., Chen, B., Chen, Z. and Xu, X, 1992. Challenges and opportunities for development of China’s water resources in the 21st Century. *Water International* 17(1): 21-27.

Zhizhou, C. 1994. *Disaggregation and Analysis of Human Development Indicators in China.* Unpublished study for United Nations Development Program (UNDP).

5 IMPACTS ON SOCIOECONOMY

The social consequences of the changes induced by the five driving forces described in the previous section are manifold. With the focus on the interconnections of water, food, poverty and urbanization, the following five clusters were identified to cover the essential social impacts in the study region countries: political instability and vulnerability, gender inequality, food insecurity, public health problems, and poverty.

It is more than obvious that all these issues are interconnected and interlinked in a very profound manner. For instance malnutrition must be included under three titles, namely food security, poverty, and public health. Yet, links to political instabilities and low status of women are obvious as well. Political problems, the lack of social and economic capacity, wars and so forth disable societies to tackle chronic social problems, and acute catastrophes such as those caused by floods, droughts, earthquakes or armed conflicts.

Most developing countries allocate only around 1% of their GDP for health care. In high-income countries, the percentage is typically around 6. The former figure is evidently far too low: many ancient diseases such as tuberculosis and malaria, which were under some control in the previous decades, have made a dramatic comeback. In addition, new plagues, particularly HIV/AIDS have spread in a catastrophic way, particularly in the Sub-Saharan Africa.

In 1999, diseases such as malaria, AIDS, diarrhea caused by the lack of clean water and sanitation, and pneumonic diseases (tuberculosis etc.) killed 160 times more people than natural disasters says the International Committee of the Red Cross. Wars have killed 23 million people since 1945, but diseases have caused 150 million deaths since 1945. Distinctions between these causes are usually more than arbitrary, however. Natural disasters and wars are major factors that allow disease outbreaks to develop to catastrophes.

Food security is one of the cornerstones of public health. A few million people suffer each year from famines caused by either natural or man-made emergencies. The big issue seldom reaches headlines, however. It is the chronic malnutrition that touches over 800 million people, most of who dwell in the study regions. Malnutrition is so closely related to poverty that it is increasingly used as an indicator for poverty.

After UNDP (1999): *"Geographical barriers may have fallen for communications but a new barrier has emerged, an invisible barrier that is like world wide web embracing the connected, and silently, almost imperceptibly, excluding the rest."* In most cases, poverty, gender inequality, food insecurity, and health problems touch the same people – those that are marginalized or getting marginalized in the globalizing world. While the global economy, on average, develops in a positive direction perhaps more successfully than before, the gap between the élite / middle class and the poor grows in most societies.

While averaged indicators on a national level, such as GNP or PPP per capita show positive signs in most parts of the world, the marginalized people are excluded even from these statistics since their contribution to cash flows is minor. The state of the human beings cannot be estimated by averages or well being of upper class. Says Amartya Sen (2000): *" Progress is more plausibly judged by the reduction of deprivation than by the further enrichment of the opulent."*

5.1 Political instability and vulnerability

Olli Varis

A factor that drives a society into a chaotic, unstable situation may be external or internal, or a mix of these. Recent years have seen many countries collapse, and to run into devastating civil wars. Most of today's armed conflicts are internal to a country. Societies face also many other risks, such as rapid economic, or natural disasters. Such conflicts and crises can take place anywhere, although some countries are more prone to them than others.

Post-cold war is hot for many

As the UN Secretary General Kofi Annan puts it, when analyzing the changing role of UN peacekeeping operations in the turn of the millennium: *"During the cold war, conflicts were neater. You had client states [that] could be controlled. Here you are dealing with warlords who don't understand the outside world and don't care… And that philosophy is spreading".* The conflicts are less between two states, but more between a state and a "maniac" (Watson 2000).

The cold war—although a sad chapter in the history—had some evidently positive impacts at least in some respects. It stabilized some regions of the globe that in the 1990s became unstable—some parts of Africa in particular. On the other hand, some countries that have suffered badly from the cold war such as Ethiopia and Vietnam have had a possibility to recover in the 1990s and have used the opportunity.

In 2001, there were twenty-five armed conflicts in the world, among which seventeen were internal wars (Figure 5.1a). Almost half of them were within the study regions.

Figure 5.1a
Armed conflicts in 1998
After Information Resource Centre, Canadian Forces College (CFC 1998).

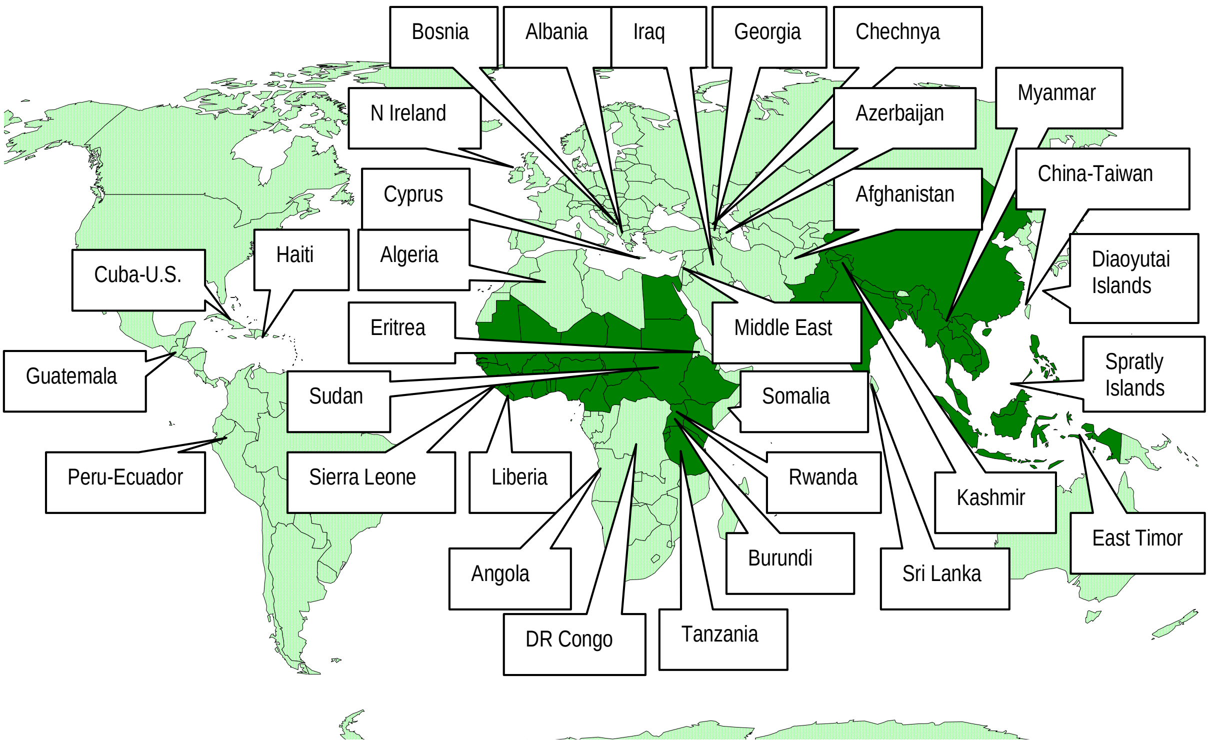
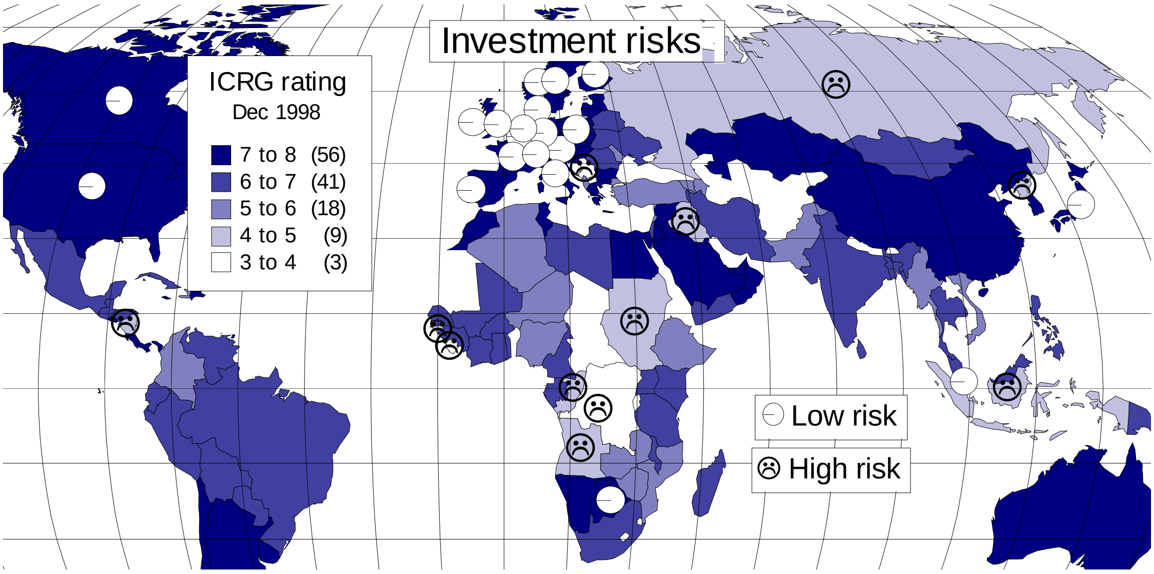


Figure 5.1b

Investment risks

Portfolio investment risks in December 1998: Composite International Country Risk Guide (ICRG) Rating (World Bank 1999). The rating is based on twenty-two political, financial and economic components of investment risk within an economy. The scale shown here is tens of percentages. A rating above 80% (denoted as eight in the map) implies a very low risk, and below 50% (denoted as five) means very high risk.



At least 100,000 people were killed directly in armed conflicts between August 1999 and August 2000 (IISS 2000). Two-thirds of that slaughtering took place in Sub-Saharan Africa.

Open conflicts are only one dimension of a risky and unstable environment. A very useful indicator is simply the level of investment risk within a country. One indicator is presented by country in Figure 5.1b.

Figure 5.1c

Refugees in 2001

Left: Refugee population by region of origin.
Right: Refugee population by region of asylum.
Sources: UNHCR (1998, 2002).

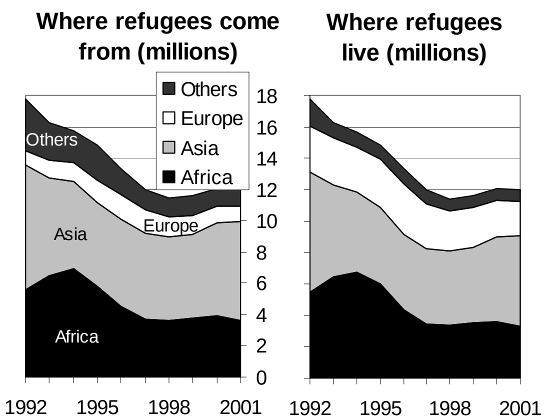
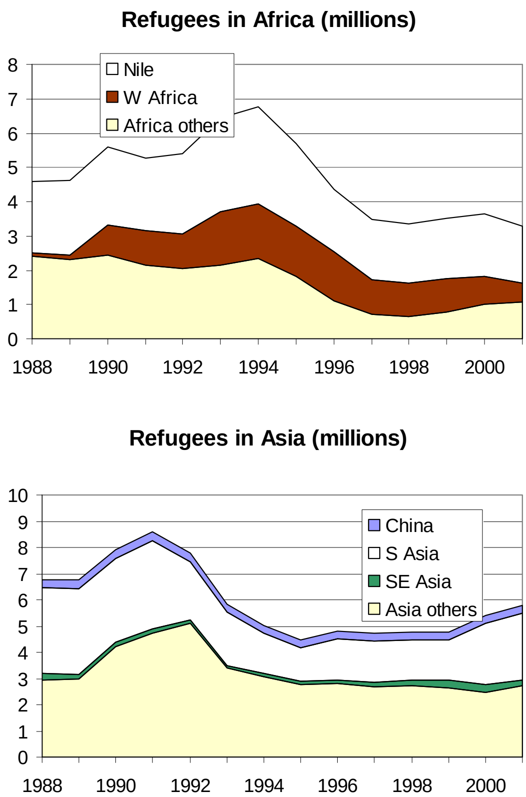


Figure 5.1d

Refugee trends in Africa and Asia

Sources: UNHCR (1998, 2002).



Over 80% of world's displaced people are in Africa and Asia (Figure 5.1c). The study regions' share of the African refugee situation has worsened (Figure 5.1d). The number of refugees is also growing in S Asia, and staying at a constant, fairly low level in SE Asia and China.

Among the study countries, Pakistan housed the largest number of refugees in 2001: 2.2 millions. Tanzania was the second with 650,000 refugees. Sudan, China, Kenya and Uganda came after them.

Africa has by far the biggest refugee problem of all continents. It has 13% of world's population, but 30% of the world's refugee problems.

Institutions, globalization, and traditions

Douglass C. North, the Nobel laureate in economics in 1993, keeps asking in his texts: *What is the glue that keeps the societies from falling apart?* (North 1990, 1997). In his terminology, such glue consists of formal and informal institutions (Table 8.1a). Formal institutions include laws, regulations, government setup, and others, that are under government's control.

In principle, formal institutions can be changed very rapidly. The informal ones, such as traditions, good habits, religions, culture, ideologies and indigenous knowledge, are a result of a long-term evolution.

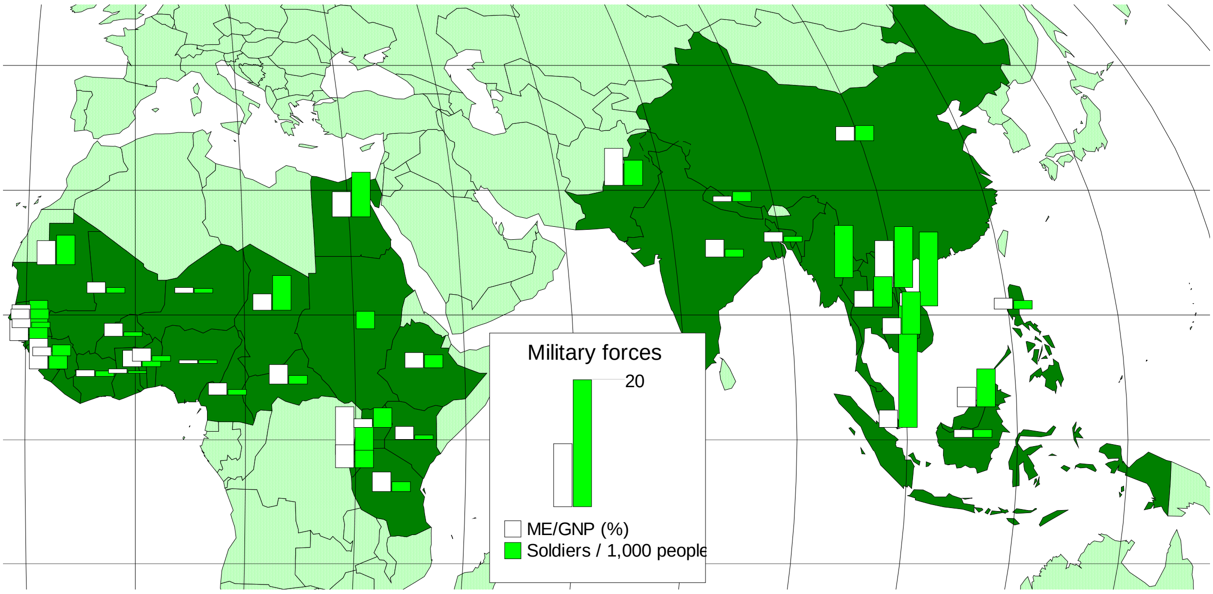
The concepts of Douglass C. North's neo-institutional philosophy have been elaborated in Chapters 3.2, 8.1 and 8.2.

The loyalty to institutions is decreasing in many parts of the world. Can formal institutions alone? I am personally very untrusting. The role of informal institutions becomes the more crucial the less loyal citizens or citizen groups, are to formal institutions and the government.

Military forces are a classical example of formal institutions for gaining stability and resistance against risks in a country. Where their importance is instrumental in many ways, their success depends very much on their accordance with informal institutions (Figure 5.1e).

Trade liberalization has added to this problematique. This would not have been necessary: according to the neo-classical and liberal paradigms, the state should provide law and order in the first place to its citizens. In practice, however, the governments have too often failed to do it. Such examples are many.

Figure 5.1e
The size of military forces does not alone tell too much about the country's or region's stability
Military expenditures (ME) as a percentage of GNI, and number of solders per 1,000 people. The 1994 situation. After Gallik and Winstead (1996). It is important to realize that official statistics are too low in many countries. In China, the actual expenditure to military is often estimated to be about three times the official figure.



In Europe, the former USSR and Yugoslavia have been subjected to internal instabilities and conflicts after the collapse of the centrally planned system in the 1990s. Many others did not. Czech Republic, takes North (1997) as an example, was able to impose the old norms that were inherited partly from the pre-Nazi and pre-communist era. This process was governed by the sentiments of 'ownership' by the people, under 'high-moral' conditions. The foreign ideologies that were imposed to the country by power were replaced by ones that were leaning on people's traditional values and moral.

Some of the informal institutions or "maniacs", using Kofi Annan's phrasing, may grow out of hands of the government. This has lead to a collapse of several countries, such as Cambodia, Rwanda, Somalia, Sudan, Sierra Leone, and Liberia and many others. What if some of the big study region countries would follow: Indonesia, China, Pakistan...

Ulrich Beck (1999) sees many of such shifts from conflicts between nations to conflicts within nations as a logical consequence of globalization. The role of the state has fainted, and global plus local questions—that do not fit into national politics—dominate more than previously.

The role of traditional institutions such as the ethic background, and religion tend to increase and become dominant in this process. Todaro (1997) estimates that around 40% of the world's countries have more than five sizeable ethnic groupings, among which one or more faces serious economical, social, and political discrimination.

The ethnic dimension has shown to be so crucial within the context of recent conflicts and riots that the main focus of the following scrutiny circles around it. It is important, though, to realize the very mixed and many interconnections of political stability to the most other chapters' topics.

China

China was increasingly exposed to foreign influence until the WWII. After that, there were decades of almost complete isolation. In 1970s, China started to open up, and this process has changed the country and its economy rapidly ever since. Thus far, China has been able to keep this transition peaceful, and the government has maintained its authority, although the ideologies have changed at least once in a decade.

This stability has been explained by the regional and ethnic homogeneity of that giant country. China has an exceptionally long and fairly uniform base of traditions and culture. This, combined with ethnic homogeneity, has kept the country regionally stabile. 93% of the population is Han Chinese. The authoritarian government has, despite of its many and drastic policy changes, leaned on ancient, Confucian traditions of discipline and authority. The military empowerment has also been extreme.

China's military force has been traditionally based on the idea of territorial defense, which means that large troops are stationed in all parts of the country, with the eventual, principal aim to control its own territory. The other side of this issue is the very limited strategic capability, including navy, air force, mobility capacity of the troops, etc. The traditional system has been slowly changed to a more mobile, smaller force, which would be more able to react to internal and external threats (IISS 2000). Yet, at the turn of the Millennium, China kept constructing its first ballistic-missile submarine.

This homogeneity is only partly true. Measured on area, a major part of the country, namely the provinces of Tibet, Xinjiang and Inner Mongolia, are traditionally not dominated by the Han Chinese, and contain still today sizeable ethnic minorities. They have been suppressed many times over the history, and have actually separatist tendencies.

Linguistically, China is not as homogeneous as people in the west often think. In contrary, China has the largest language diversity on earth (Economist 1999b). The national language, Putonghua, is the universal language of the government. It is used in schools and universities, where regional dialects are not allowed. Consequently, most of urban Chinese can manage with some sort of Putonghua. The eight so-called regional dialects of Chinese are de facto distinct languages, which are not mutually comprehensible. The written Chinese is more comprehensible among the eight regional Chinese languages, but far from completely. In addition, there is a population of 75 million non-ethnic Chinese who speak a high number of minority languages.

The economic liberalization challenges the stability of China as well. Today, the different parts of the country develop with diverging rates, in contrary to the past ideals of uniform development in all parts. More open communication has boosted the official use of local and regional languages (Economist 1999b).

Hong Kong is not the only economic core of China. The other coastal mega-cities—wealthiest of them being Shanghai—grow rapidly in importance, as well as the special economic zones, while the large, land-locked agriculture-dominated provinces lose their economic share. The regional income differences are notable in China. Shanghai's GNI per capita is four times the national average (Hong Kong excluded), whereas most of the landlocked provinces can provide their dwellers only 10 to 20% of Shanghai's GNI. Shanghai's province rates as upper-middle income economy, with a GNI per capita close to Mexico and Poland. It is 10% of the Hong Kong level.

The core regions have accumulated much more wealth than the rest of the country. This leads to polarization, not only in terms of economy, but also with respect to education and ideologies. It is an open question, whether the wealthy, highly industrialized and liberal coastal regions will continue to have the 'ownership' to the formal institutions, in the rapid transition process that is expected to continue over decades.

The other side of the coin is the development of hinterland—regions dominated by collapsing or collapsed state-owned industries and rural areas, which are losing their educated people to cities. Such areas include most of the country's territory, yet perhaps most strongly the inland provinces of Guizhou and Sichuan, which used to have a massive, heavy industry (Economist 1999a).

The question of Taiwan keeps bothering both the People's Republic of China and Chinese Taiwan. Even though the talks are very vivid every now and then, IISS (2000) considers a military conflict as a very remote risk.

PR China has more trouble with its internal affairs, including the regional tensions, social transformations, natural disasters, and, e.g., the Falun Gong movement.

China is still fairly vulnerable to natural disasters. An example is the 1998 flood in the Yangtze River. Its costs were estimated to amount to US$ 50 billion, which is 4.7% of the country's GNI. Since then, almost every year has seen dramatic and economically devastating floods in China.

After all, China has so far been successful in the conduction of modernization, economical and social transformations, so that the society has not unstabilized out of control. Whether the economic growth, opening communication, possible economic depression, or some other cause will make the country more instable than it has been in the last decades of the 21st century remains to be seen.

S Asia

S Asia has a fairly uniform colonial past, until the year 1949. In that time, the sub-continent was split into the Hindu-dominated India and the Islamic Pakistan. The kingdom of Nepal has, however, been independent since 1768.

The Pakistani civil war in 1971 led to the secession of the former East Pakistan, which became Bangladesh. The two republics are almost equal in population, yet Bangladesh has only 18% of the territory of today's Pakistan.

Accordingly, the boundaries between Pakistan and India, as well as India and Bangladesh, are the most important generic tension lines of that sub-continent. The non-agreed boundaries between India and China are similarly problematic.

The ethnic and cultural diversity, however, is much complex. The Indian-Pakistani tension line is accorded by the unresolved situation of Jammu and Kashmir, Punjab split between two countries, the tension between the Sikh and other population in Punjab, to mention some of the most important ones.

A dark shadow of fear and threat is cast over the sub-continent by the existing nuclear capabilities of, not only Pakistan and India, but China as well. The doctrines and agreements concerning the possible application of these arms are very unclear and attempts to reach agreements have resulted only little (IISS 2000).

SE Asia

SE Asia has been a playground of colonial powers and local warlords with a whole rainbow of ideologies.

Indonesia is an umbrella state that covers a rich mix of cultures spread over thousands and thousands of islands. The number of ethnic groupings on these tropical islands is well over one hundred. Tensions within ethnically mixed areas such as big cities are remarkable, and so are regional tensions between ethnically different regions. An example of the former are the easily provoked insurgences between the Chinese and Malay population in Jakarta, and of the latter, the separatist movement of the N part of Sumatra, claiming an independence for the region of Aceh.

The Philippines is infamous for its instabilities due to several reasons. The Muslim-dominated islands in the South are unsatisfied with their situation as a part of the Philippines. The very strong concentration of power and wealth seems to have become a destabilizing factor that turned president Ferdinand Marcos down in 1980s and this tradition seems to be difficult to cut. The violent traditions of the colonial powers Spain, USA and Japan constitute a difficult foundation to build upon.

Singapore, Brunei Darussalam, Malaysia and Thailand are ethnically mixed, but the strong economy and fairly stable governance has kept these countries out of major instabilities.

Myanmar, formerly Burma, is still under military rule, which is usually classified as a Marxist one. However, it is difficult to recognize many of the SE Asian extremely militaristic and violent "ideologies" as anything but "maniac". Myanmar has a number of ongoing internal conflicts, which mainly have an ethnic determinant. For instance, the armed tension between Karens, in the country's eastern part, and the government has lasted over decades.

The rest of the Indo-China, namely Vietnam, Laos and Cambodia have suffered exceptionally from the ambitions of superpowers, as well as local warlords. The evolution from the French colonial time through US, Soviet, and Chinese pressure to independence has been very bloody. US troops dropped more bombs to the silent Laos than the grand total was in the WWII.

The Khmer Rouge government of Cambodia killed approximately 1.5 million of its own people between 1970-79. The recovery from that sad period, both mentally and materially, will take several decades. The Communistic Khmers were initially armed by the Vietnamese, but the Vietnamese invasion in 1978-79 pushed them out of the capital to carry guerilla war which continued two decades and Cambodia's stability remains fragile.

African regions

Most national boundaries in Africa have their roots in the colonial times. They do not usually follow ethnic or cultural boundaries of the local population.

The growth of the death toll in Africa has been shaking since the mid-1980s. Armed conflicts have become the absolutely dominant reason for disaster-caused deaths gradually since the late 1980s.

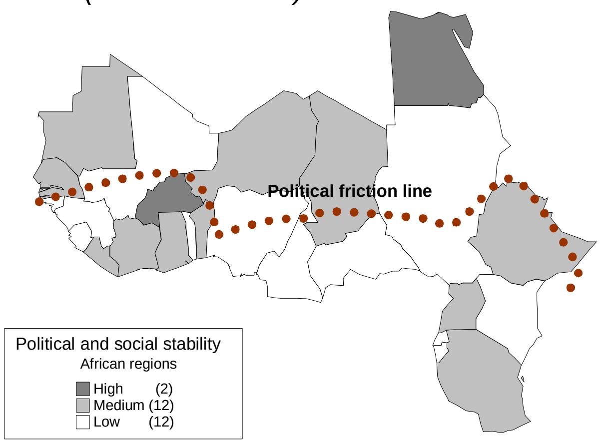
Among the 100,000 individuals killed in armed conflicts over a year to August 2000, two out of three were killed in Sub-Saharan Africa. Although the AIDS situation is sharply deteriorating in the continent, the number of lost lives is still about one-tenth of the number of those killed in wars. An armed conflict of some form was going on in ¾ of the countries of Sub-Saharan Africa (IISS 2000).

The root causes of instability and conflicts are very complicated in Africa, as in the other continents. The friction line cited below is only one among many small-scale confrontations. Eritrea, Ethiopia, Uganda, Kenya, Tanzania, Rwanda, Burundi in E Africa, and almost each W African state has had conflicts in recent decades. Most dramatic of them are perhaps the hostilities in Sierra Leone and Liberia.

Within the study regions, perhaps the most important friction line is the one shown in Figure 5.1f. It has been a continuous scene of conflicts. Its Western end is at Senegal's Casamançe region and in Guinea-Bissau, which both are very volatile. In Nigeria, it crosses the line between Hausa and other, Muslim-dominated groupings of the North, and the Igbo, Yoruba, and other Christian-dominated groups in the South. The line crosses the sensitive regions of Chad and the Sudan, where the civil war has continued decades, and ends to Ethiopian borders with Eritrea and Somalia.

The World Water Vision Process has emphasized the crucial role of political instability as one of the key constraints to water resources development in both West Africa and the Nile basin (Global Water Partnership 2000).

Figure 5.1f
Governance environment in Africa
The classification of the African study countries with respect to political and social stability (after Damhaug et al. 1996). The most important cultural-religious friction line of the regions is also shown (after Grove 1986).



5.2 Gender inequality

Virpi Lahtela and Olli Varis

Women are typically considered being suppressed by men. This is obviously more often true than false. The traditional roles of males and females are very different in most cultures. The tasks are divided between sexes in very distinct manner. Such traditional roles collide almost invariably with modern attitudes when traditional societies are imposed to urbanization, education, modern lifestyles, industrialization, and so forth. Today, over 70% of the world's poor are estimated to be female.

Are women poorer than men?

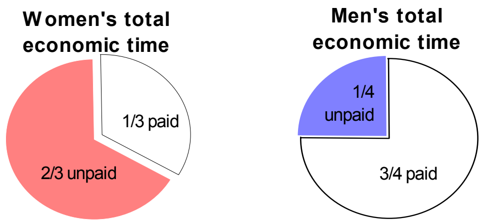
Feminization of poverty is a hot topic. It is claimed that women-headed households fall below the income poverty line more often than households headed by men. However, this is not always the case.

According to UNDP (1997) feminization of poverty is rather a question of the severity and hardship of poverty that women are facing more often than men do. Various inequalities and biases in societies lead to the fact that women have fewer opportunities to start with and therefore leave them more vulnerable when adversities strike.

According to Cagatay (1998), the problem with finding out the connections between poverty and women raises from the fact that gender inequality and poverty appear so differently depending on the economic, social and ideological context. In addition there is little data available considering only one gender.

However, it has been discovered that measured by some basic factors (education, access to health care) women are poorer in most societies but when measured by other indicators, such as life expectancy, this is not the case (Cagatay 1998).

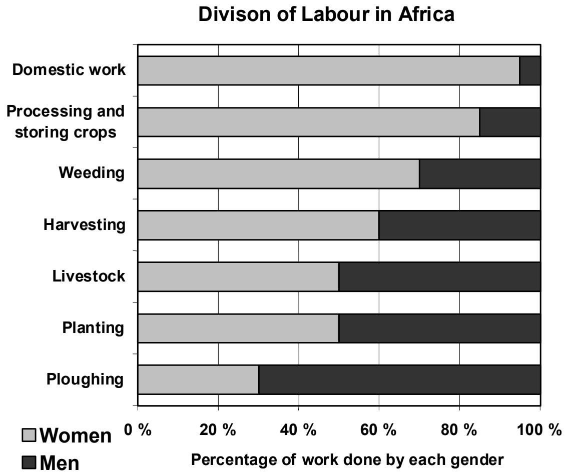
Figure 5.2a
The men's and women's roles in the work life
Women carry more than half of all work load, but men receive most of the income and work recognition. Most of women's work remains unrecognized, unpaid, and undervalued (UNDP 1995).



Women have less means to transform their capabilities into incomes or well-being. In many societies "*women specialize in unpaid reproductive or caring labor compared to men, who tend to specialize in paid production activities*" (Cagatay 1998, Figure 5.2a). Still, when combining paid and unpaid labor time, women work more than men (UNDP 1997).

This is the case especially in developing countries (Figure 5.2b). Much of women's work is socially unrecognized and as a result unpaid; even if women on average work more, they have less command over income as well as assets (Cagatay 1998).

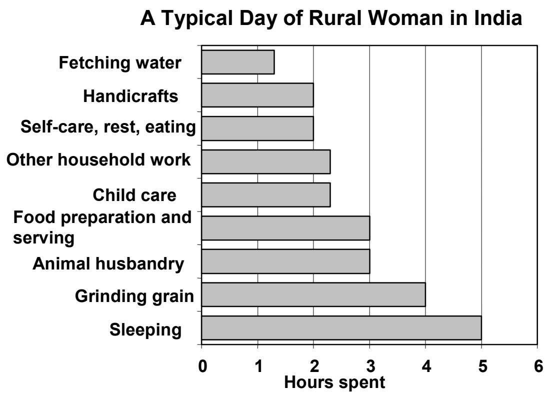
Figure 5.2b
Division between the work made by men and women in Africa
Source: Rodda (1991).



Role of women in poverty alleviation

It has been acknowledged that the role of women in managing the everyday household life of a poor family is indispensable (Figure 5.2c). For example, in Egypt it was discovered that the wife/mother is the one who makes the small income stretch the household needs. *"Even if the head of the family spends a large part of his small income on personal expenditure, - ... - she is the one who takes responsibility in finding out ways to get sufficient income to feed her children and provide the basic needs expenses for the family..."* (Korayem 1996). It has also been found out that women are keener on educating their children than the father, even if the income is small.

Figure 5.2c
Rural woman's day in India
Source: CSE India (1998).



One way for women (and at the same time for the whole family) out of poverty would be providing the possibility for education. Educating women has been called by the chief economist of the World Bank as *"The Most Influential Investment"* because of its favourable impact on health, income, family planning, and the well-being of children and families (FINNIDA 1994). Educating women as a mean of poverty reduction stems from many different sectors.

Education provides women motivation and knowledge to limit the family size. Also, the role of woman as a worker collapses with the role of mother and therefore having fewer children eases the tensions of having too many demands simultaneously (Harrison 1993). As being mainly responsible for fetching and handling water, hygiene education aimed on women have highly positive effects on overall health situation of families.

Women and population growth

In many societies women's status depends on the amount of children, especially sons, she bears (Rodda 1991). Thus, until the traditional role and undervaluation of women change, the population growth has fewer means to decline.

The connection between educating women and lower fertility is highly evident in nearly all developing regions. An example from Kerala State in Southern India shows how important the effect of education is on birth rates. In this state women are traditionally treated equally to men and the literacy rate in the society has been high. Once few women started using birth control in the 1960s the information soon spread in the educated society. As a result the birth rates fell from 3.0 children in 1979 to 1.8 in 1991 even though there were no structural changes or economic development in the society (Ehrlich et al. 1995).

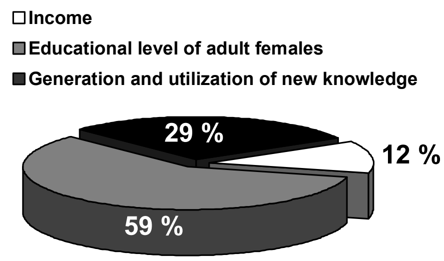
Another example from India reveals how the most educated caste, the Brahmins, were the first ones who started to plan their family sizes while the least educated caste, the Bhangis (sweepers), multiplied at twice of the rate of the Brahmins. Further, the Brahmins could benefit from education for example by getting good jobs and being able to invest on their children's education. At the same time the Bhangis were having a lot of children in order to maximize their income and to insure against old age. As a consequence: *"the rich got richer – and the poor got children"* (Harrison 1993).

Women and health

Gender, education and health create a tight vicious circle in poverty reduction. This circle, on the other hand, is rather easy to break. Educating women makes them able to take better care of their families. Teaching women to use more nutritious food, obtain pure water and use sanitary practices are all means, which help more children to survive. That makes women more willing to use birth control since the survival of children is more secured.

Figure 5.2d shows the effect of income, education level of adult women and generation and utilization of new knowledge on fertility reduction. As can be noted, the effect that educating women has on the total fertility rate is far bigger than the role of income and approximately half bigger than the generation and utilization of new knowledge.

Figure 5.2d
Sources of fertility reduction
Source: WHO (1999).



Women and water

Families in the developing world need water for drinking, domestic purposes, personal hygiene and sanitation as well as for farming and food production. Usually women are responsible for collecting water and controlling its use for these purposes. Women are the ones who know the location, reliability and quality of water sources and who also are responsible for carrying this water (often over 20 kg few times a day). An example tells: "*Very few men carried water, although some did escort women to the taps at night…*" (Rodda 1991).

Women are also often responsible for paying for water. The case study in Egypt (Lahtela 2000) showed that in all fifty households covered by the study, a woman was mentioned to be responsible for paying for water. Sometimes this money comes from the husband, sometimes women have to find ways to get this money in other ways (selling cheese, making clothes etc.). Women often pay also for the maintenance of the water supply. A study from Kenya Water Supply Programme (FINNIDA 1994) showed that women paid 74.7% of the water supply maintenance fee while men paid 25.3%.

Due to the role of women for what comes to water, it is essential to target water related improvement work on women. However, even when this is done women's role is often limited to the simple low-level physical work. This can be seen as one of the biggest mistakes, which can be done when including women in any kind of development work: *"To consider women only at the field level and not in policy and institution-building means that once the project is over there is no foundation of which to sustain women's involvement"* (FINNIDA 1994).

Women and food security

Van Hofwegen and Svendsen (2000) note, that particularly in Sub-Saharan Africa, fewer and fewer men farm. Men are increasingly leaving rural areas for urban centers to earn higher wages. Women farmers have been estimated to produce already as much as 80% of staple food in Sub-Saharan Africa and the Caribbean. Accordingly, the gender issue is deeply interwoven to the development of small-scale farms that are the backbone of food security among the rural population, particularly in Africa.

On the other hand, the traditions of different cultures disagree here conspicuously. In rural Senegal, different ethnic groupings are living side by side, scattered in villages and living in a semi-nomadic way. For Wolof, it is common that the men are responsible for farming, whereas for most of the other groupings the women are in charge. Such local cultural features are of primary importance in the gender issue, yet many macro-level analyses tend to ignore them.

Selected gender development indicators

A couple of standard development indicators are commonly used to describe the gender issue. UNDP has made reasonable attempts to develop a unified index that would combine the various aspects of gender development. The work has yielded the gender-related Development Index (GDI), which corrects the Human Development Index (discussed in many Chapters, see e.g. 4.5) with the inequality measure between men and women. As Figure 5.2e clearly shows, GDI does not tell much more than HDI about a country, keeping in mind the reasonable unreliability in the comparison of any macro-level data that various countries are publishing. These combined indicators are naturally subjected to such problems.

Some more conventional indicators, namely female illiteracy rate, birth rate, and infant mortality rate (Figure 5.2f) are very revealing. There are many interconnections between such indicators, which is obvious. They are analyzed below in more detail.

Figure 5.2e
Human Development Index and Gender Development Index tell almost the same story
Source: UNDP(2004).

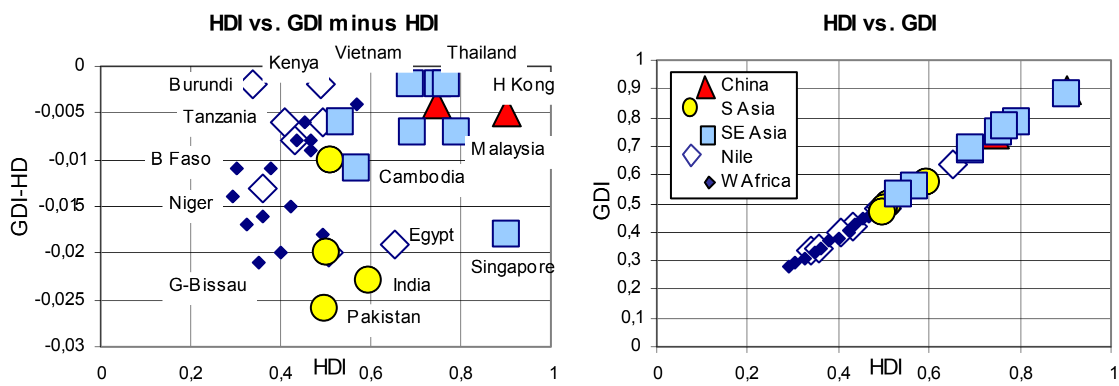
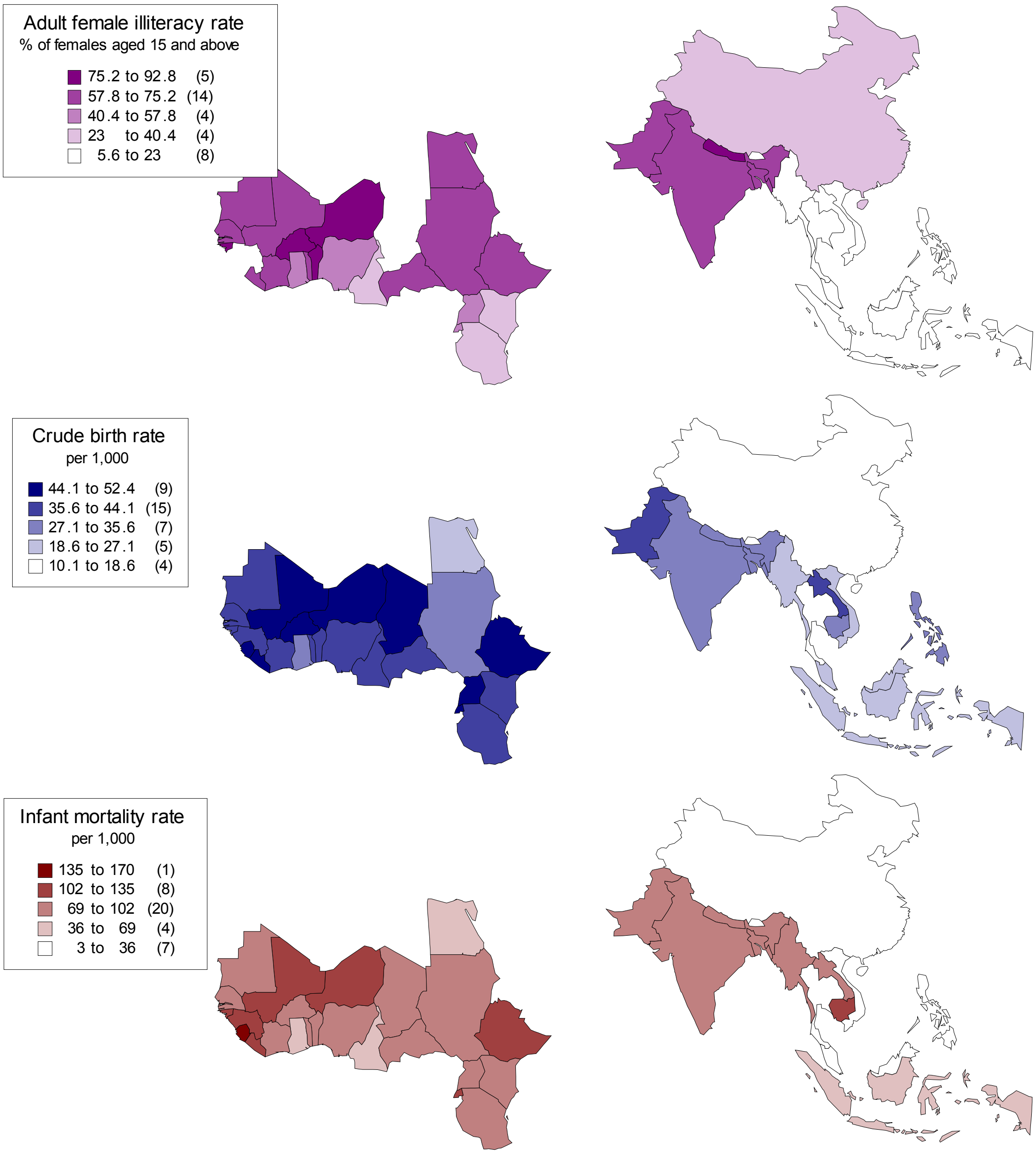


Figure 5.2f
Female illiteracy rate, birth rate, and infant mortality in study region countries in 1997
Source: World Bank (1999).



Comparisons

Even though the effect of educating women has been emphasized it can't be said that solely educating women would lead to poverty reduction. This is clarified by the following statistical example elaborated from the idea of Hanson et al. (1994).

First, birth rate data and infant mortality rate data for study countries was compared and drawn as two different scatter plots: one for years 1970 and 1997 each (Figure 5.2g upper diagrams). After this the birth rate data was compared with female illiteracy rate data and similar scatter plots were done to these two indicators (Figure 5.2g lower diagrams). Correlation coefficient (R) was calculated in both cases (with confidence level of 97.5).

As can be seen from the scatter plots, there is a positive association between birth rate and infant mortality rate and also between birth rate and adult female illiteracy rate. Correlation coefficients for the former pairs are 0.71 for 1970 and 0.85 for 1997 and for the latter 0.7 for 1970 and 0.71 for 1997. These results might lead to a conclusion that improvements in infant mortality rates lead to birth rate decline as much as does a decline in female illiteracy rates. This conclusion could be drawn especially if only the data from 1970 was used (the correlation coefficients are almost equal).

Yet, the former conclusion can be misleading. Statistical correlation alone cannot prove any causal links between birth rate, infant mortality rate and female illiteracy rate. They can be just by-products of some other incidents or improvements in a society. In order to get rid of the possible influence of these other incidents *changes* instead of *levels* were reviewed (Hanson et al. 1994). Figure 5.2h shows these scatter plots.

Now the correlation coefficient of birth rate decline and infant mortality rate decline is 0.69, while the one between birth rate decline and female literacy rate decline is only 0.37. This can be interpreted so that educating women (in this case reducing illiteracy) alone does not lead to birth rate decline, but there are other changes in society, which may eventually, together with raising female literacy rate, reduce birth rates. Therefore educating women as a means of fertility reduction (and eventually poverty reduction) is not a solution. Though, education can reduce infant mortality and in this way contribute also to fertility reduction.

Box 5.2

Missing women of South Asia

UNDP's World Development Report of 2000 has come to a result that 79 million women are missing from S Asia. In other parts of the world, there are 106 females against 100 males, but in S Asia the ratio is inverse: 94 women against 100 men. Only China and some Arab countries share this feature. For the case of China, see Chapter 7.1

Pakistan and the Maldives are the most male-dominated countries in terms of the population size (Table 5.2). UNDP (2000) concludes that the role of women in India, Pakistan, Bangladesh, Sri Lanka, Bhutan, and the Maldives is worse than in the rest of the world. Women are missing, since the number of child babies is smaller and the mortality of women is higher than in the case of males. Girl babies are aborted much more often than boys, and abandoned alike. In Pakistan, the mortality of women aged between 20 and 29 doubles that of men. This is due to poorer alimentation, health care and human rights in large. The explanation of UNDP relies largely on the traditions of this sub-continent.

Table 5.2

Women's position in S Asia after UNDP (2000)

	Share of population %	**Female literacy** %	**Income** % of men's income	**Women in parliament** %
India	48	39	34	8.7
Pakistan	46	25	26	2.6
Bangladesh	49	27	30	12.4
Nepal	50	21	50	7.9
Sri Lanka	50	88	55	4.9
Bhutan	50	30	48	2
Maldives	47	96	55	6.3

The same tendency is clearly reflected in the World Bank (1999) statistics of the life expectancy of men and women. In high-income countries, women tend to live around 6 years longer on average than men do. This is, conventionally, not considered as a non-egalitarian setting for some reason. In S Asia, both sexes have almost equal life expectancy, though the situation is changing towards longer lives for women (Figure 5.2i). UNDP is correctly stressing the weak position of women in S Asia, but the direction of change is there towards the better, whereas in many of the African study region countries, the direction is towards worse, according to life expectancy data. The situation is particularly problematic in Nile basin countries. This is again in contrast with the data in Table 5.2a: Nile basin countries have improved their gender situation most notably among the study regions!

Figure 5.2i

The differences between women and men in life expectancy at birth after World Bank (1999)

Women lose over men Change in life expectancy difference, 1970-1997, years			**Women win over men** Change in life expectancy difference, 1970-1997, years		
	Nile basin	-3	China	*China*	2
	Nile basin	-2	Bangladesh	*S Asia*	2
	W Africa	-2	Pakistan	*S Asia*	2
	W Africa	-2	Indonesia	*SE Asia*	2
	Nile basin	-1	Malaysia	*SE Asia*	2
	Nile basin	-1	Thailand	*SE Asia*	2
	Nile basin	-1	Viet Nam	*SE Asia*	2
	W Africa	-1	Benin	*W Africa*	2
	W Africa	-1	Niger	*W Africa*	2
	W Africa	-1	India	*S Asia*	4

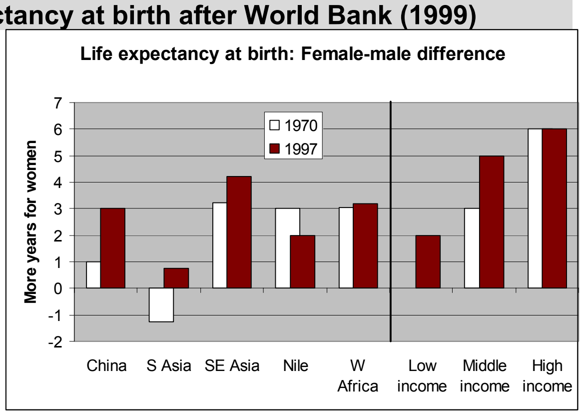


Figure 5.2g

Scatter plots for birth rate, infant mortality and adult female illiteracy rates

Adopted for the study region countries by Lahtela (2000) after the idea of Hanson et al. (1994). Data: World Bank (1999).

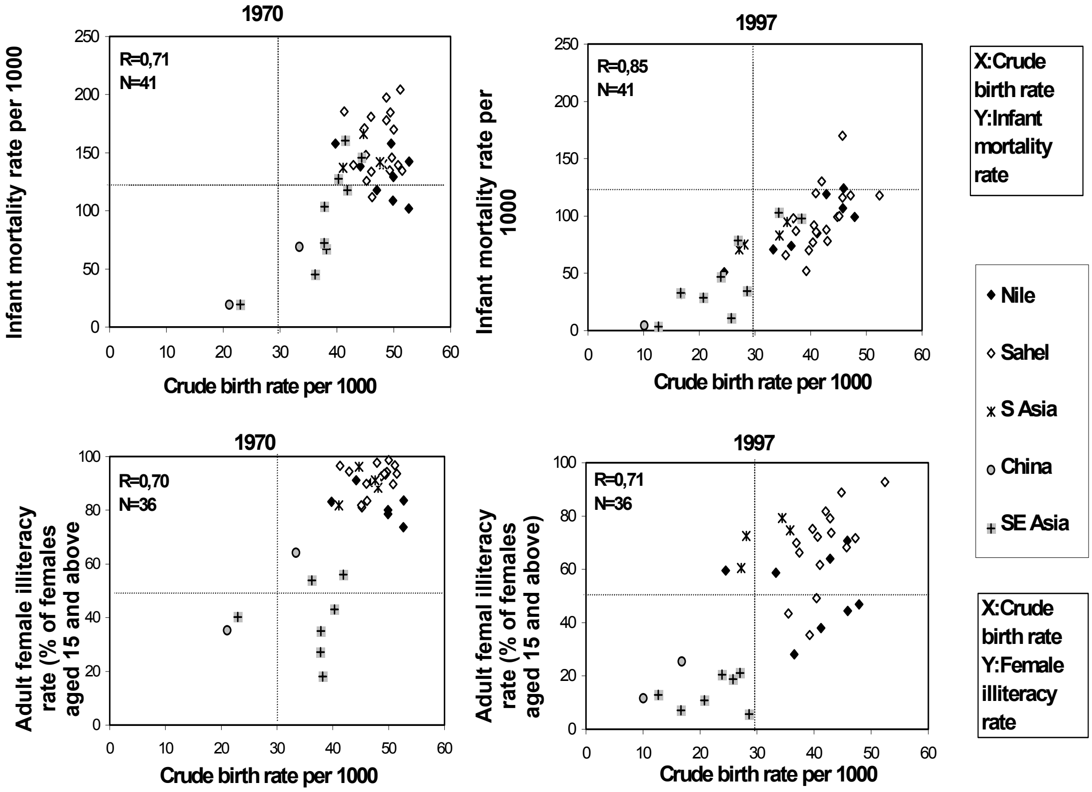
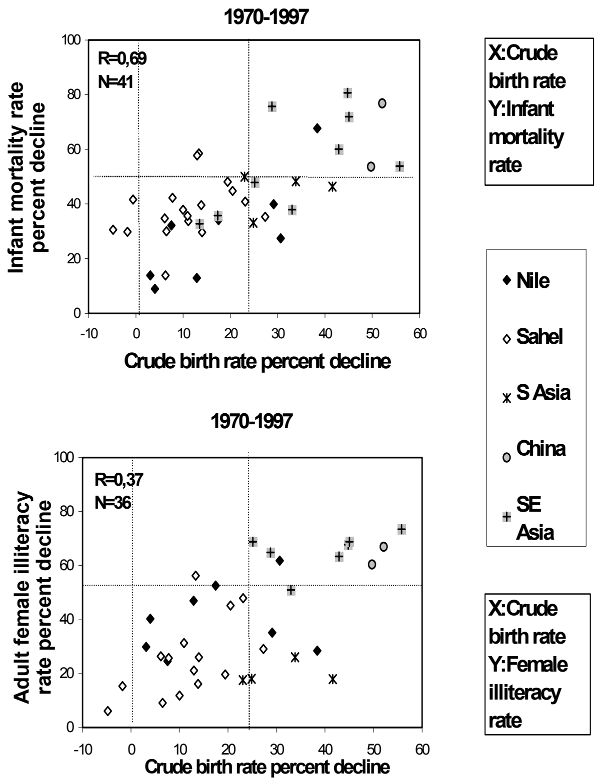


Figure 5.2h

Scatter plots for changes in birth rate, infant mortality rate and female illiteracy rate

By Lahtela (2000) after the idea of Hanson et al. (1994). Data: World Bank (1999).



5.3 Food insecurity

Olli Varis

Around one out of six human being suffers from food insecurity. In Sub-Saharan Africa, over 2/5 are food insecure, and in S Asia, almost 60% of children are chronically malnourished. Global projections suggest better days to come yet the optimism is largely based on the assumption that low-income countries will increase their food imports. This means, that their economy should grow steadily, and food markets should be stabile.

What is food security?

The food problem, as experienced by poor people in particular, is a very diverse issue. This is reflected in the multiple uses of the term *food security*. Maxwell (1996) presents an overview of the historical evolution of the concept, and presents thirty-two different definitions for food security.

In the World Food Conference of 1974, where Henry Kissinger stated that no child should go hungry to bed, the food security was defined as: "*availability at all times of adequate world supplies of basic foodstuffs … to sustain a steady expansion of food consumption … and to offset fluctuations in production and prices*". This definition focused on the supply side; national self-sufficiency and stabilization of the world market were high on the agenda. The food self-sufficiency paradigm was particularly strong in many African countries (Harsch 1992, Maxwell 1996).

Another mainstream that emerged gradually after that – and was in a way opposite in direction – was the "*food entitlement*" approach (Sen 1981, Devreux 1993). The access to food and the entitlement were emphasized. The concept was supported by actions and policies needed in real-life famine situations.

Whereas the former approach represented clearly a macro-scale view and the supply side, the latter paid attention to the micro-level and the demand side. Most of the recent definitions follow the food entitlement philosophy, either on the individual or the household level. According to the World Bank (1986) definition, "*Food security is access by all people at all times to enough food for an active, healthy life*".

The next paradigm shift has reflected the need to consider the issue in a more integrated manner from the viewpoint of the demand side. Instead of just food entitlement, the human livelihood perspective has gained increasing notice, a secure and sustainable livelihood being the basic requirement. According to Oshaug (1985): "*a society which can be said to enjoy food security is not only one which has reached (a) food norm, … but which has also developed the internal structures that will enable it to sustain the norm in the face of crises threatening to lower the achieved level of food consumption*". Sensitivity appears to be in an increasing role.

The conventional criteria for nutrition include target levels such as daily calorie inputs (Reardon and Matlon 1989, Alexandratos 1995): below 2,000 too low, to 2,600 as medium, and 3,300 too high, or the use of the share of agricultural labor of the total labor force as a measure of vulnerability of the society to agricultural instabilities (Alexandratos 1995): below 1/3 implying low dependency. These very simplified but very practical criteria have been criticized by many; attention has been paid on qualitative and preference aspects such as: "*lack of choice, feelings of deprivation, and food acquisition in socially unacceptable ways*" (Radimer et al. 1992). FAO (1995) summarizes that food security has four key components: *availability, access, stability, and cultural acceptability*.

Recent studies, e.g., Alexandratos (1995), put increasing emphasis on the issue of environmental sustainability: "*To what extent may the resource and environmental constraints impinge on the prospects for increasing food supplies and assuring access to food by all, the very essence of food security? Can such progress be achieved while ensuring that the gains made and the potential for further gains are maintained for future generations, the very essence of sustainability?*"

From self-sufficiency to self-reliancy

Consequently, the policy shift has been from the supply emphasis, food self-sufficiency, and stabile markets, towards the demand focus: open, user-centered, decentralized approaches, participatory rural planning and appraisal, acknowledgment of diversity and needs to flexibility, and to process views to replace the "blue-print" approach (see also Chapter 3.1).

Food self-sufficiency has traditionally been seen as a strategically important goal for an independent nation. Most countries in all continents have striven towards food self-sufficiency at almost any cost.

Libya is constructing a water transfer system—The Great Man-Made River—that allows it to exploit old groundwater deposits of the Saharan desert. Libya already uses almost ten times the amount of its renewable water resources in order to produce food for its six million inhabitants. Libya is just one of the numerous countries, that have attempted to make their ways out to produce their own food. In fact, such countries include most of the world's humans. Water constructions and management schemes have been among the key policy measures for achieving this goal.

It can be argued that in many conditions the food self-sufficiency paradigm becomes rather expensive. It would be cheaper to buy the food from the world market, yet this is neither without problems. If all countries counted on the international market, the prices would be fairly unstable, affecting naturally those that cannot afford the market prices. Agricultural investments tend to be capital-intensive in comparison to industrial ones, when relating investments to the rates of expected return.

Therefore, food production for the poor would apparently be a still less attractive option for globalizing cash flows. The dilemma between cash crop production for export and domestic and particularly subsistence food production is also always there. A risk exists that the poor suffer from this development, if the wealth cannot be distributed to them.

Food self-sufficiency is expensive but decreases vulnerability and dependency of other nations. The paradigm of self-reliancy has been adopted more and more frequently as a compromise for the extreme two strategies discussed above.

Cereal import and aid in the study regions

The Asian study regions are more self-sufficient as well as more self-reliant with food than the African ones. Chapter 2.5 presents an overview of food production and markets within the regions, as well as in the global context; see particularly Figure 2.5h. This chapter will evaluate the issue in more detail.

Figure 5.3a summarizes the volumes of cereal imports and aid to the study countries. Cereal aid to each region has decreased due to two tendencies. First, a policy shift has taken place among the donor agencies. Direct food aid is the first option only in emergency situations for which no proper preparation has not been done beforehand. Second, the overall nutrition situation has improved in the period studied.

China and S Asian countries have traditionally striven for self-sufficiency. Still in the beginning of the 1990s, imports were less than 10% of the domestic production. Bangladesh received the largest percentages of direct food aid, particularly within the context of emergency situations due to floods.

In SE Asia, cereal imports are also rather small in comparison to domestic production, except in Malaysia, which imports most of its cereal. Singapore—excluded from the statistics used—imports even more, and neither receives food aid. Cambodia is the only country that has received substantial food aid recently. It is important to compare these figures with the self-sufficiency rates in Figure 2.5i, which show how important regional role Thailand has as the main grain—particularly rice—exporter in SE Asia.

In the Nile region, the food aid has been more voluminous than in the Asian regions. The countries also depend more on cereal imports than the Asian study countries (except Malaysia and Singapore).

W Africa imports markedly more cereal than the other study regions. The imports have grown sharply between 1980-84 and 1990-94. About every second country imports more cereal than it produces. The countries have developed the efficiency of their agriculture in recent years, but much is still to be done. The Sahelian zone from Mauritania and Senegal all the way to Ethiopia and the Sudan has suffered from severe droughts during decades, and has therefore been one of the main targets of international food aid.

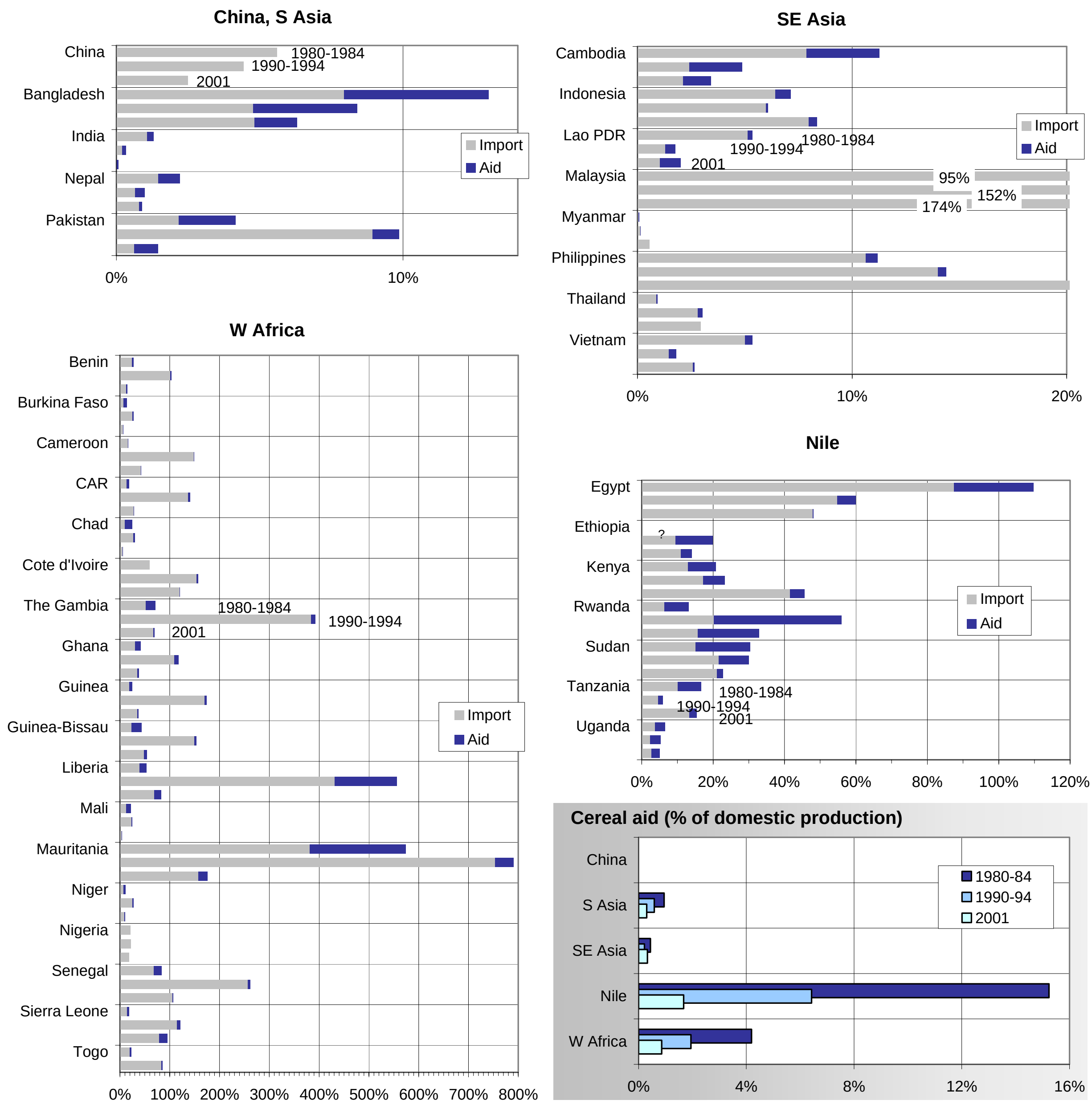
Undernourishment: chronic

According to FAO standards, an adult individual needs at least 2,200 calories per day for healthy life. The world average human consumption is 2,700 calories, while the average in Africa is only 2,300 calories. Thirty years ago, the world average was still 2,300 calories per day (FAO 1996a, b).

In the early 2000s, more than 850 million people were undernourished in the world, among which 200 million were children (see Figures 5.3b, 2.2b and 2.5k). In S Asia, more than 50% of children are undernourished. Every fifth person in developing countries suffers from chronic malnutrition.

Asia has the highest number of malnourished people, but proportionally, the situation is worst in Sub-Saharan Africa. According to FAO (1996a, b), in seventeen African countries that are worst off in this

Figure 5.3a
Cereal imports and cereal aid
Percentage of domestic cereal production, annual averages in 1980-84, 1990-94 and 2001. Sources: World Bank (1997) and FAOSTAT (2003). Note the different scales in the horizontal axes.



respect two out of three people do not have adequate food. IFPRI (1997) projects that the number of undernourished will be 680 million in 2020, while FAO's estimate is 700 to 800 million in 2010 (see also Rosegrant et al. 2001, FAO 2002 and Chapter 2.5).

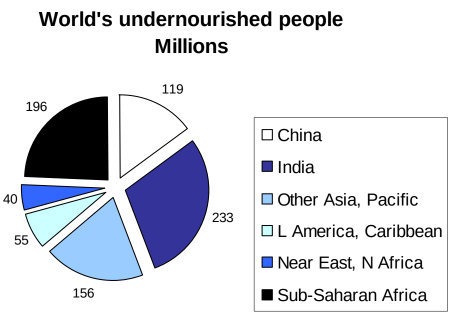
FAO (1996a, b) calculated that since cereals contribute to around 60% of human nutrition in developing countries, 30 million grain tons would eliminate the malnutrition. This can be compared with the annual 9-12 million tons of direct food aid (as cereal equivalents) in the 1990s. 30 million tons is around 1.5% of world's total annual grain production of 2,000 million tons, 43% of which goes to animal feed.

Daily calorie inputs

Recalling FAO's critical level, 2,200 calories per day per person, Figure 5.3c indicates that most of the study countries have hard time in even reaching that limit as an average for their citizens. In the Nile basin, Egypt is the only country that is clearly above that level. The Sudan and Uganda have approached this critical level recently. The other countries are far below it.

In W Africa, Côte d'Ivoire has traditionally been doing better than others. Benin, Ghana, Mauritania and Nigeria have recently been successful in increasing their food supply per capita close to 2,500 calories, and several other countries have also recorded remarkable improvements.

Figure 5.3b
World's undernourished people
Situation in 1998-2000 (source: FAO 2002).



In SE Asia, the situation is best in Indonesia, Malaysia, Myanmar and Singapore. Cambodia is the only country below 2,200 calories per day per person.

India, Nepal and Pakistan have a supply of around 2,400 calories. Bangladesh is well below that. China does best of all the study countries, reaching the supply level of 3,000 calories. Its development, according to the statistics, has been very fast. China's food security has been a topic of intensive discussion during the recent past (cf. Chapter 2.2). Box 5.3 summarizes one of the studies, that of IIASA (Heilig 1999).

Chronic undernourishment is closely linked to poverty, lack of education, nation's political instability, gender issues, and public health, which all are scrutinized in their own chapters in this section. FAO's (2002) statistics are summarized in Figure 5.3d.

A much-used reference is the FAO list of low-income food-deficit countries. It was developed in the late 1970s to operationalize food security problems. According to the definition (FAO 1998a), a nation must fill the following two criteria to be included in the list:

- Poor: net average income level per capita must fall below the World Bank eligibility level for ordinary development assistance, which in 1998 was US$ 1,505 per person.

- Net importers of food: in past three years, food imports must have been remarkable, and the country must lack sufficient foreign exchange to purchase enough food on the international market.

The 2001 list included eighty-three nations, thirty-four of which belong to the study regions. Only six study countries were not listed. They were Uganda, Malaysia, Myanmar, Singapore, Thailand and Vietnam.

As was discussed above, many study countries in Africa suffer from continuous malnutrition. Those countries are increasing their grain imports with increasing GNP per capita. In other words, they import food once they can afford it.

Undernourishment: emergencies

Undernourishment can be a temporary or a chronic problem. The temporary undernourishment can be due to reasons such as droughts, earthquakes, fires, floods (see Box 10.1a), pests, storms, wars, and internal conflicts. Unfortunately, often several of these work together, and cause exceedingly complex emergency situations.

Famines—as chronic malnutrition—do not usually touch equally the whole population but the poor, refugees, suppressed groups, etc., are most vulnerable and suffer most from emergency situations.

The history is desperately rich of severe famines, not least in the study regions. The catastrophic drought that afflicted Ethiopia and several other countries in the Sahelian zone in Africa in 1984-85 triggered a famine that killed more than one million people.

A cyclone that struck Bangladesh in 1991 left 140,000 people to live in ruins, and that of 1998 flooded 2/3 of the whole country. The civil war of the Sudan has been going on from the mid-1980s. Droughts and the war have constituted a chronic famine situation, which has killed millions (Nelan 1998). In 1994, 800,000 people were killed in the civil war of Rwanda, and more than 2 million people flied to neighboring countries (FAO 1998b).

Whetton and Rutherford (1994) analyzed Indian famines from the year 1500 to the present. They have been rather frequent (Figure 5.3e) and often very severe: in the famines of 1702-04 and 1769-70, altogether 5 million people lost their lives. Each generation has seen several famines. At least nineteen famines of the twenty-four since 1780 can be associated with droughts. Many droughts can retrospectively be calculated back as caused at least partially by El Niño (described in Chapter 4.3).

In the past 2,000 years, the number of major floods in China has been 1,600, while major droughts have occurred about 1,300 times. After Niu and Harris (1996), the frequency of natural disasters in China has been steadily growing over the past 1,500 years (Figure 5.3f). This can be attributed to the degradation of China's environment in that period. The worst famine ever recorded on this planet was in China in 1876-79 killing 9 to 13 million people (FAO 1995).

Not only natural catastrophes and wars trigger famines. The last decades have seen massive famines, caused by application of political ideologies that have proven disastrous. Such examples include the late 1990s situation in N Korea, where 10 to 15% of the population—that is 2.4 to 3 million—have starved to death in 1995-98 (Paul 1998). Most observers point man-made causes such as poor agricultural policies.

It is impossible to make an exclusive analysis of historical famines in the study regions; there exists no unambiguous data or even a definition how many must starve before an event can be called a famine.

After all, next to all the study region countries are more or less in a risk concerning their food security.

Box 5.3

Can China feed itself?

A summary of IIASA's study on China's food security.

IIASA published in 1999 a profound analysis of China's future possibilities to feed its people (Heilig 1999). The analysis consists of a series of potential and possible scenarios. It presents a respectable amount of data as the basis of its argumentation. Table 5.3 shows the main aspects that were analyzed. The study concludes that the following ten requirements must be met to maintain China's next-to-complete self-sufficiency in agricultural production:

- China can (and should) greatly improve water use efficiency in agriculture
- A trans-basin water diversion is necessary to better supply China's high population concentration in the North China Plain
- Bottlenecks in transportation infrastructure, technology, and logistics have to be removed
- Larger farm sizes should be promoted by gradual privatization of the arable land
- China would benefit from a moderate increase of (feed) grain imports
- Flood prevention measures must be intensified
- Research in bio-technology should be further supported
- Some state intervention in the grain sector is necessary to guarantee a sufficient grain supply
- Family planning can prevent a larger than expected growth in food demand
- China's agriculture might benefit from climate change

Some other analysts have ended in very different conclusions. Perhaps most pessimistic is the one by Worldwatch Institute (Brown 1995). It concludes that China must most probably be prepared to import as much as 207-369 million tons of grain in 2030, which correspond almost half of the food demand of the nation. As was mentioned above, these figures are partly corrupted by the 40% too low arable land area—which were published as official Chinese statistics still in the late 1980s—and were used as the basis of the analysis (see Chapter 2.5).

After all, China's agriculture continues to face great challenges, many of which are water-related. The favorable economic development, if it continues, is prone to relax the situation, and allow China increased possibilities to import food if needed, and hence be less dependent on year-to-year variations in food production. Apparently, the trend will be from food self-sufficiency to food self-reliancy, facilitated by improved economic situation and opening trade.

Table 5.3

Matrix for screening of factors driving China's food security (Heilig 1999)

	Trends	Impact	Data quality	Prediction error	Intervention possibilities	Intervention costs
Population	Massive growth unavoidable	Drives food demand	Good	Very large	Possible, but limited	Direct low, indirect high
Change in diet	Data show rapid change in diet	Drives feed crop demand	Medium	Large	Difficult or impossible	Not very cost-effective
Urbanization	Rapid urbanization is likely	Commercial agriculture and food industry	Very poor	Large, but clear overall trend	Very difficult	High
Arable land/soils	Scarcity, highly unreliable land-use data	Decline, degradation, soil loss	Poor	Large	Possible but difficult	Very high
Water resources	Growing demand, regionally very scarce	Deficit, flooding, pollution	Mixed	Large	Possible	Very high
Agricultural policy grain import, land ownership, market access, food prices	Liberalization of agriculture since 1978	Increases efficiency	Uncertain	Very large	Possible	Low
Science, technology in agriculture & food industry	Improved science & technology	Increases productivity	Adequate	Large	Possible	Medium

Figure 5.3c
Calorie inputs per person
Sources: Alexandratos (1995) and FAO (2002).

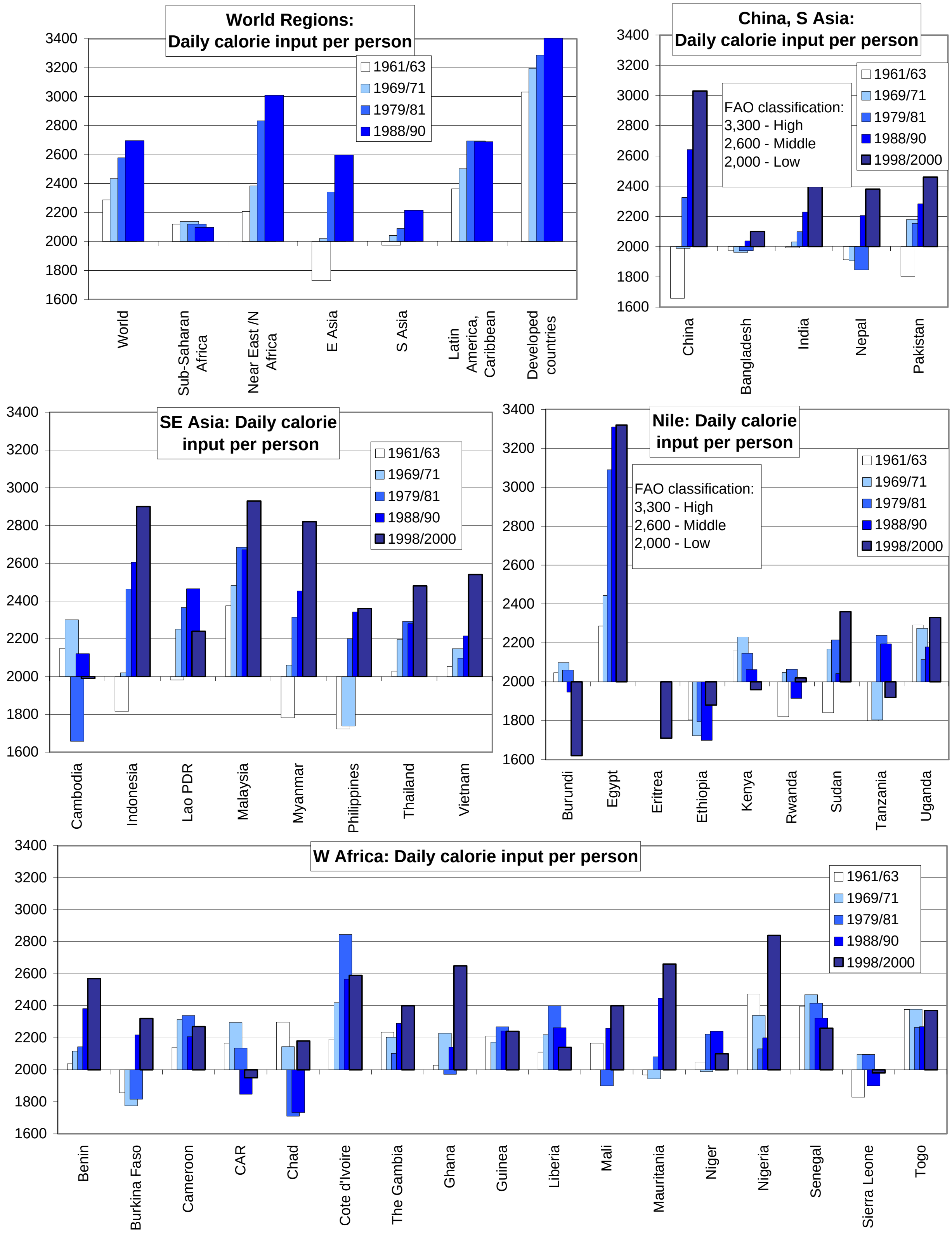


Figure 5.3d
Proportion of undernourished in total population
Source: FAO (2002).

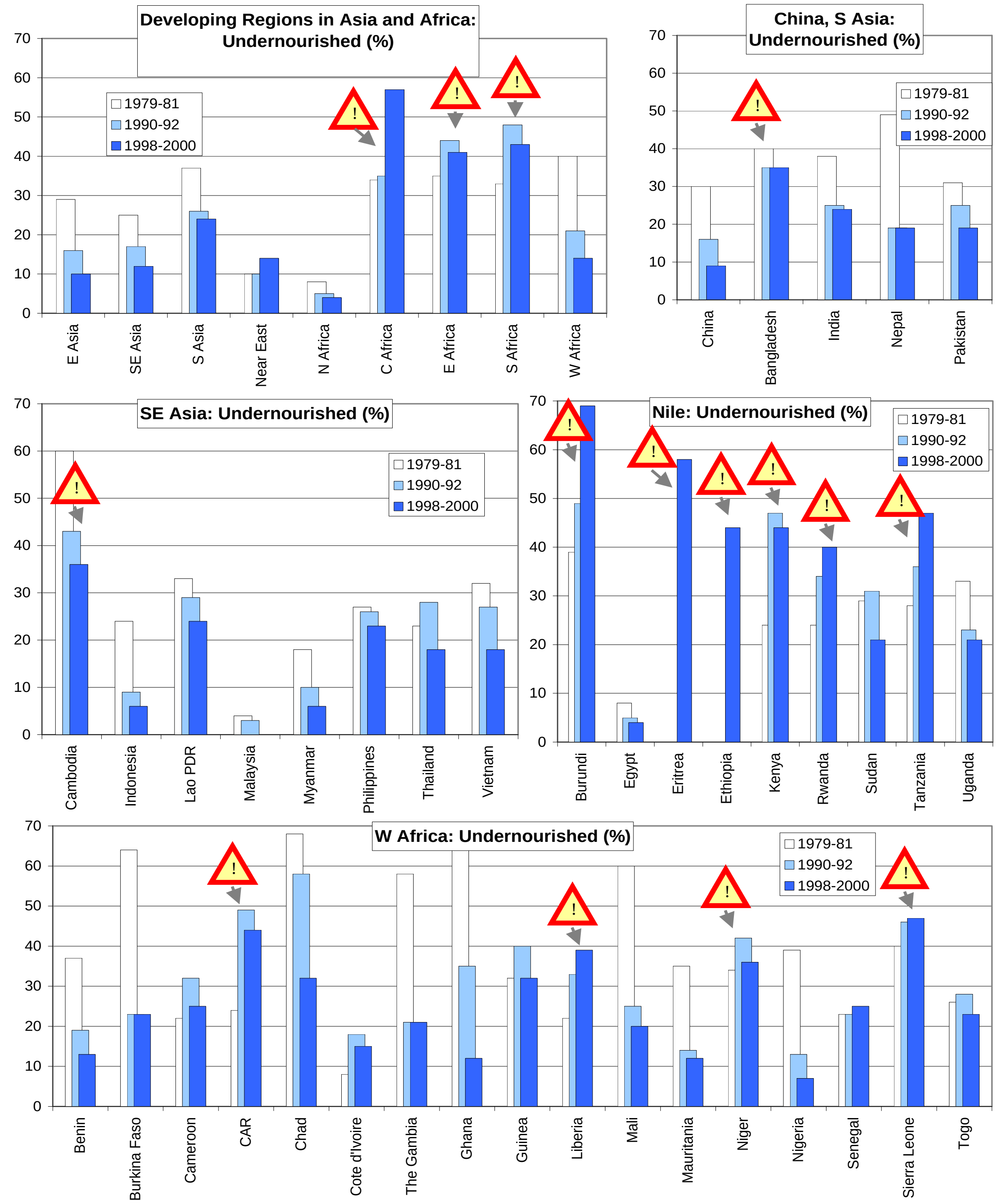


Figure 5.3e
Famine years in India
Accomplished from various sources by Whetton and Rutherford (1994).

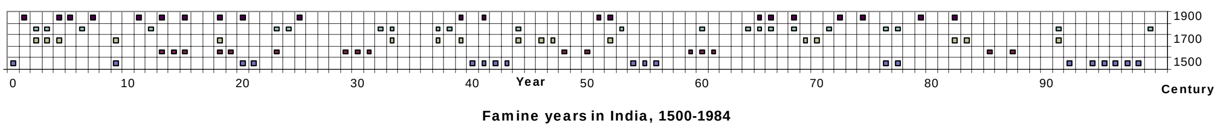
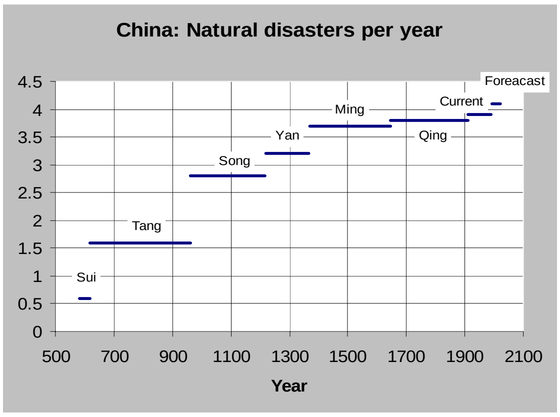


Figure 5.3f
China's natural disaster frequency
Average number of natural disasters per year during different dynasties and historical periods in China after 581 AD (Niu and Harris 1996).



The only exceptions are the few wealthy countries that are well buffered by their foreign exchange reserves allowing them to purchase food from international markets in practically any conditions.

So what?

Although policy tools are scrutinized in sections 7 to 10, a brief look to various possibilities for increasing food security are mentioned below. As background reports of the World Food Summit in 1996, FAO prepared regional assessments of the food security situation. Below are lists of the major issues that affect food security and proposed actions from the reports for the Asia-Pacific and the Africa regions.

In the Asia-Pacific report (FAO 1996a), the major issues affecting food security are:

- *Land* degradation and *water* scarcity
- Lack of *preparedness* for acute and large-scale food shortages due to natural disasters
- The risks of *trade-based* supply stabilization
- Inefficient food *marketing* systems
- *Vulnerable groups* such as the poor and refugees

Actions to improve food security included improvements in the above issues, plus arrestments and reversions of the negative development paths, and:

- *Raising productivity* and *output* in food sector
- *Alleviating malnutrition*

As addressed in the Africa report (FAO 1996b), the key actions for that continent were:

- Enabling *political and economic environment* for food security
- Improving *food access to poor and vulnerable groups*
- Ensuring *adequate and timely food aid and emergency assistance*
- Enhancing *domestic food supply* capacity
- Enhancing *export earning capacity* to meet import needs
- Accelerating *agricultural and rural development*
- Enhancing *human development* and *social participation*

These lists include issues and actions that differ very much from one another. Also they differ with respect to the region under concern. For instance, for Africa, increasing cropping area and livestock production have been mentioned as major issues but not for Asia.

The share of agricultural labor was mentioned as one of the ingredients of food security in the beginning of this chapter. This issue is forwarded to Chapters 4.4 and 9.1 for a thorough analysis.

How about Malthus?

The Malthusian argument to famines would be that the current population exceeds the carrying capacity of the respective regions, and in longer term, it is reasonable that the nature takes care of the regulation of the human population (see Chapter 3.2). I completely disagree with this view:

- Most emergency situations occur as a complex combination of poor politics, armed conflicts, and natural conditions. Many nations can sustain much higher population densities than those under famine conditions, once they have been able to raise their society and economy to a level which allows them balanced livelihood.
- It is unjust and inhuman to raise such arguments while the inequity in the world scale and within most of the suffering countries is as huge as it is (cf. Chapter 5.5).
- It has been seen clearly enough that in balanced societies the fertility and mortality rates tend to balance out, and the population growth control through wealth is much more sustaining and human than by poverty, famines, and catastrophes (cf. Figure 3.3b).

5.4 Public health problems

Virpi Lahtela and Olli Varis

In developing countries waterborne infections account for 90% of all infectious diseases. Water related diseases kill about 3.4 million people annually, among which, diarrheal diseases cause 2.2 million, malaria 1.1 million and sleeping sickness 40,000 deaths. Some variation of data considering water caused deaths exists. After pessimistic estimates waterborne diseases alone kill more than 4 million children under the age of five.

Common diseases

In 1997 infectious and parasitic diseases caused about 33% of all deaths being the biggest single death-causing group of diseases (WHO 1998). These diseases are mainly to be found in developing countries where the population density, high urbanization rate and lack of clean water and sanitation provide suitable settings for the infectious diseases to spread. Table 5.4a shows the major infectious diseases.

Table 5.4a
World major infectious diseases in 1997
Source: WHO (1998).

Disease	Deaths (million)
Acute lower respiratory infections	3.7
Tuberculosis	2.9
Diarrhea	2.5
HIV/AIDS	2.3
Malaria	1.5-2.7

Malaria is an example on disease, which is becoming increasingly hard to control due to microbial evolution. Even if malaria has been successfully diminished in many parts of the world, it still remains a persistent plague especially in Africa. Therefore malaria is one of WHO's top priorities (WHO 1999).

Health and water

Water and hygiene-related diseases can be divided into five groups according to the way they are born or how they spread among people (Silfverberg 1994):

- Waterborne-microbiological diseases
- Waterborne-chemical diseases
- Water-washed diseases
- Water contact diseases
- Water vector habitat diseases

Table 5.4b summarizes the different water-borne diseases and describes the ways they spread and gives some examples of diseases in each category.

Control and prevention of diseases

Controlling waterborne diseases requires improvements in water supply, sanitation (Figure 5.4a) and waste disposal as well as in health education. Lacking the control in one of these fields results only in temporary and short-sighted progress.

In rural areas surface water (streams, rivers, lakes, ponds) has traditionally been the main source of water supply. Using untreated surface water is always a health risk, but many times using such water is the only option for various reasons. According to Silfverberg, (1994) those reasons can be:

- No alternative water resources available
- Poor knowledge on the risks of untreated surface water
- Surface water is traditionally used
- Lack of knowledge of alternative solutions
- Lack of organizational and financial support

In big cities water supply is based on piped solutions. Problems with such systems include:

- Inadequate quantity of water; growth of cities have exceeded the capacity of original installations
- Unsafe quality of water; lack of chemicals
- Unreliable functioning of systems; high leakage resulting in lack of quantity and contamination of water network

Table 5.4b

Water-borne diseases

Source: Silfverberg (1994).

Disease	Description	Examples on diseases	Remarks
Waterborne-microbiological diseases	Animal or human originated contamination lets the pathogen to enter the body through drinking water or food, which has been contaminated	Diarrheas Cholera Hepatitis A	Usually faecal-oral pathway, sometimes through skin contact or animals
Waterborne-chemical diseases	Toxic substances (resulting from natural origin or pollution) contaminate water	Toxicoses Cancers Mutations Birth defects	Acute symptoms if chemicals are in high concentrations, usually cumulative effect leading to chronic diseases
Water-washed diseases	Lack of water results in difficulties to maintain reasonable personal, household and environmental hygiene	Diarrheas Skin and eye diseases	Adequate quantity of water (for bathing and cleaning) and safe sanitation would prevent the diseases effectively
Water contact diseases	Lack of proper sanitation and sewage treatment results in spreading the diseases. Water development projects (irrigation systems, reservoirs) may increase the risk	Scistosomiasis Leptospirosis Skin, eye, ear, nose & throat diseases	Caused by infecting agents, which develop in specific water animals (instead of spreading directly from person to person)
Water vector habitat diseases	Diseases are spread by biting insects (mosquitoes, tsetse flies etc.)	Malaria	Safe sanitation and water supply can reduce the snail-vector diseases, but water supply actions may increase mosquito-vector diseases

Means to improve water supply vary between geographical areas. In humid environments using ground water and harvesting rainwater could be options while in arid regions even finding one possible solution can be hard. In densely populated big cities piped water supplies are usually needed. The problems with such systems arise from technical complexity and high cost (Silfverberg 1994).

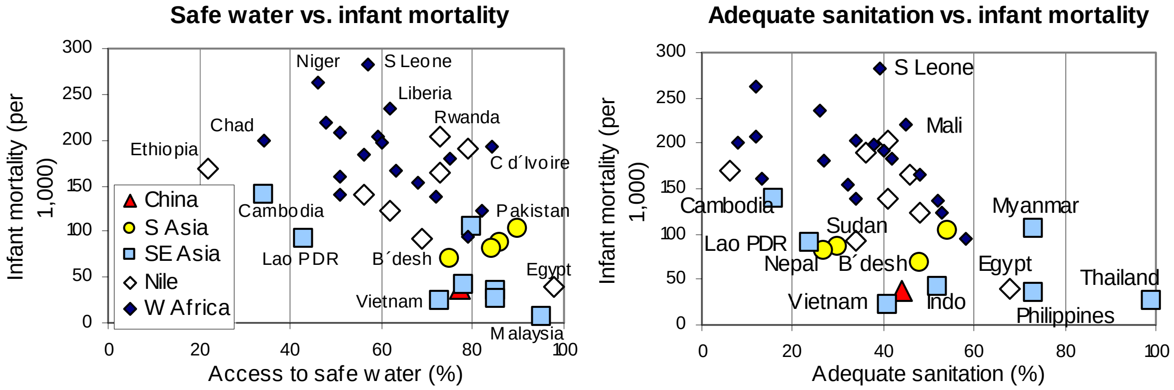
Problems with adequate sanitation vary from cultural behavior to lack of education and money. In most cultures defecation is extremely private and personal practice and in some countries even someone seeing a person to enter a latrine may be too big of a threshold. Also if people don't know the link between sanitation and health, it doesn't make any sense to change the current practice of using bushes or water bodies. But the major problem is financing. Often the benefits of sanitation are not understood or they are seen mainly as potential and hypothetical whereas water supply is considered as a necessity of life (Silfverberg 1994).

The cultural challenges are one of the most important concerns when planning a sanitation system. Other ones include for example the active participation of the beneficiaries themselves, and substantial contribution of cash and labor and environmental conditions, including land-use (Silfverberg 1994).

Figure 5.4a

The level of water and sanitation services explain one part of the health situation

The correlation of infant mortality to access to water supply (R^2 = 0.32) and sanitation (R^2 = 0.29) is weak. Singapore is excluded from both charts. Malaysia is excluded from the latter chart. Source: WHO (2005), WHO and UNICEF (2005).



One crucial factor in preventing water-borne as well as other diseases is education. It has been generally acknowledged and there is statistical evidence, that formal education even without emphasis on health education improves the health conditions. Specific health education campaigns can be effective in striking down a specific disease or health problem, but in the long run the general level of education, especially primary, is essential. According to Hurskainen (1994) education in developing countries suffers from both quantitative and qualitative problems, the former ones resulting from the fact that education doesn't reach the whole population. Quality related problems originate from favoring male population over female in education and from relying on the educational objectives those of the former colonial masters while forgetting and disrespecting the traditional knowledge.

Malaria

WHO (1999) has estimated the number of people who are in a risk of getting malaria to be 40% of the world's population. Alone in Africa 1-2% of children are killed by the deadliest, chloroquine-resistant malaria parasite *Plasmodium falciparum*. After failed attempts to eradicate malaria in 1960's the mosquitoes have now developed resistance against drugs, which makes the fight against the disease extremely hard and a run against time (Whittle 1994).

Unfortunately malaria and underdevelopment are closely intertwined. Malaria prospers in places where social and environmental crisis occur and health systems are weak (WHO 1999). Even though there is already a lot of knowledge and modern techniques to fight malaria, these progressive means do not necessarily always reach the ones who need them the most.

Even though the malaria situation has improved a lot since the beginning of the century, Africa is a deplorable exception (Figure 5.4b). Among the poor, malaria affects the most Sub-Saharan Africa. It is estimated that in Kenya and in Nigeria the treatment costs against malaria for small farmers are as high as 5% and 13% of the total household expenditure, respectively. Also, governments have to spend a lot in fight against malaria. In Rwanda nearly fifth of the health budget was spent on malaria treatment in 1989. It is estimated that the overall (including indirect consequences) adverse economic impact of malaria in Africa is more than 1% of GDP (WHO 1999).

Despite many attempts to reduce malaria since 1950s, it is still a major problem among the poorest countries. In October 1998 UNICEF, UNDP, the World Bank and WHO agreed on a global program to roll back malaria. This program states that malaria is also a social and economic burden, not just a health concern and therefore fight against malaria is at the same time fight against poverty (Figure 5.4c). Different from previous efforts and in addition to the new tools for malaria control, the new program aims on strengthening health systems for sustainable health improvement. Uninvolved communities and weak health systems are now seen as a part of the malaria problem (WHO 1999).

Figure 5.4b
Africa dominates the Malaria scene
Malaria mortality is not declining in Sub-Saharan Africa (absolute mortality numbers per 100,000 population in bars). Source: WHO (1999).

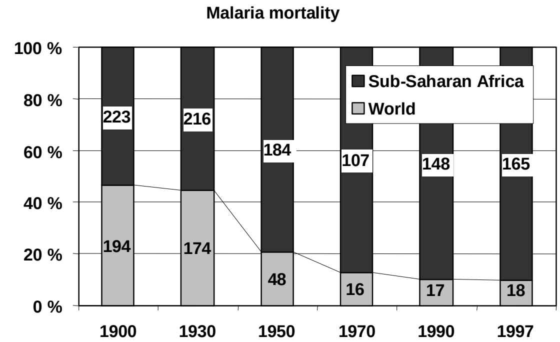
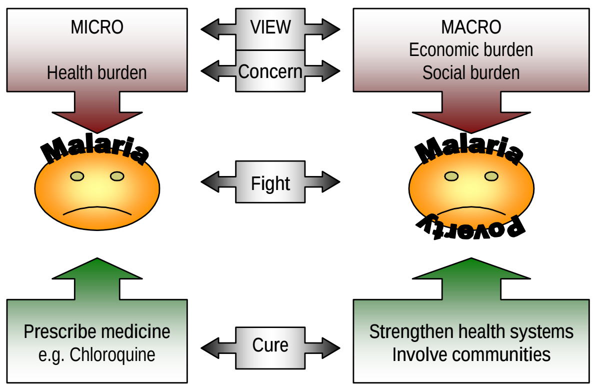


Figure 5.4c
Roll back malaria
It seems that the macro issues have only recently been acknowledged by international organizations. This has shifted the focus of malaria programmes from medical issues to include also social and economic issues.



Malnutrition

Water caused health problems can also be seen in the form of malnutrition. The use of polluted water often causes diarrhea and kills about 2.2 million children each year (Worldwatch 1999). Diarrhea elevates the proneness of an individual to infections and weight-loss. Especially among children this cycle of infection, malnutrition and reinfection can develop all the way to a severe malnutrition up to point of no return (Harrison 1993).

Malnutrition is also connected to water from another end. Over two-thirds of world's water use goes to irrigation of agricultural fields, and in arid climates, typically this share is much bigger. Meeting the growing needs of alimentation of the growing population contains almost invariably a substantial water resources management and allocation element.

Malnutrition is lack of energy, proteins, minerals or vitamins in a diet. The result can be seen in various formations, such as learning disabilities, mental retardation, poor health, low work capacity, blindness or premature death. Malnutrition is found most frequently among children between ages of 6 months and 5 years, but it can plague as well older children and adults (Morley 1994). The most widely distributed form of malnutrition is Protein Energy Malnutrition (PEM), which means that food intake is insufficient in quality and quantity. The two main forms of PEM plaguing children (sometimes also women in mild forms) are *kwashiorkor* (sufferers are 20-40% underweight for their age) and *marasmus* (over 40% underweight) (Harrison 1993).

Malnutrition occurs also as chronic, which especially can be the case among rural and urban poor living in densely inhabited areas. These chronic forms of nutritional deficiencies can be seen for example as *anaemia* (iron deficiency), *goitre* (lack of iodine) or *zerophthalmia* (deficiency of vitamin A) (Harrison 1993). Epidemic form of malnutrition can occur during natural catastrophes or wars (Morley 1994).

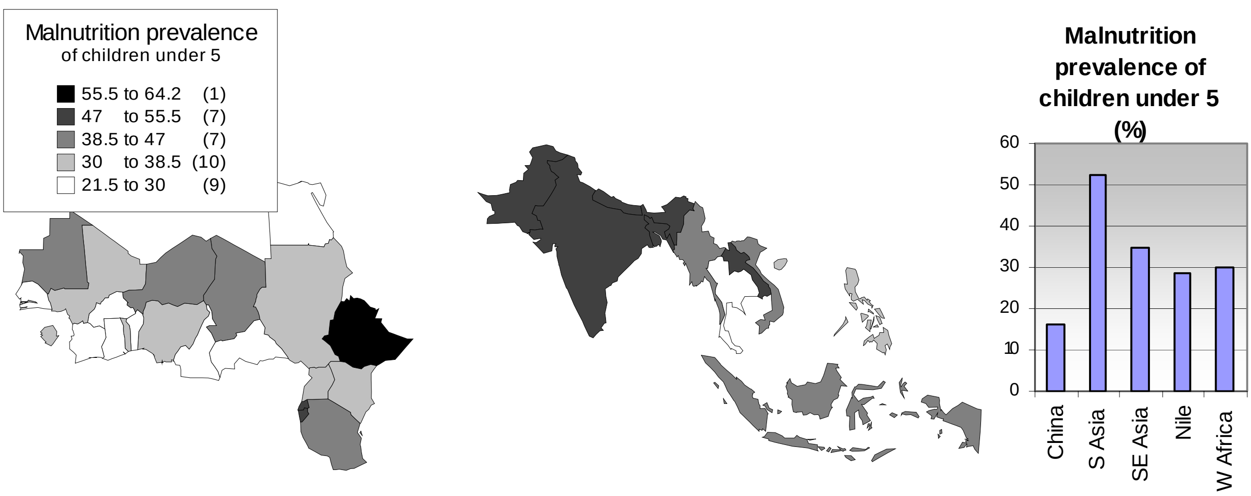
Malnutrition is in very close interconnection with socioeconomical situation and development in a community (Morley 1994). Figure 5.4d shows the percentage of malnutrition among under-fives in the study areas. The figure is presenting the children suffering of moderate or severe malnutrition defined as "having a weight-for-age which is more than two standard deviations below the median weight-for-age (using the international standard recognized by WHO)" (UNICEF 1996).

It can be seen from the Figure 5.4d that in China the percentage of malnourished children is the lowest in comparison to the other areas. This is usually the case in cultures, which by tradition have a very mixed diet (Morley 1994). Also the example of China shows, that political situation affects heavily on malnutrition. In countries, where the distribution of resources has been more appropriate, severe malnutrition has also become more infrequent. The events in North Korea on the other hand showed the extreme consequences on the effects what politics can have in causing a severe malnutrition affecting most of the population.

Malnutrition is tightly connected with poverty. Therefore the responsibility for its prevention is mainly in the hands of politicians and other levels dealing with poverty reduction (Morley 1994). Unlike some other plagues, fairly easy mechanisms and efforts can be used in preventing malnutrition.

The improvements in preventing malnutrition should consist of consumer education, ensuring the availability of common foodstuffs and water for all, and distribution of pharmaceutical supplements in order to add vitamins and minerals in diets. Further, it's essential that the policymakers and consumers have committed themselves in achieving the goals of reducing malnutrition (World Bank 1994).

Figure 5.4d
Malnutrition among under-fives, percentages
Source: UNICEF (1996).



HIV/AIDS: From health to security crisis

Although AIDS is not a water-transmitted plague, the severity of the epidemic situation particularly in the African study region countries justifies a short summary of the situation.

According to the executive director of the UNAIDS (Joint UN Programme on HIV/AIDS) Peter Piot, the AIDS was regarded primarily as a serious health crisis still in early 1990s. The seriousness of the problem was not properly seen and the predictions were dramatically too low. The 1991 predictions for the AIDS prevalence in Sub-Saharan Africa at the turn of the millennium said that 9 million people would be infected. The actual numbers are almost three times of those predicted only eight years before (Table 5.4c). In 1999, among the world's 34.3 million infected individuals, altogether 24.5 million were in Sub-Saharan Africa. This has turned the consideration of the AIDS plague from a health crisis to a development, and even a security crisis (Figure 5.4e).

Sub-Saharan Africa's situation is alarming. The burden of the HIV/AIDS epidemic is heavy and still rapidly increasing in very many of the nations. The situation is worst in Southern Africa. In Botswana, over 35% of adult population already carried the virus in 1999, and the life expectancy at birth has gone down with seventeen years in comparison to the imaginary situation without AIDS. Of the study region countries, Burundi, Central African Republic, Côte d'Ivoire, Kenya, Rwanda, Uganda, and Tanzania had over 8% of their adult population infected (Figure 5.4f). The number of children whose mother or both parents have died to AIDS is 12.1 million in Sub-Saharan Africa, and 1.1 million in the rest of the world.

Each year, over 5 million people get the virus in the world. The rate of new infections decreases in most of Europe and Americas due to efficient propaganda and growing public awareness. This is unfortunately not the case in Africa, S and SE Asia, and the Caribbean, where the infection spreads like a fire. However, some positive signs are already there. UNAIDS (2000) notices, inter alia, Uganda and India's Tamil Nadu as states with good initiatives in public awareness programmes that are starting to yield positive results.

Prevention is the only plausible cure in practice. Medical treatment of an AIDS patient costs an approximate US$ 10,000 a year. Therefore, only less than 2% of the AIDS infected receive medication. Disregarding of this, UNAIDS (2000) estimates that in many African countries, the negative effect of HIV/AIDS to GNP exceeds 14% by 2005. This is not only due to treatment of the disease but also includes loss of active labor force and other macro effects.

Table 5.4c
HIV/AIDS situation in 1999: Africa dominates
Source: UNAIDS (2000).

	AIDS prevalence (millions)	AIDS Deaths (thousands)
Nile region	8.0	789
W Africa	5.7	548
Sub-Saharan Africa other	10.9	863
China	0.5	17
S Asia	3.8	320
SE Asia	1.7	137
Other countries	9.8	600

Figure 5.4e
The spreading speed of the HIV/AIDS epidemic in Sub-Saharan Africa has been a surprise
The concern is no longer in health issues but includes national security and development.

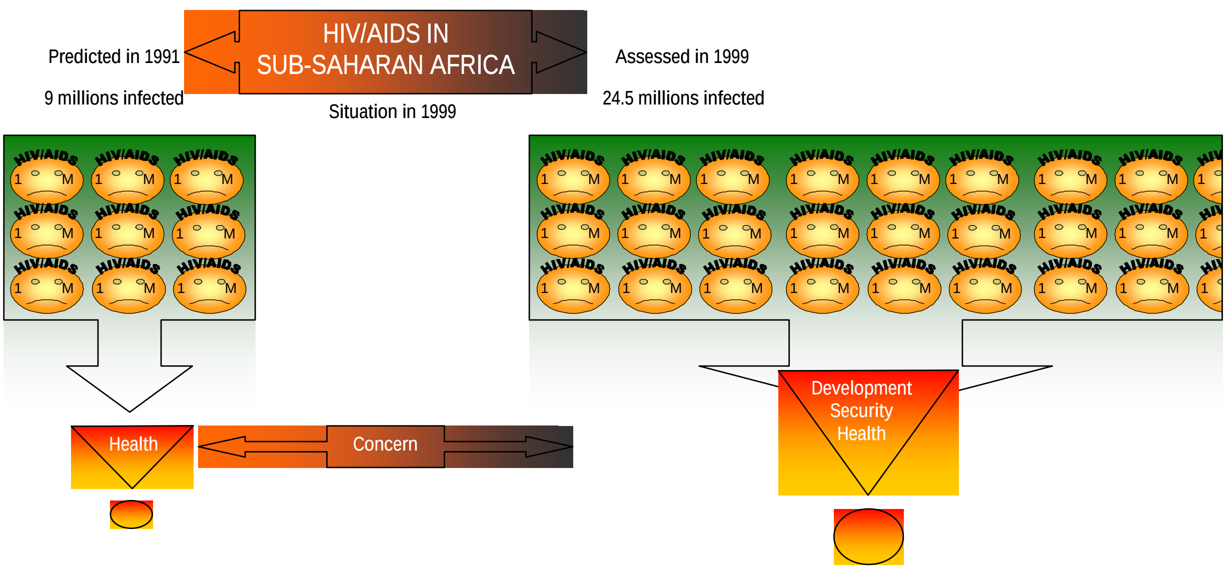
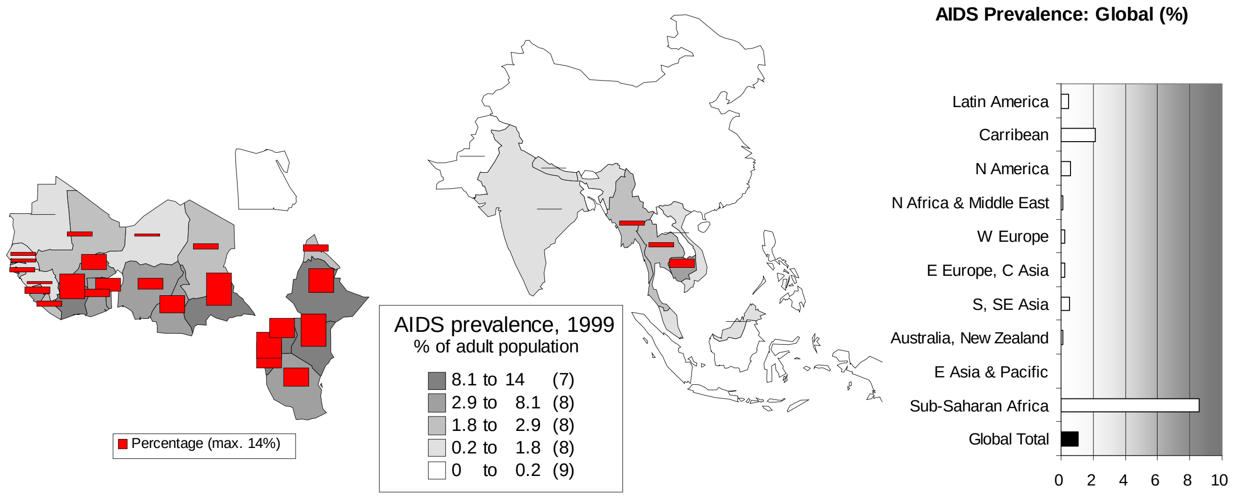


Figure 5.4f
HIV/AIDS prevalence in study region countries and in the global level
Source: UNAIDS (2000).



Health care

Needs in health care can be divided into three levels: the type and frequency of health problems, material and technology needed, and based on those, the needed level of skills and knowledge of the personnel. Further, the health care services can be divided into primary health care and secondary health care (hospital care). Historically in developed countries the division between health care services has been organized in variety of ways according to each country's situation (Mäkelä and Banerji 1994).

Organization, which works in one place, may not suit well to a country with totally different culture, society, people, diseases, and skills of the personnel. That is not always kept in mind when transferring a health system to a developing country. Many times a developing country has inherited parts of the health care system of its old mother country. This has resulted to a variety of problems, which are one reason for the ineffective health care system of today's developing countries (Mäkelä and Banerji 1994).

The World Bank and International Monetary Fund apply the policy that privatizing and commercializing services in public sector, such as health care, would lead to economic recovery in debt burdened countries. Structural adjustment programmes are tailored to carry out this principle in various developing countries. This kind of program was implemented for example in Nigeria unfortunately with wretched consequences. Before introducing the health service fee, all aspects of maternal care at hospital level in Zaria were free. When hospital care came chargeable, the number of mothers attending hospital fell dramatically with distressing consequences: during 1983-88 maternal mortality increased by 56% and the share of complicated labor rose from 20% to more than 60% (Bergström 1994).

Hellberg and Mäkelä (1994) are convinced, that in poor, debt-burdened countries privatizing health care and tightening already small health budgets can only lead to weakening health care for what comes to the poor proportion of people. It has been stated that even though medical care has become more accessible, it has not become more affordable to large parts of the population

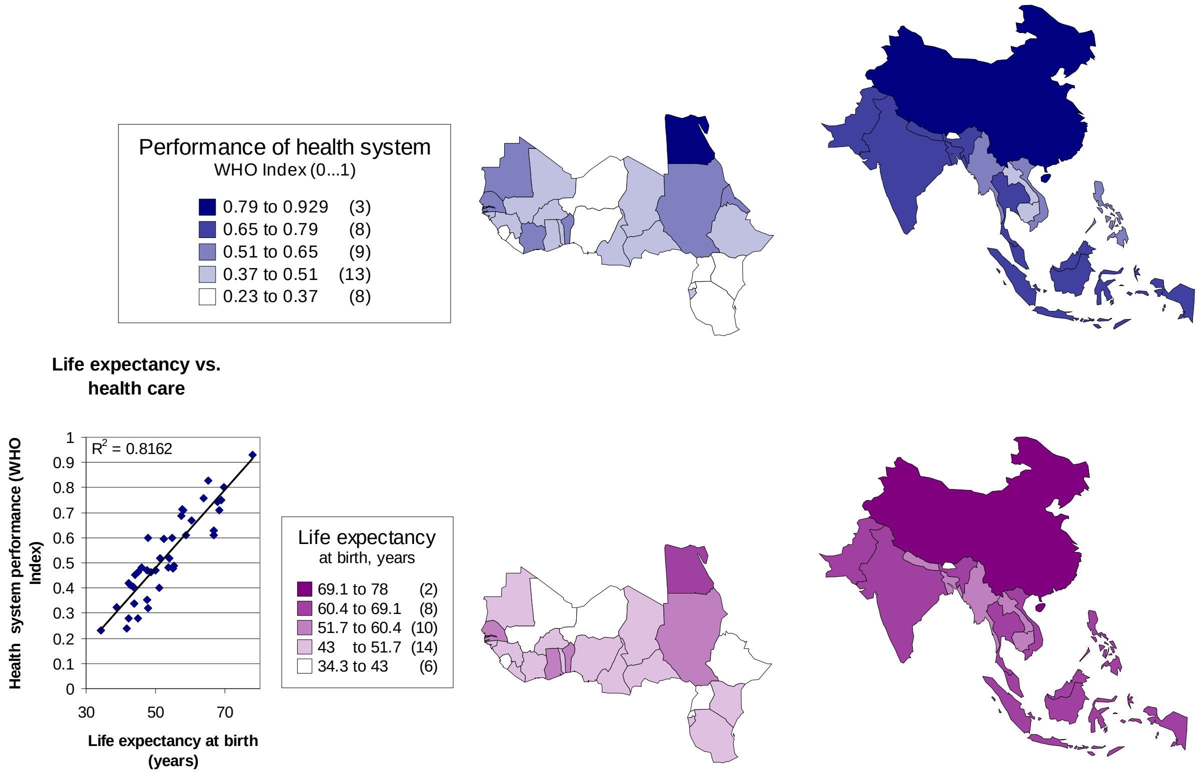
Vienonen (1994) introduces three most important features in *health systems management*: efficiency, effectiveness and equity. Efficiency and effectiveness of those are the easiest ones to understand, former being the goal of economists and managers and the latter one of doctors and health workers. Equality on the other hand brings the ethical questions into picture. If resources are finite, it can be hard to decide whether to treat the ones who suffer the most, the ones who would benefit the most or the ones who can pay the most. Often in developing countries the health care management is not working properly turning the three important E's into three unfortunate I's: inefficiency, ineffectiveness and inequality.

Figure 5.4g shows the WHO (2000) data on the overall performance of the health system in the study region countries. The correlation of this index and life expectancy at birth is very high. UNDP (1995) stresses the problem of the rural-urban gap in health services. In Sub-Saharan Africa, only 49% of rural people had an access to health services, whereas 78% of urban dwellers were able to utilize health services.

Figure 5.4g

Overall performance of health system and life expectancy correlate surprisingly well

Sources: World Bank (1999), WHO (2000).



Box 5.4

Health care in Egypt

After Lahtela (2000)

The major sources or morbidity and mortality in Egypt have shifted, typically for low- and middle-income country, from children's malnutrition and acute infectious diseases into adult's diabetes, high blood pressure, heart disease and cancer. Even though the infectious diseases, such as dehydrating diarrhea and schistosomiasis, have showed decline in Egypt, maternal mortality and chronic degenerative diseases continue to be a problem (Mehanna and Winch 1998).

Though, what probably affects the rural poor the most, is the lack of proper health care system. There are six sources for health care in Egypt: the home, pharmacists, the government health unit or clinic, hospitals, private doctors and sheikhs (practicing traditional Arabian medicine) (Mehanna and Winch 1998). The public health care is suffering strongly from insufficiency and inefficiency and a study has proved that people rather pay more money and use more time for travelling to private doctors in order to get adequate treatment rather than use inadequate public health services. The governmental health units are only used, when it's known that free treatment is available there for the specific condition a person think he or she has (Mehanna and Winch 1998).

The low service level of the public health service can be partly explained by the low amount expenditure on health services (3.2% of the total public expenditure in 1994-95). This amount is not expected to increase in the near future, and therefore the private medical sector will remain strong in Egypt. This fact will further keep the health care facilities far away from the reach of the poorest people. Though, there are a number of Islamic organizations, which are providing low-cost health care especially for the poor (Assaad and Rouchdy 1999).

In health care, as well as many other similar issues, the poor women are facing the worst possible situation. The maternal mortality is 174 per 100,000 live births and anemia and other dietary deficiencies are plaguing the poor women. In addition, it has been shown that there is "direct correlation between the socio-economic status and the type of assistance provided during delivery" (Assaad and Rouchdy 1999).

5.5 Poverty

Olli Varis

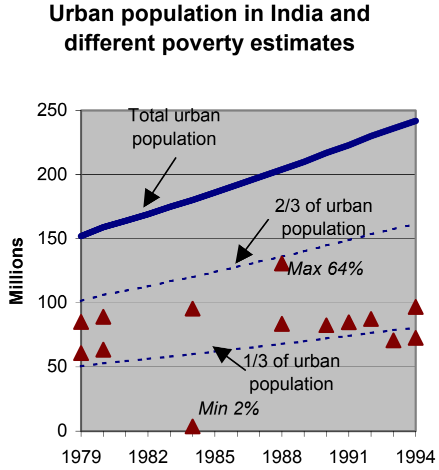
Is the wealth relative or absolute? Are some people rich because some others are poor? At least the former ones have the power to exploit the latter ones as they will. The question of poverty is very difficult and many-sided. Accordingly, the answer is not as easy as the somewhat provocative statement above. It is true partly, but poverty has definitely a dimension, which is more absolute, related to the capability of an individual or community to meet their basic personal needs.

What tells the data?

Everyone has an intuitive view what poverty is. However, the issue is extremely many-sided and complicated, when discussing it in a wider context, up to the global level. Therefore, the recent poverty-related literature is rich—and inconsistent—in approaches to its analysis, alleviation, and definition. The concept varies across scientific disciplines as well as cultures, and has changed markedly over time (Nafziger 1997).

One example of the deviating assessment results—that clearly are due to diverging definitions and research approaches—is presented by Amis (1997). Figure 5.5a shows some data accomplished by him. The published urban poverty rates of India range between 2 and 64%— inconsistent indeed.

Figure 5.5a
Urban poverty in India
The percentage ranges from 2% to 64% among different assessments. Data accomplished by Amis (1997) from various sources.



Wealth disparities

There is not a single country, where all people are equally wealthy. There have been several attempts to reach such a society, but so far all have failed. The uneven distribution of wealth is a reality everywhere. Not only inside countries, but even more drastically between countries. This fact has many reasons, which raise fundamental moral questions, particularly in the international level.

One generation ago, the richest 20% of the mankind were around 30 times richer than the poorest 20%, but now they are over 50 times richer (Figure 5.5b). In the countries of the study regions, S Asia shows the lowest disparities in income. The rapidly industrializing countries in SE Asia, together with China, have a wider gap between the rich and the poor.

In Asian countries, the celebrated Kuznets (1955, 1963) theory seems to be valid. It says that the income disparities grow with economic development, until a middle-income level is reached, and decreases thereafter. In African study countries this seems untrue. There are great disparities in several countries, which are not really far in economic development.

For poverty alleviation, economic growth is not enough. One must pay attention to income distribution and social equality. These issues are discussed in more detail in Chapter 7.3.

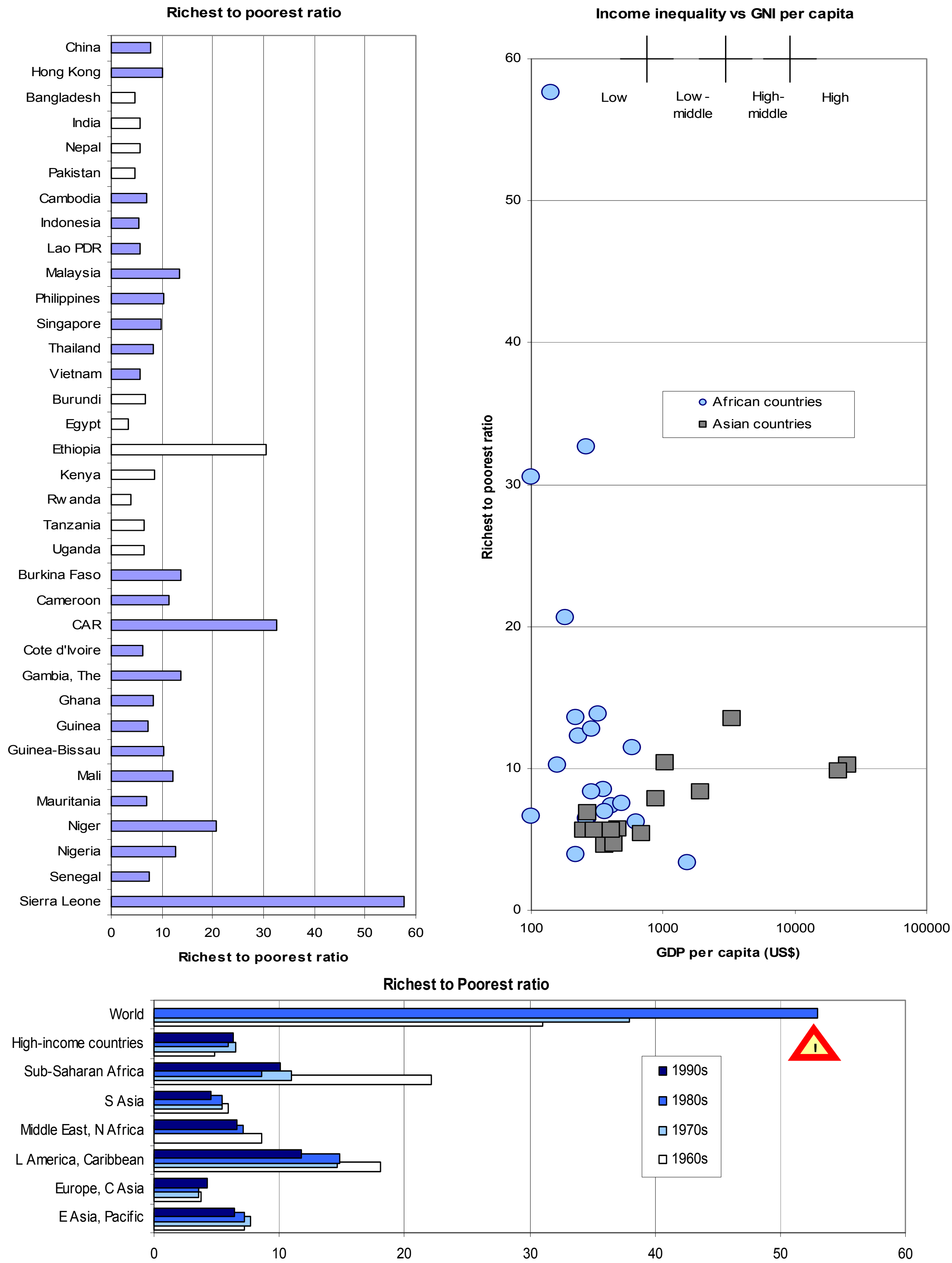
Definitions of poverty: macro vs. micro

Since poverty has both an absolute and a relative dimension, its definitions include both concepts, with varying weights. Another axis to the diverging definitions comes from the tradition of economics as science: the split to macro and micro oriented views and weightings is evident in many analytical approaches and definitions throughout economics.

Figure 5.5b

Richest to poorest ratios

Ratios of the income levels of the richest 20% and the poorest 20% in study countries from which data was available by World Bank (2003). These ratios are also related to the GNP per capita. The lowest diagram (World Bank 1997) shows that the global income disparity is in steady growth.



$ 1 a day

Perhaps the extreme macro oriented definition is the income level of *US$ 1 per day* or alternatively *US$ 2 per day*. It is a widely used concept in international comparisons by institutions such as the World Bank. This indicator, as many macroeconomics oriented approaches, understands poverty as an absolute concept: any individual with an income less than US$ 1 or 2 a day is defined to be poor,

- Whether urban or rural citizen,
- Whether a tribal person in highlands or unemployed worker in urban suburbs,
- Whether living in a country where the GNP per capita is US$ 200 or 20 000,
- Whether woman or man, etc.

The power and the weakness of this indicator is its extreme simplicity. It is a straightforward tool in comparative studies, but provides only very limited information about the individual's ability and preferences to access the basic goods and needs.

Poverty line indicators

Several extensions or variations to the basic indicator exist. I summarize some of them below. For more comprehensive summaries, see Nafziger (1997), Todaro (1997) and World Bank (2003).

- *International poverty line:* Adjustment with purchasing power parity (PPP) corrected GDP. International comparisons become slightly more sophisticated when replacing the absolute money unit with the relative, country-specific purchasing power of money.
- *National poverty line:* A level of income deemed appropriate for the country by its national authorities. National estimates by the World Bank are based on population-weighted subgroup estimates from household surveys.
- *Extreme poverty line:* Defined by the World Bank as the income needed to purchase the basic nutrition of an individual. The basic nutrition includes 2,250 calories per day, and some other diet-related indicators.

Social definitions

The use of the above indices—despite of their high operationality and illustrativeness—has been criticized widely. This is understandable, knowing the complexity of the poverty issue, and the dangers of using too simplified indices and approaches in any policy making.

According to Sen (1992), *" poverty is not low well-being but inability to pursue well-being because of the lack of economic means".* He has widely studied the interconnections of welfare, poverty and famines (see Chapter 7.3). He has developed approaches to study the poverty question with a higher resolution than the above indices (e.g. the poverty gap approach used by the World Bank). He argues, that the empowerment of the poor and their entitlement to food is the cornerstone of avoiding famines, not the (nationally-averaged) food supply per capita.

"If poverty means human needs are not met, then most of the estimates for the scale of urban poverty in Africa, Asia, Latin America and the Caribbean appear too low", argues Satterthwaite (1997) when studying the existence and character of urban poverty in the world. According to him, poverty is not only income dependent but related to access to basic needs such as housing and basic services as well as human rights.

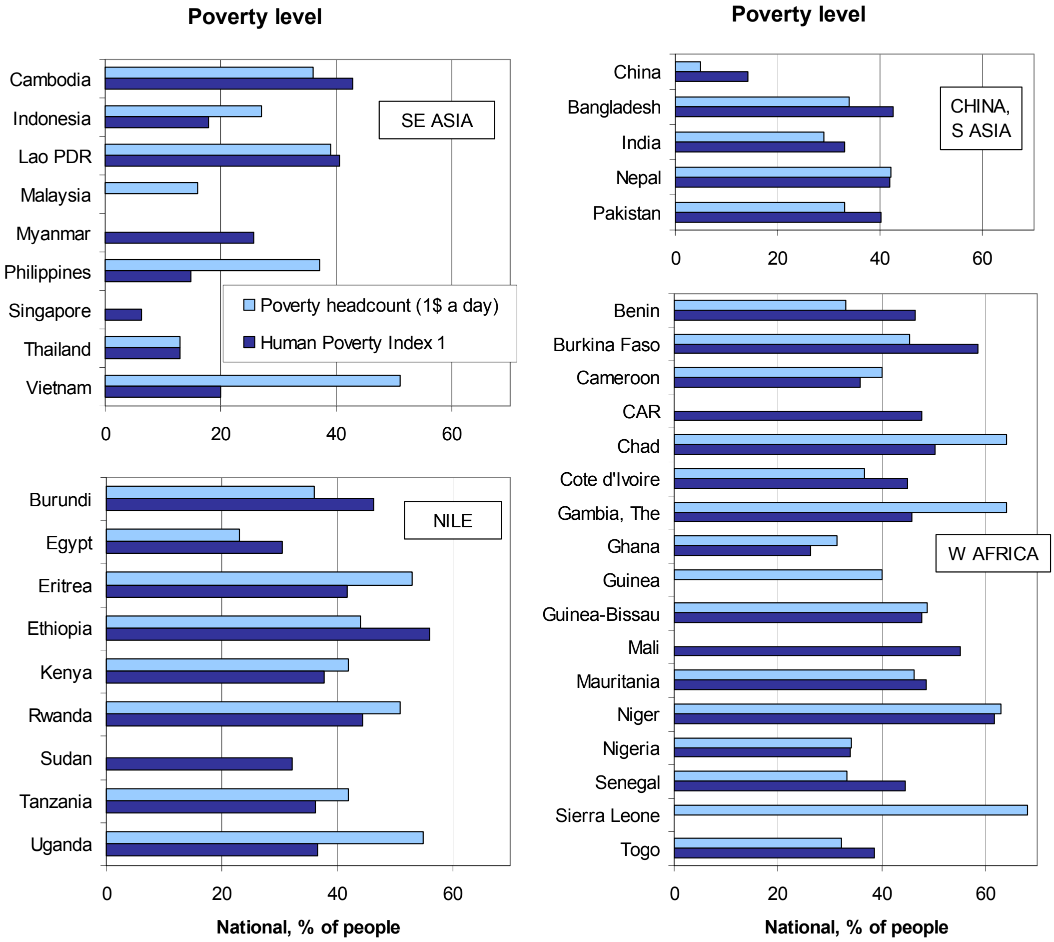
Such attempts—among which only two were mentioned—are highly important when developing better approaches to increase our understanding on the poverty problem, and to develop policy measures for dealing with it.

It is not easy to put social definitions into operational indicators. A pioneer in this field has been the UNDP. It has developed a series of Human Poverty Indices (HPI). The most used of them, HPI-1 combines four indicators of *deprivation from decent standard of living*. These indicators are

- Population without sustainable access to improved water source.
- Children under weight for age.
- Probability at birth of not surviving age 40.
- Adult illiteracy rate.

Figure 5.5c shows the international poverty line indicator of the World Bank (1$ per day) and the HPI-1 indicator by UNDP for the study region countries. There are many mismatches and differences. In China, both of these indicators are relatively low. In S Asia, both are high but the HPI-1 is higher than the Poverty headcount. In SE Asia, Cambodia and Lao PDR have a very high poverty incidence. The Philippines, Vietnam and Indonesia have a high Poverty headcount value but a relatively low HPI-1. In all the

Figure 5.5c
Poverty incidence by country
Population classified as poor according to the Poverty headcount index by World Bank (2003) and the Human Poverty Index (HPI-1) by UNDP (2003).



African study countries, poverty is high. Egypt is doing best among Nile countries and Ghana among W African countries.

Poverty, people, and environment

Poverty is a part of many facets of the society:

- *Informal and formal institutions.* Social exclusion due to poverty leads easily to erosion of the loyalty of individuals to formal institutions. The results are the more negative the less the person respects the "positive", informal institutions such as good habits, traditions, culture, religions, etc. (Table 8.1a). Then, an individual easily looses the feeling of ownership to development efforts within a community and society. Poverty is strongly associated with the informal sector. Rapid changes in a society such as wars, massive urbanization, environmental changes, etc., tend to uproot people from traditions without providing them a proper new institutional "home". This leads to marginalization and poverty.

- *Population growth* and poverty are closely interlinked in both directions. The fertility of the poor tends to be far above the average within a country. Also if population grows very fast, the poverty problem tends to worsen. For SE Asian experience, see Gilbert (1997) and de Haan (1997).

- *Urbanization.* If urban poverty rates are much lower than rural ones, cities—their informal sectors in particular—are prone to grow faster. In the study countries, there are differences in most cases (Figure 5.5e).

- *Gender, education and health.* Poverty and the low status of women are the key components in the multigenerational vicious circle of fertility, gender, poverty, and education. Most of the poor are illiterate. Poverty is also an empowerment-related issue (Chapter 7.4).

- *Ethnic issues.* Poverty is often very unevenly distributed among different ethnic groups within a country. 40% of the world's countries have more than five sizable ethnic populations, one or more of which suffers from severe economic, social, and political discrimination.

- *Environment.* Poverty has been recognized widely as an important factor in the degradation of the nature and the environment. The share of the poor in causing water quality problems, uncontrolled deforestation, etc., is grand in the global scale, and investing to poverty reduction is an important policy measure in working against degradation of natural resources and the environment (see Jalal 1993 and Figure 3.3a).

There are various ways to reduce poverty (Chapter 7.3). Water is a component in many of them. Poverty has an economic dimension but it seems that economic growth does not help much in poverty alleviation if no redistributive policies are there.

An important distinction must be made between people who live in traditional societies, often on subsistence farming, fishery etc. and marginalized people even though economic indicators (such as 1-2$ a day) make no difference between them. The contrast between traditional and modern sectors in the Mekong Basin is discussed in Box 5.5.

Figure 5.5d
Absolute poverty in developing countries
30% of the population of developing countries live in absolute poverty according to the international poverty line (Nafziger 1997).

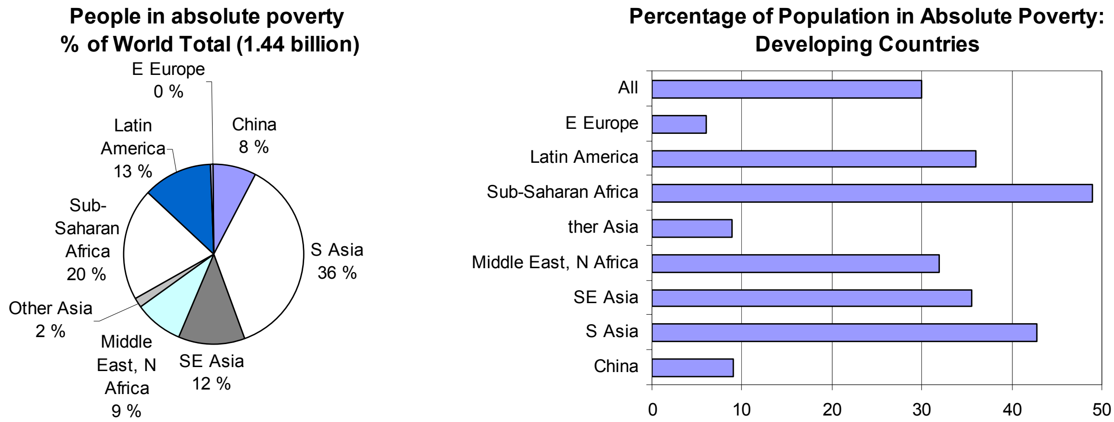
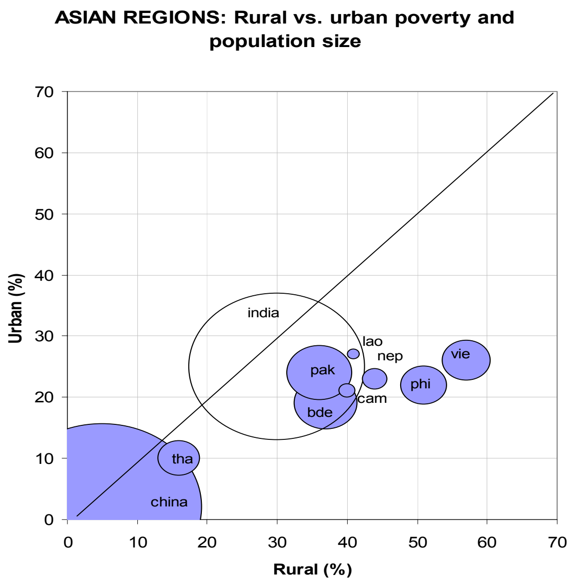
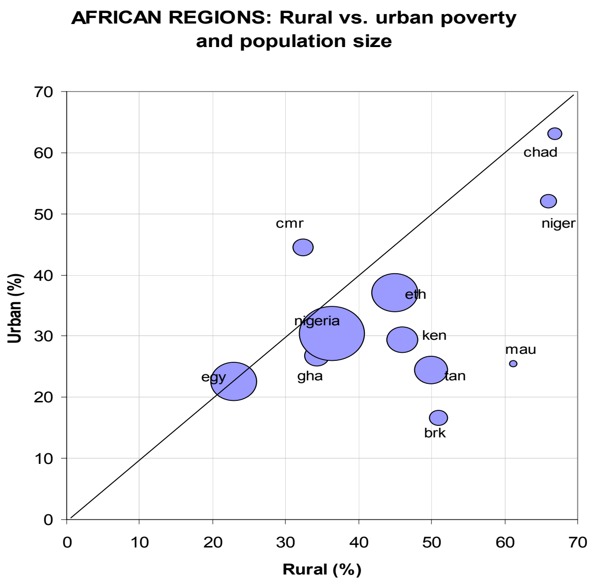


Figure 5.5e
Poverty rates are higher in rural than in urban areas with few exceptions
Population below the national poverty line in rural and urban areas in study countries from which data was available by World Bank (2003). The size of the bubble is relative to each country's population size.





Box 5.5

Confronting subsistence and modern sector in the Mekong Basin

After Varis (2006)

In the case of the Mekong basin, it is striking to realize how strong the contrasts are between the traditional livelihoods and the emerging modern economic sector. Table 5.5 summarizes some of the key features of these two sectors.

Table 5.5

Subsistence and modern sector in the Mekong Basin

Subsistence (traditional sector)	Modern sector
Uses no or very little money	Is driven by money
People supply themselves with basic commodities such as food, water, fuelwood, etc.	Nature is used as a resource of tradable goods that are primarily valued after their trade value
Institutions are primarily customary, religious, etc.	Institutions are primarily set up by government, etc.
People are living within the nature	People are using nature as a resource base and are living out of the nature
Example activities: family farms/fishery/forestry for village-level supply	Example activities: cash-crop farming, commercial fishery, fish farming, industry, hydropower generation, urban water supply plants

The subsistence sector is often called traditional sector. Basically, this sector includes the urban informal sector that includes illegal dwellers, shantytown inhabitants and so forth, who in a way are living outside or at the borders of the formal economy on the subsistence level.

In many cases, increased aspirations of the modern sector have introduced massive changes to the traditional, much more stagnant co-existence of the nature and traditional livelihoods. These depend clearly whether the region in question is in the phase of being primarily appreciated for its traditional activities, for direct economic benefits, if the environmental consciousness is already there, or if the priority has shifted to rehabilitation efforts.

Does the Mekong Basin need to go this way? Can we work against marginalization and exclusion of the traditional sector people, so that their fate in the modernization process of an economy would not mean massive exclusion? In Sen's (2000) philosophy, the local economic activities should be developed so as to allow the people the control and ownership over the productive resources and the local markets as well as other institutions should function well. These local markets should be connected to the urban markets so that the growing urban wealth would benefit rural population.

In Cambodia, for instance, there is still a long way to go to reach such a situation. On one end, rural land tenure and other governance systems are unclear, discontinuous, and corrupt, local financial markets are underdeveloped; transportation infrastructure is defunct, education system insufficient, and so forth. On the other end, the affluent part of the urban people tend to use a great share of their spending on imported goods even what comes to food products, not to mention the surprising density of luxury cars in the streets of Phnom Penh.

Natural reserves are one way to conserve lake ecosystems and lake basin nature as a whole. In this context, an interesting question arises on the relation of traditional sector and natural reserves: Should we see the traditional sector as a part of the ecosystem to be conserved? Do we encounter human rights questions? How should we handle the poverty reduction issue in such situations?

If conservation efforts hinder economic activities of the local population, the countereffect may be the erosion of loyalty of those and related groups and subsequent expansion of illegal exploitation activities, at least in cases in which the governance system is weak as for instance in Cambodia. The contrast between economic development and environmental degradation tends to be seen very one-sidedly; it is too often disregarded that the negative impact of social deprivation on environment is a massive problem in most parts of the world (see e.g. Palo and Mery 1996), and it can be tackled by social and economic policies rather than solely with environmental policies.

References to Section 5

Alexandratos, N. 1995. *World Agriculture: Towards 2010 – An FAO Study*. Food and Agriculture Organization of the United Nations (FAO), Rome and Wiley, Chichester.

Amis, P. 1997. Indian urban poverty: where are the levers of its effective alleviation? *IDS Bulletin* 28(2): 94-105.

Assaad, R. & Rouchdy, M. 1999. *Poverty and Poverty Alleviation Strategies in Egypt*. Cairo Papers in Social Science 22: 1. The American University in Cairo Press, Cairo.

Beck, U. 1999. *World Risk Society*. Blackwell, London.

Bergström, S. 1994. The pathology of poverty. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries*. Macmillan Press, London.

Brown, L. 1995. *Who Will Feed China: Wake-Up Call for a Small Planet*. The Worldwatch Environmental Alert Series. Norton, New York and London.

Cagatay, N. 1998. *Gender and Poverty*. UNDP's Social Development and Poverty Elimination Division, Working Paper 5. United Nations Development Programme (UNDP), New York.

CFC 1998. *War, Peace, and Security Guide*. Information Resource Centre, Canadian Forces College (CFC), Department of National Defence, Toronto.

CSE India 1998. *Statistics, Rural Burden*. Down To Earth 6: 17. Center for Science and Environment (CSE) India, New Delhi. oneworld.org/cse/html//dte/dte980131/dte_60.htm (18.2.2000).

Damhaug, T., Gilgan-Hunt, E., Grey, D., Okaru, V., Rothberg, D. & Sharma, N.P. 1996. *African Water Resources: Challenges and Opportunities for Sustainable Development*. World Bank Technical Paper 331. The World Bank, Washington D.C.

Devreux, S. 1993. *Theories of Famine*. Harvester, Wheatsheaf.

Economist 1999a. China's inglorious poor. *The Economist*, 16 January: 56.

Economist 1999b. Chinese whispers. *The Economist*, 30 January: 81-82.

Ehrlich, P.R., Ehrlich, A.H. & Daily, G.C. 1995. *What it will take*. Mother Jones Magazine, September/October 1995 Issue. www.motherjones.com/news/feature/1995/09/ehrlich.html (3.5.2006).

FAO 1995. *Dimensions of Need. An Atlas of Food and Agriculture*. Food and Agriculture Organization of the United Nations (FAO), Rome.

FAO 1996a. World Food Summit: Food security situation and issues in Asia and the Pacific. FAO, Rome. www.fao.org/wfs/resource/english/aprc964.htm (3.5.2006).

FAO 1996b. World Food Summit: Food security situation and issues in the Africa region. FAO, Rome. www.fao.org/wfs/resource/english/arc96-4.htm (3.5.2006).

FAO 1998a. FOCUS: FAO's Emergency Activities. FAO, Rome. www.fao.org/FOCUS/E/disaster/default.htm (3.5.2006).

FAO 1998b. SPFS News. The Special Programme for Food Security, FAO, Rome. www.fao.org/spfs/ (3.5.2006).

FAO 2002. *The State of Food Insecurity in the World*. FAO, Rome.

FAOSTAT 2003. *FAOSTAT Statistical Databases*. FAO, Rome. http://faostat.fao.org (3.5.2006).

FINNIDA (Department for International Development Cooperation) 1994. *Looking at Gender, Water Supply and Sanitation*. Ministry for Foreign Affairs, Helsinki.

Gallik, D. & Winstead, D. (Eds.) 1996. *WMEAT*. U.S. Arms Control and Disarmament Agency, Washington, D.C.

Gilbert, A. 1997. Work and poverty during economic restructuring: the experience of Bogotá, Colombia. *IDS Bulletin* 24(2): 24-35.

Global Water Partnership 2000a. *West African Water Vision*. 2nd World Water Forum, 17-22 March, The Hague.

Global Water Partnership 2000b. *Water Vision for the Nile Basin*. 2nd World Water Forum, 17-22 March, The Hague.

Grove, A.T. 1986. The state of Africa in the 1980s. *Geographical Journal* 152(2): 193-203.

de Haan, A. 1997. Urban poverty and its alleviation: Introduction. *IDS Bulletin* 28(2): 1-8.

Hanson, L.Å., Bergström, S. & Rosero-Bixby, L. 1994. Infant mortality and birth rates. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

Harrison, P. 1993. *Inside the Third World.* 3rd Edition. Penguin Books Ltd., Harmondsworth.

Harsch, E. 1992. Enhanced food production: an African priority. In: Maxwell, S. (Ed.): *Food Security in Africa: Priorities for Reducing Hunger*. Africa Recovery Briefing Paper 6, UN Dept. of Public Information. United Nations, New York.

Heilig, G.K. 1999. *ChinaFood: Can China Feed Itself?* IIASA LUC Project CD, Version 1.1. International Institute for Applied Systems Analysis (IIASA), Laxenburg.

Hellberg, H., Mäkelä, M. 1994. Health for all – or for some only? In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

van Hofwegen, P. & Svendsen, M. 2000. *A Vision of Water for Food and Rural Development.* The 2nd World Water Forum, 17 March, The Hague.

Hurskainen, A. 1994. The Neglected Education. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

IFPRI 1997. *The World Food Situation, Recent Developments, Emerging Issues, and Long Term Prospects*. The International Food Policy Research Institute (IFPRI), Washington D.C.

IFRC 2002. *World Disasters Report 2002.* International Federation of Red Cross and Red Crescent Societies (IFRC), Geneva. www.ifrc.org/publicat/wdr2002 (4.5.2006).

IISS 2000. *The Military Balance 2000-2001.* International Institute for Strategic Studies (IISS)/ Oxford University Press, Oxford.

Jalal, K.F. 1993. *Sustainable development, environment, and poverty nexus*. Occasional Papers 7. Asian Development Bank (ADB), Manila.

Korayem, K. 1996. *Structural Adjustment, Stabilization Policies, and the Poor in Egypt.* Cairo Papers in Social Science 18:4. The American University in Cairo Press, Cairo.

Kuznets, S. 1955. Economic growth and income inequality. *American Economic Review* 45(1): 1-28.

Kuznets, S. 1963. Quantitative aspects of the economic growth of nations. *Economic Development and Cultural Change* 11(2): 1-80.

Lahtela, V. 2000. *Poverty and Water*. Helsinki University of Technology, Water Resources Laboratory, Espoo. www.water.tkk.fi/wr/tutkimus/glob/publications/Lahtela/alku_v.html (3.5.2006).

Mäkelä, M. & Banerji, D. 1994. Levels of health care. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

Maxwell, S. 1996. Food security: a post-modern perspective. *Food Policy* 21(2): 155-170.

Mehanna, S. & Winch, P. 1998. Health units in rural Egypt: At the forefront of health improvement or anachronisms? In: Hopkins, N. (Ed.): *Directions of Change in Rural Egypt.* The American University in Cairo Press, Egypt.

Morley, D. 1994. Malnutrition in children. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

Nafziger, E.W. 1997. *The Economics of Developing Countries.* 3rd Ed. Prentice-Hall, Upper Saddle River.

Nelan, B.W. 1998. Sudan: Why is this happening again? In unholy synergy, drought and human folly are producing another shocking famine. *Time*, 27 July.

Niu, W-Y. & Harris, W.M. 1996. China: the forecast of its environmental situation in the 21st Century. *Journal of Environmental Management* 47(2): 101-114.

North, D.C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, Cambridge.

North, D.C. 1997. *The New Institutional Economics and its Contribution to Improving our Understanding of the Transition Problem.* 1st Annual Public Lecture, 7 March, United Nations University/World Institute for Development Economics Research (UNU/WIDER), Helsinki.

Oshaug, A. 1985. The composite concept of food security. In: Eide, W.B., Holmboe-Ottesen, G., Oshaug, A., Wandel, M., Perera, D. & Tilakaratna, S. (Eds.): *Introducing Nutritional Considerations into Rural Development Programmes with Focus on Agriculture: A Theoretical Contribution.* Institute of Nutrition Research, University of Oslo, Oslo.

Palo, M. & Mery, G. (Eds.) 1996. Sustainable Forestry Challenges for Developing Countries. Kluwer Academic Publishers, Dordrecht / Boston / London.

Paul, A. 1998. North Korea's sad road to capitalism. *Fortune* 138(24): 32.

Radimer, K.L., Olson, C.M., Green, J.C., Campbell, C.C. & Habicht, J.-P. 1992. Understanding hunger and developing indicators to assess it in women and children. *Journal of Nutrition Education* 24(1): 36S-45S.

Reardon, T. & Matlon, P. 1989. Seasonal food insecurity and vulnerability in drought-affected regions of Burkina Faso. In: Sahn, D.E. (Ed.): *Seasonal Variability in Third World Agriculture: the consequences for Food Security*. Johns Hopkins University Press, Baltimore and London.

Rodda, A. 1991. *Women and the Environment.* Zed Books Ltd., London.

Rosegrant, M.W., Paisner, M.S., Mejer, S. & Witcover, J. 2001. Global Food Projections to 2020: Emerging Trends and Alternative Futures. The International Food Policy Research Institute (IFPRI), Washington D.C.

Satterthwaite, D. 1997. Urban poverty: reconsidering its scale and nature. *IDS Bulletin* 24(2): 9-24.

Sen, A.K. 1981. *Poverty and Famines: An essay on Entitlement and Deprivation.* Claredon Press, Oxford.

Sen, A. 1992. *Inequality Reexamined.* Harvard University Press, Cambridge.

Sen, A. 2000. Development as Freedom. Oxford University Press, New Delhi.

Silfverberg, P. 1994. Environmental health hazards. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

Todaro, M. 1997. *Economic Development.* 6th Ed. Longman, London and New York.

UNAIDS 2000. *Report on the Global HIV/AIDS Epidemic*. Joint United Nations Programme on HIV/AIDS (UNAIDS), Geneva.

UNDP 1995-2004. *Human Development Report*. United Nations Development Program (UNDP)/Oxford University Press, New York. (*published annually*)

UNHCR 1998. *Statistical Overview 1997.* United Nations High Commissioner for Refugees (UNHCR), Geneva.

UNHCR 2002. *Statistical Yearbook 2001*. UNHCR, Geneva.

UNICEF 1996. League table of malnutrition, In: *The Progress of Nations 1996.* United Nations Children's Fund (UNICEF), New York. www.unicef.org/pon96/contents.htm (3.5.2006).

Varis, O. 2006. Does economic growth mean poverty reduction? In: Varis, O., Kummu, M. & Keskinen, M. (Eds.): Modern Myths of the Mekong. White Lotus Press, Bangkok. In press.

Vienonen, M.A. 1994. Health systems and their management. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

Watson, A. 2000. The five virtues of Kofi Annan. *Time.* 4 September: 40-47.

Whetton, P & Rutherford, I. 1994. Historical ENSO teleconnections in the Eastern hemisphere. *Climatic Change* 28(3): 221-253.

Whittle, H. 1994. Malaria. In: Lankinen, K.S., Bergström, S., Mäkelä, P.H. & Peltomaa, M. (Eds.): *Health and Disease in Developing Countries.* Macmillan Press, London.

WHO 1998. *The World Health Report 1998.* World Health Organisation (WHO), Geneva. The World Health Reports are available at www.who.int/whr/en/ (3.5.2006).

WHO 1999. *The World Health Report 1999*. WHO, Geneva.

WHO 2000. *The World Health Report 2000*. WHO, Geneva.

WHO 2005. *The World Health Report 2005*. WHO, Geneva.

WHO & UNICEF 2005. Joint Monitoring Programme for Water Supply & Sanitation. Water & sanitation data query tool. WHO and United Nations Children´s Fund (UNICEF), Geneva and New York. www.wssinfo.org/en/welcome.html (22.8.2006).

World Bank 1986. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries.* The World Bank, Washington D.C.

World Bank 1994. *Enriching Lives: Overcoming Vitamin and Mineral Malnutrition in Developing Countries*. The World Bank, Washington D.C.

World Bank 1997. *World Development Indicators 1997 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 1999. *World Development Indicators 1999 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2003. *World Development Indicators 2003 on CD-ROM*. The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

Worldwatch 1999. Beyond Malthus. Worldwatch Institute, Washington D.C.

6 ENVIRONMENTAL IMPACTS

An escalating pressure on the nature on this planet is an obvious follow-up of the massive population growth and urbanization, combined with climatic changes and variations as well as changes in the economic systems and human development level.

This section starts with a view on the changes in consumption and production of human economic systems in different parts of the world, and how these changes—characterized by a rapid growth in most cases—influence the basic material cycles. The material cycles have been subjected to exceptionally rapid disturbance in the past few decades, in particular in the study regions. Whereas they produced 8% of world's CO_2 emissions in 1970, in 2000 their share had climbed up to 22%. At the same time the economic production of the regions, 8% of the world total, has not grown since the 1970. Both these trends witness a development which should be reversed.

The population keeps growing, and the dietary patterns change towards increasing meat consumption. The agricultural production should hence grow much faster than the population growth does. However, the area of arable land tends to decrease. The unit yields must keep growing rather fast. Due to rapid urbanization and other factors that open material cycles the soils are threatened by degradation in terms of loss of organic matter, salinization, erosion, and so forth. Competing land uses appear to restrict a remarkable growth in arable land. The land resources in the study regions have been and will be subjected to exceptional pressures, which lead to massive land degradation problems.

Streams, lakes, reservoirs, and wetlands are used and exploited in a rich variety of ways throughout the world. They also contain cultural and religious values that are very important. The exploitation of surface waters contributes to the deterioration of water quality and changes in hydrology. The natural patterns of seasonality and other variations also cause mismatch between supply and demand of the resource. The water quality problems tend to accumulate into in areas and regions where water is also scarce in quantity. Such particularly problematic regions include North China Plain and many parts of continental India.

Groundwater is among the major sources of freshwater, making up a substantial portion of the supply in many areas. It serves domestic and municipal supplies and irrigation. Its importance as a reliable and high-quality source is rapidly increasing, but the groundwater resources are deteriorating with a growing rate. This causes, besides widely reaching social and economical problems, also ecological damage and even desertification.

The driving forces of global changes cause various pressures to wildlife, forests, other ecosystems, and the natural biodiversity. The daily, global rate of deforestation is 430 km^2, chiefly due to land acclamation to agricultural use. Solely in the period of 1990-1995, SE Asia lost 6.7% of its forest cover. Biodiversity is one of the key elements of sustainability of the earth's ecological system. It has been estimated that 50,000 species disappear in the world each year.

6.1 Consumption, production and opening of material cycles

Olli Varis

How are socioeconomic changes propagated into production of food, services and manufactured goods, and how these are in turn driven by consumption patterns? This is the baseline of this chapter. The same can be said in an inverse, perhaps even in a more causal manner, starting from the demand: How consumption changes influence the production system and how, in turn, the resource use and related emissions follow?

Energy, emissions, water, and economy

Both poverty and affluence create environmental stress (cf. Figure 3.3a). The immediate consequences of poverty are often very visible in destruction of forests, degradation of waters and land, etc. Palo and Mery (1996) are convinced that poverty is the greatest threat to world's forests. Accordingly, the pressure to forests is particularly elevated in Africa.

This is one part of the issue, but this chapter will concentrate on the other side, the opening of material cycles due to increased production and consumption – affluence in other words. Economic wealth and opening of material cycles are usually in strong positive relation. Figure 6.1a shows an example of this, namely those of carbon dioxide emissions and Purchasing Power Parity adjusted Gross Domestic Product (PPP adjusted GDP) in study countries.

Figure 6.1a
Emissions go up with economic growth
Purchasing Power Parity adjusted GDP (PPP) vs. carbon dioxide emissions in study region countries. Source: World Bank (2004).

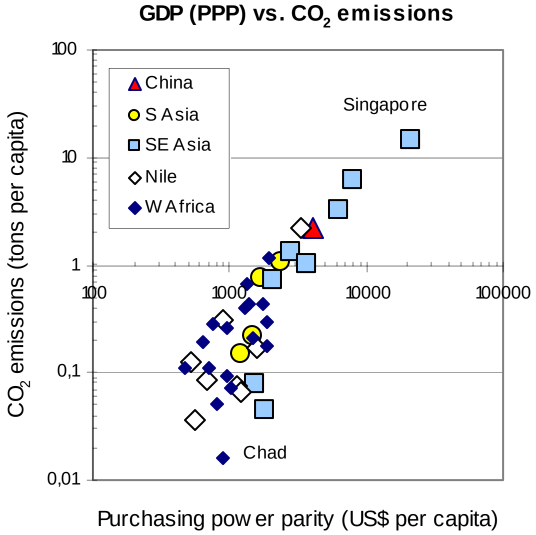
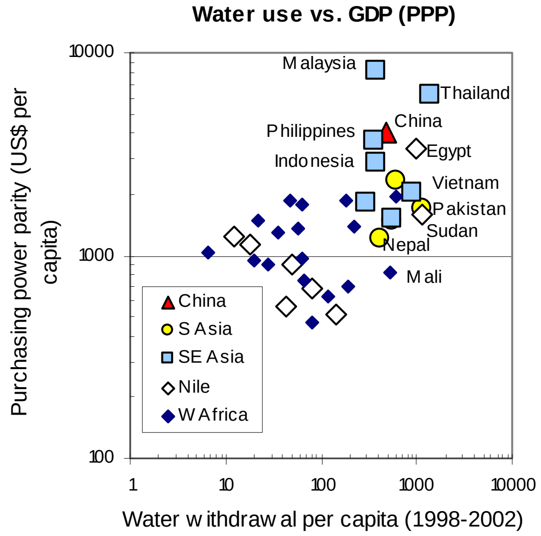


Figure 6.1b
Water use does not grow with economy
GDP (PPP) vs. water consumption in study region countries. Source: World Bank (2004) and FAO (2005).



Naturally, the economic structure, energy policy, and industrialization rate, among other things, influence such relations. In Figure 6.1a, this can be seen in the emission levels of Nigeria and Chad: Nigeria produces nearly twenty times more emissions than Chad. The former is an oil producer, and the refinery industry is a source of substantial CO_2 emissions, whereas the latter has hardly any modern industry.

What comes to water consumption, the relation to wealth at a national level is, however, not equally clear (Figure 6.1b). This is due to the dominating role of irrigated agriculture of water withdrawals, as will be shown later in this Chapter. Some important agricultural countries such as Pakistan and Egypt score much higher per capita water consumption rates than most high-income countries.

The economic structure of the study region countries has been elborated in detail in Chapter 4.4 (see Figures 4.4m and n). The analysis was made on the different contributions of the industrial, agricultural, service, and informal sectors on national economies. The two first ones of them—industry and agriculture—will be looked more carefully below, in terms of their energy and water household.

Energy and CO_2 emissions

World's CO_2 emissions grew about 1.6% annually in 1970-1997. This is well in pace with the population growth rate, which averages to 1.7% in that period. In the study regions, CO_2 emission growth was 6.0% per year, while the number of people increased by 2.0%. This is due to rapid urbanization, industrialization, and spreading of modern lifestyles.

Figure 6.1c
Study regions' CO_2 emission share grows
Source: World Bank (2003).

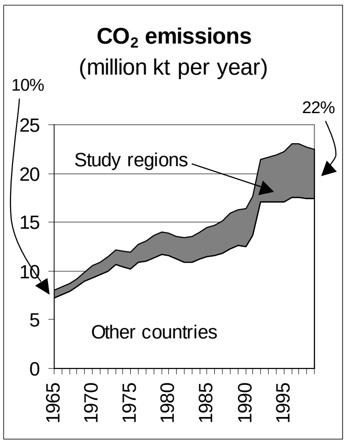
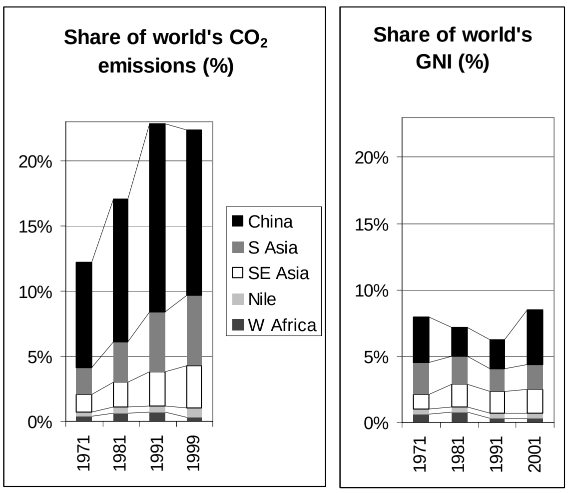


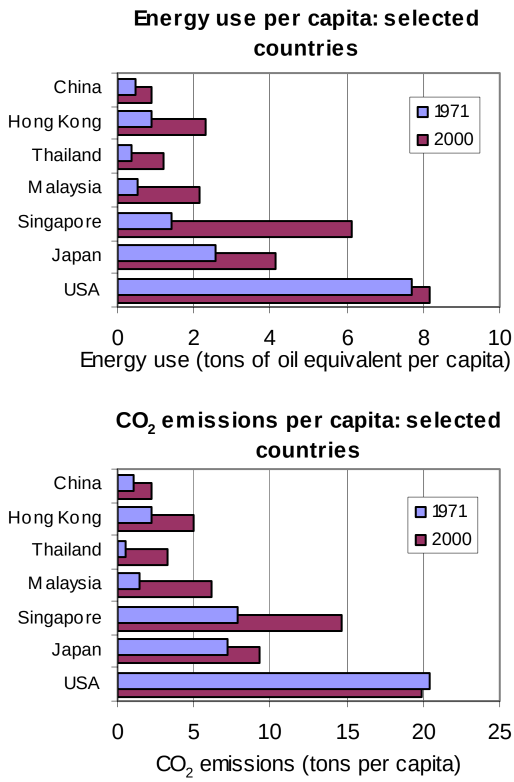
Figure 6.1d
The tide has changed?
Compared with the world total, the economic capacity of the regions dropped remarkably but the CO_2 emissions went dramatically up until the 1990s but seemingly there has been a positive change since that and both of these tendencies have revered. Source: World Bank (2003).



What follows is the observation that the countries outside the study regions are now producing less emissions per person than they used to do, and the share of the study countries was in constant growth until the 1990s. Since then, the study regions, particularly China has been able to cut down emissions and develop the economy in a notable way (Figure 6.1d).

Yet, in per capita terms, the energy use and emissions are still far lower than in high-income countries, as can be seen when comparing the situation in the most industrialized study region countries with Japan and USA (Figure 6.1e).

Figure 6.1e
Energy use and emissions in comparison
The energy use per capita and CO_2 emissions in the most industrialized study region countries. The levels of Japan and United States are presented as comparison. Source: World Bank (2004).



The data on industrial CO_2 emissions in the study region countries suggest the existence of the following pattern (Figure 6.1f):

- In the *pre-industrial* countries, the emissions are very low, both in terms of per capita and per produced wealth (former around 0.1 to 0.5 tons per person, latter below 1 kg per produced US$).

- In *industrializing* countries, emissions grow rapidly. The per capita rates are around 1 to 2 tons, and the emissions per produced dollar may be two to five times bigger than in pre-industrialized countries.

- In *industrialized and post-industrial* countries, the emissions per capita elevate to the range of 5 to 20 tons, yet the produced CO_2 per produced wealth goes back close to the level of pre-industial conditions.

This implies that the industrializing countries, if doing well in economic terms, are those that should be able to cut their emissions most strongly, along with the maturing of the industrial structure. Most study countries, however, are not able to increase their energy efficiency, disregarding of the level of industrialization (Figure 6.1f). The most notable positive exception is China, which, on the other hand, still is tremendously energy inefficient, although there have been notable improvements (Box 6.1a).

Industrialized countries, on the other hand, produce still most of the world's emissions, and therefore are important targets to reductions. A feasible range that can be used as a reference is from the efficient Japan's 9 tons to the inefficient USA's 20 tons of CO_2. If the US would suddenly and surprisingly become as energy efficient as Japan, the world's CO_2 emissions would go down by 1/8! This 1/8 is close to China's all emissions, or to all the emissions of the other study region countries excluding China.

Owing to the facts that the global wealth distribution is very uneven and, consequently, the consumption is far from being in equal levels in different economies, many political and consumption-related decisions made in developed countries have a notable influence on developing countries. According to Todaro (1997), around 20% of the world's population account for 80% of the use of resources. Therefore, consumption pattern changes in developed countries could re-direct and free resources to combat problems in developing countries.

Agriculture, food and water

Due to the fact that agriculture dominates water consumption in most parts of the world, the focus of this section is in agriculture. Figure 6.1b showed how loose the relation between water consumption and a nation's wealth is. This is due to agriculture's dominant role in water consumption – particularly important is irrigated agriculture.

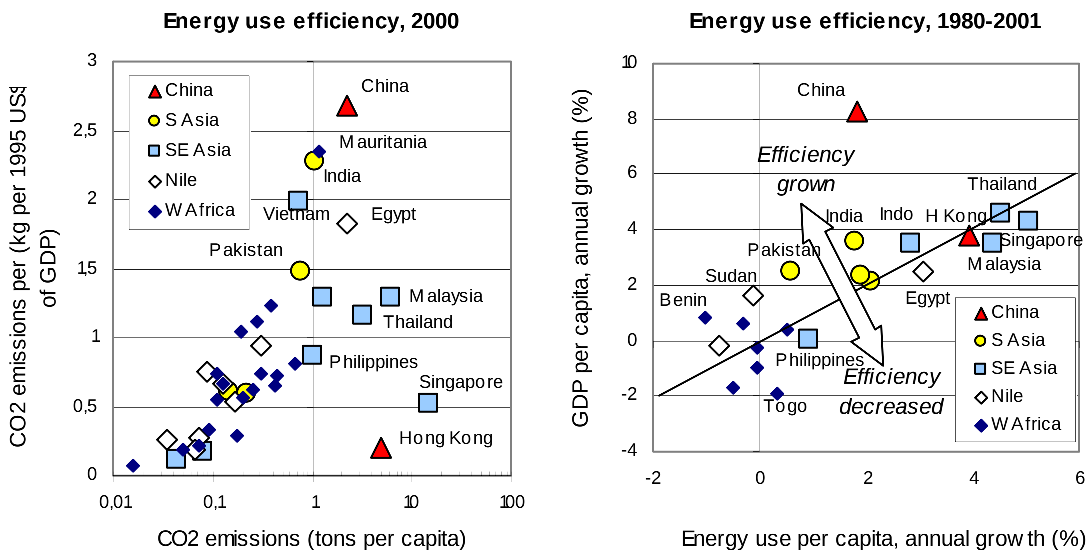
The countries with important irrigation activities are the biggest water users. Thailand is on the lead with 1,400 m^3 per person annually. Sudan, Pakistan, and Egypt follow (See Figure 10.4a).

Water use efficiency per produced wealth tends to be one order of magnitude higher in industry than in agriculture. Therefore, the agriculturally dominated economies of the Indus and the lower Nile valleys should find more efficient ways to develop their thirsty economies through industrialization and, of course, by water savings in agriculture. The water scarcity issue is always in close relation to economic structure.

Figure 6.1f

Energy efficiency is most problematic to countries that have started to industrialize

Source: World Bank (2004).



Box 6.1a

China's energy use and emissions

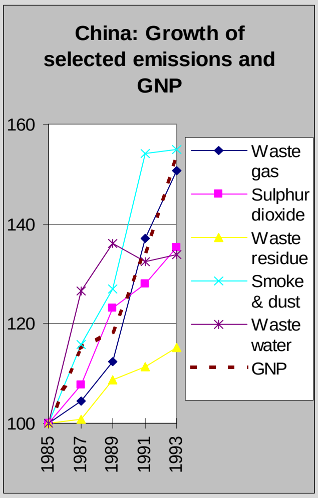
China's emissions are in rapid growth. Yet, it seems that the emissions are now growing in pace with the GDP growth or even less. China is expected to double its GDP again in the next 10 to 15 years. This could virtually happen without increase in energy consumption and related emissions, if efficiency growth and technological progress would be successful (Niu and Harris 1996).

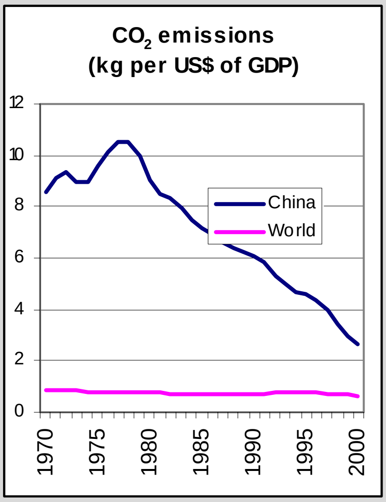
China has topped the world in terms of emissions per produced GNP over decades, along with some parts of the former USSR. Very recently, though, it has made rapid progress (Figure 6.1g). For comparison, some data on study regions are compiled. Clearly enough, China has gone a long way to half its emissions per produced wealth, but it still must half its emissions once or twice to reach the level of the other industrializing study region countries. Some comparative data from high-income countries include the 2000 values for Germany (0.3 kg CO_2 per GDP in US$), Japan (0.2), France (0.2), Finland (0.3), Italy (0.4) and United States (0.6). For reaching that level, China must half its emissions 3 times.

Figure 6.1g

China's emissions are enormous, but energy efficiency is on a good track

China's emissions are still in growth, but the efficiency is also in rapid progress, particularly in the energy sector. In the Table: Industrial CO_2 emissions per produced US$ (1995 rate) of GNP. Indexed values, 100 is China's level in 2000. Source: World Bank (1999, 2004).





	1980	2000
China	337	100
India	83	85
Pakistan	45	55
Bangladesh	13	22
Thailand	29	43
Malaysia	33	48
Singapore	42	19
Indonesia	47	48
Egypt	56	68

This is not, however, the way for everybody to go on. With the growth of human population by 1.5% per year, and changing consumption patterns, food production must grow constantly. van Hofwegen and Svendsen (2000) estimated that: *"water supplies in agriculture will have to be augmented by an additional 15 to 20% over the next 25 years, even under favourable assumptions regarding improvements in irrigation efficiency and agronomic potential to meet food requirements. This amounts to an additional 0.6% to 0.7% of water supply per year."*

The needed increase in food production must take place dominantly in countries where the consumption increases, disregarding of the common forecasts of sharply growing international trade of food products. Egypt and Pakistan are forced to increase their food imports, but many study region countries are not. This applies chiefly to African nations.

After the results of IWMI (2000), Pakistan is indeed beyond its limits of sustainable level of water diversions (Figure 6.1h). India, Egypt and China are approaching their limits. These results were calculated using the PODIUM Policy Dialogue Model, which allows country specific simulations of water use, food consumption, food production, needed agricultural land and inputs, and agricultural trade (IWMI 1999).

The trade results tell that the African nations included in this study—Egypt, Ethiopia, the Sudan, and Nigeria—must be prepared to import more and more food (Figure 6.1i). For Egypt, there will be no major problems, but the other three are not too well off in economic terms, and the threat of famine is always there if the local supply of food is insufficient. Among the Asian countries, the biggest changes are expected to be in Pakistan and the Philippines—growing imports—and in Vietnam and Myanmar—growing exports.

Figure 6.1h

The four tops: Pakistan, Egypt, India, and China are approaching their limits in water consumption

The renewable water resources, estimates for utilizable resources, total diversions, and agricultural diversions in 1995 and projections for 2025. Selected, important agricultural study countries are shown. The IWMI (2000) Base Scenario results are shown.

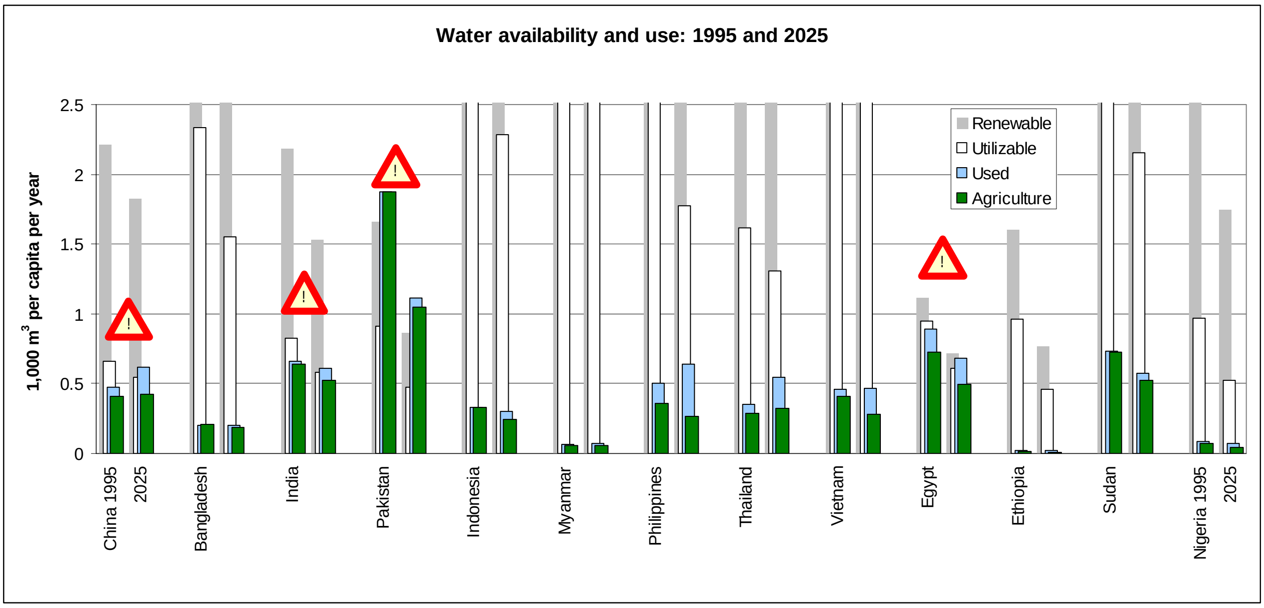


Figure 6.1i

Meat consumption doubles or more

Projections of food consumption (cereal, animal, and other origin), population growth, and the percentage of meat consumption of all food intake. Export possibilities and import needs of cereal. Selected, important agricultural study countries are shown. The IWMI (2000) Base Scenario results are shown.

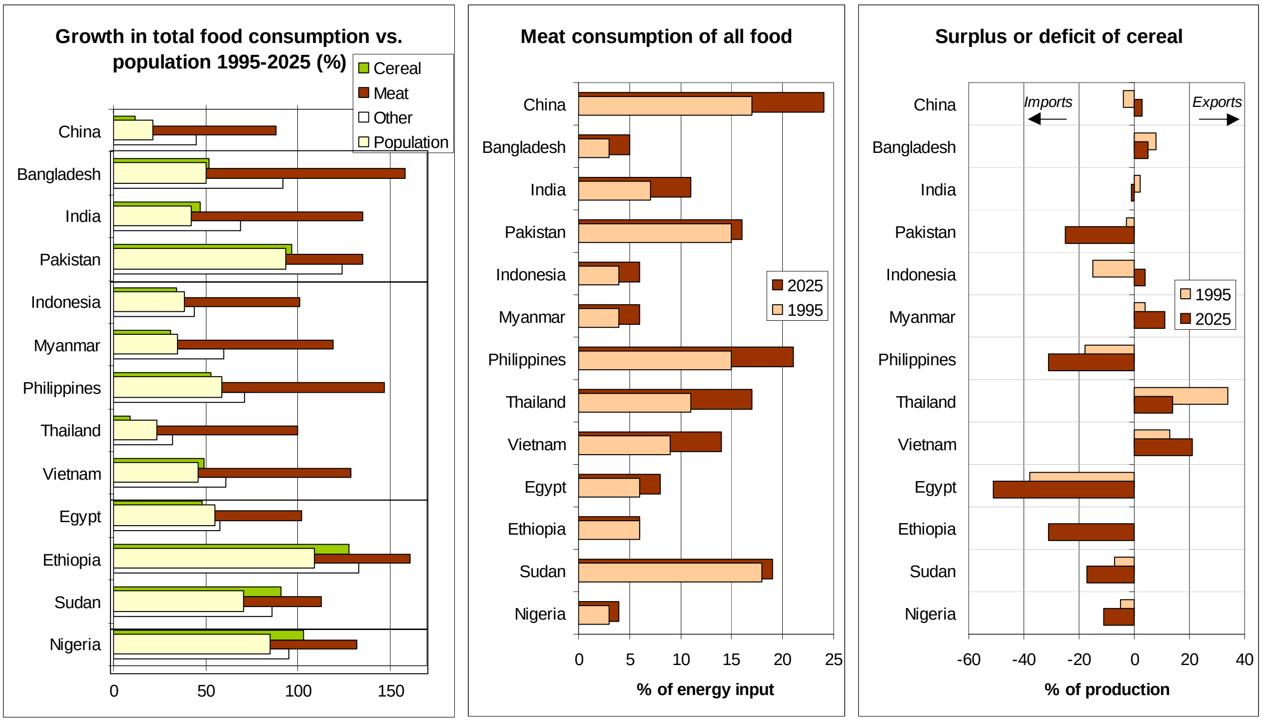


Table 6.1a
Beefeaters consume much water
Estimated water volumes required to produce selected food products (Pimentel et al. 1997).

Crop or product	Liters/kg
Potatoes	500
Wheat	900
Alfalfa	900
Sorghum	1110
Corn	1400
Rice	1912
Soybeans	2000
Broiler chicken	3500
Beef	100,000

The IWMI analysis included also projections for diet consumption (Figure 6.1i). It is interesting, how much meat consumption is projected to grow in the countries included in the analysis. This growth is a particular challenge to the water sector, knowing the high water demand of meat production (Table 6.1a). The production of 1 kg of beef requires 100 tons of water!

In order to produce meat, plant production must increase. After FAO (Alexandratos 1995), cereal consumption in high-income countries is around 635 kg per year per person. This is 46% of the global production. If people eat more meat in developing countries the quantity of arable land must increase as well. Increased meat consumption will also presuppose that more irrigation water is needed.

Brown (1995) is concerned about the diet changes in China. While the meat consumption was only 7.7 million tons in 1977—at the time of the economic reforms—it grew 5-fold in 16 years, till 1994. The growth per capita was from 8 kg to 32 kg per year. Feed grain use went up accordingly, from 20 to 80 million tons. IWMI’s (2000) results in Figure 6.1i suggest China’s meat consumption to double in the period 1995-2025. Enormous damages to the land and water resources of China have followed (see Chapters 6.2 to 6.5).

There is a justified concern about the food habits of the Chinese. Yet—using Brown’s figures—an inhabitant of the United States consumes approximately 800 kg grain per year while in China the consumption is only 300 kg, and meat consumption in the US is still far above the Chinese level (Table 6.1b). The big meat consumers are in the high-income countries.

A study region summary

In the same way that the economic structure of the study countries was analyzed in Figures 4.4h and 4.4i, the balance of consumption, production, resource use, and emissions is presented by country in Figure 6.1j. The indicators used are, respectively: PPP, energy use, water use, and CO_2 emissions.

Table 6.1b
Who is to blame for meat consumption?
Annual consumption of grain and livestock products in selected countries (kg per capita; Brown 1995).

	United States	Italy	China	India
Grain use	800	400	300	200
Beef	42	16	1	0
Pork	28	20	21	0.4
Poultry	44	19	3	0.4
Mutton	1	1	1	.2
Milk	271	182	4	31
Eggs	16	12	7	13

A concern on sustainability

Agenda 21 of the Earth Summit ‘92 in Rio de Janeiro postulates the concern and urgent need to plan and implement environmentally sustainable development strategies. Evidently, in addition to the environment, the sustainability criteria should incorporate also the exploitation of natural resources, development of human resources (health and education) and offering an efficient macroeconomy.

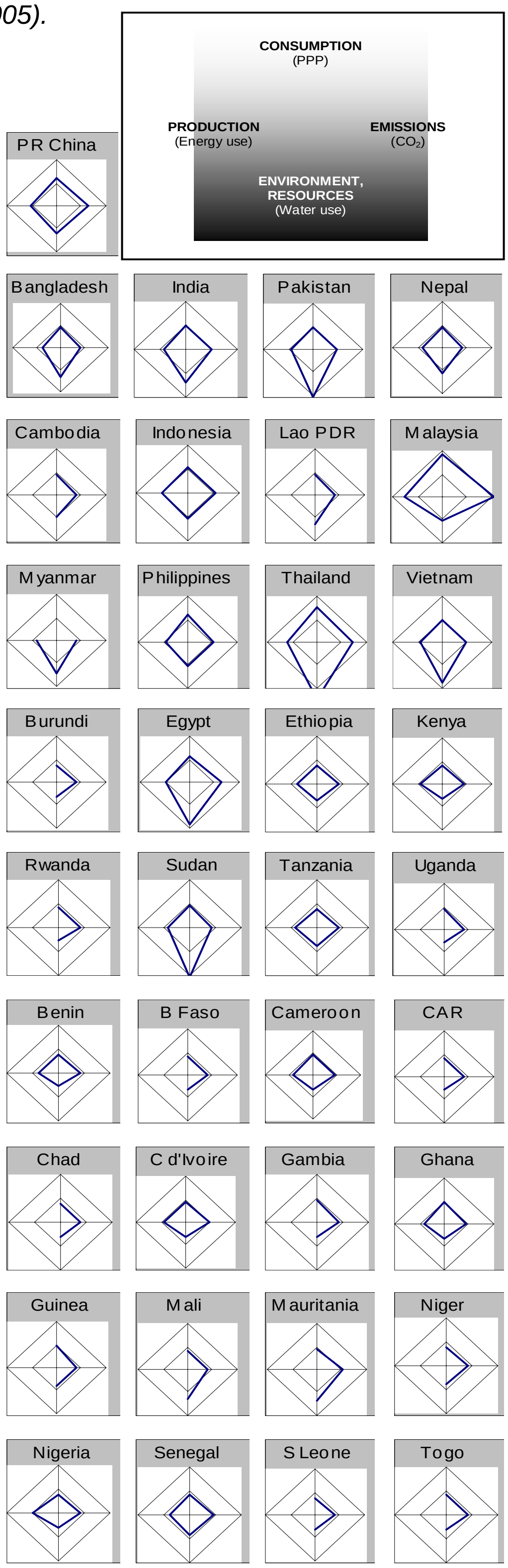
When exploring the current development pathways of human demographic development, and particularly that of urbanization and mega-cities, one easily ends up with a conclusion that any level of sustainability in their future development is a distant dream with no possibilities to be managed in foreseeable future but in minor details. Now, this is where we simply must start from, but keeping in mind the entire problem setting with the population pressure, resource scarcity, environmental problems and socio-economic realities (Box 6.1b).

Without making an attempt to contribute to the rapidly growing literature on the definitions of sustainability, one basic point deserves mentioning here, which is not sufficiently emphasized. Evidently, water management should attempt to close the material and energy cycles as much as possible (e.g. Niemczynowicz 1993).

This requirement is in fundamental contradiction with the present type of urbanization process, in developing countries in particular. Instead, the high population densities should be avoided, unless the waste produced in cities can be recycled to the production of food or other mass products.

The wastes, if discharged to watercourses and aquifers, contribute essentially to the water scarcity through pollution (Figure 6.1k). High population densities may, on the other hand, facilitate very efficient resource use, as pointed out by von Weizsäcker et al. (1997), but this requires careful management of material cycles.

Figure 6.1j
Country profiles of study countries
The approach is similar to the one used in Figure 4.4h. Source: World Bank (2004) and FAO (2005).



A sustainable, and often, in long term the most economic solution should be based on the principle of closing the material and energy cycles. This can be made in many ways (Varis and Somlyódy 1997), but should not be overlooked in any case.

Figure 6.1k
From waste to resource
Closing material cycles is a prerequisite for sustainable water resources management.

Box 6.1b
Factor four

The Club of Rome has been an important forum of new thoughts and discussion on global sustainability issues over decades. One of the Club's major outputs in the late 1990s was the F4 (factor four) concept (von Weizsäcker et al. 1997). The story goes:

The technological and economic progress of industrialized countries has mainly been achieved by the increase in labor productivity. A roughly 20-fold increase in 150 years has been possible through advancements in science and technology.

Resource productivity—GDP output per unit of resources—has been out of the scope. It first decreased in industrialized countries (see Figure 6.1f and adjacent discussion), but has later increased, but only with a rate of roughly 1% per year. In this perspective, China's recent progress is exceptional (Box 6.1a).

The resource consumption per capita in high income countries is now too high, by an order of magnitude. A catastrophe would follow if all the globe's six billion people consumed so much resources.

There the F4 steps in. Resource productivity can be quadrupled using present knowledge. By halving resource consumption, the mankind is—in theory—capable to double well being. In other words, resource productivity could be quadrupled. If resource productivity would grow by 3% per year instead of the present 1%, the factor four would be reality in forty-five years.

In addition, the emerging and industrializing economies, particularly in Asia, should leap over the polluting and resource-intensive phase of the industrialization process, which has been characteristic to the development of N American, European, Chinese, and other industrial economies. The emerging and developing economies would benefit themselves the most by building efficient economic structures.

6.2 Land degradation

Olli Varis

The population keeps growing. Food production should grow much faster than the population does since more and more meat is consumed. However, the area of arable land goes down. The unit yields must grow rather fast. Due to speedy urbanization and other factors that open material cycles the soils and waters are threatened by enhanced degradation. Competing land uses appear to restrict a remarkable growth in arable land.

Types of land degradation

At present, more arable land is lost than produced. It is estimated that about 12 million ha of arable land is lost annually because of soil degradation (Pimentel et al. 1995). Soil degradation is caused by erosion, the ground becoming waterlogged and saline, and impoverishment and acidification of the soil (Box 6.2). Desertification can be defined as the process of soil degradation in dry areas (cf. UNEP 1992). Land degradation is also touched in the watershed management chapter (Ch 10.5).

Settlement, industry and agriculture also compete for land, and it is often agriculture that loses. This is especially common in the best agricultural areas, in river valleys and estuaries where urban and industrial growth usually concentrates.

Erosion

Erosion by water and wind makes the topsoil thinner and in the worst case unfit for growth. About 1/3 of agricultural land on the earth is arable and 2/3 grassland. Around 80% suffer from erosion to some extent. Arable land is more susceptible to erosion because it is regularly cultivated and without vegetative cover for some months during the year. As for grassland, overgrazed areas suffer most from erosion. Such areas comprise more than half of the total grassland area.

Erosion has a negative effect on plant production because it makes the topsoil layer thinner and in this way changes the water and nutrient balance of the soil and makes the living conditions for microorganisms more difficult. The effect is case-dependent, however, and there is no reliable total assessment of the effect of erosion.

There is no reason to understate the problem caused by erosion; in agricultural areas of Asia, Africa and S America it amounts to, on average, 30-40 tons per ha per year and in Europe and the United States 17 tons per year (Barrow 1991). Natural generation of the topsoil is, according to Pimentel (1995), 20-40 times slower than soil degradation caused by erosion.

Salinity and waterlogging

Soil becoming saline is mostly a problem of irrigated areas but it can also take place in non-irrigated areas where a high rate of evaporation cumulates salts to the topsoil. The salts carried by evaporating water get stored in the root layer if water is not used sufficiently to wash the salts out from the soil.

Waterlogging is another important problem of irrigated areas. It is due to insufficient dewatering of soil. Irrigation in these areas causes groundwater to rise to the root layer, which renders the areas unsuitable for cultivation. According to the FAO (Alexandratos 1995) 0.2-1.5 million ha annually vanish from cultivation because they become waterlogged and saline.

Soil degradation and loss of fertility

The soil becomes less fertile if the nutrients and trace elements are constantly used without taking proper care of the mass balance of the soil. This is a problem especially in Africa, but also elsewhere.

The total effects of this impoverishment are not known. The effect of the increasing acidity of the environment on the quantity and quality of plant production is also highly uncertain.

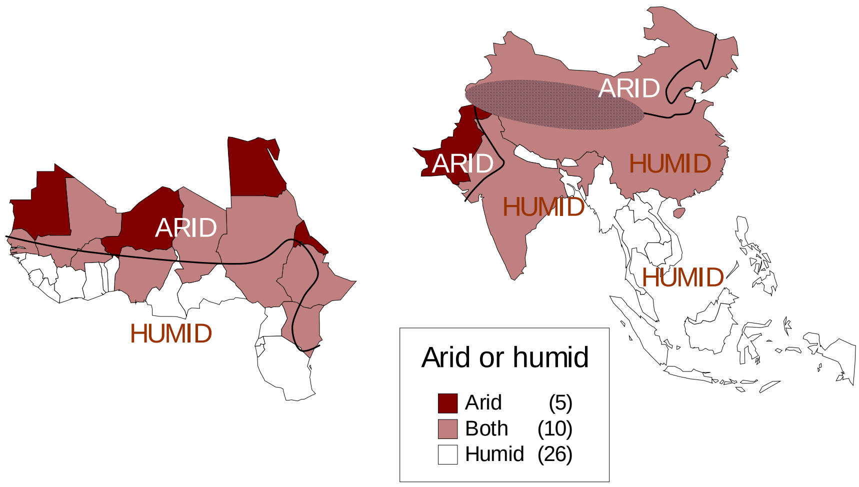
The arid—humid divide

Among the myriad factors that determine the amount and type of soil degradation, the divide between the arid and dry climate is extremely important in macro-level studies. In humid climate, annual rainfall is greater than annual precipitation, and in arid climate, the relation is the opposite.

Typical forms of land degradation for arid and humid

Figure 6.2a
The border between arid and humid climate is an important divide of land degradation types
The border region is most vulnerable region of desertification.

	Humid	Arid
Water erosion	x	x
Wind erosion		x
Soil fertility decline	x	(x)
Waterlogging		x
Salinization		x
Lowering of water table		x



climates are shown in Figure 6.2a. All the study regions are crossed by the border between arid and dry climate, except SE Asia, which belongs entirely to the humid zone.

China

Land degradation is a serious problem in China (Figure 6.2b). From the early 1950s, the area of ecologically degraded land area has grown 38%. In the Yangtze (Changjiang) basin, the area from which severe erosion occurs has doubled in the last fifteen years (Niu and Harris 1996).

Water erosion is a great problem in most of China. It occurs primarily in regions, which are heavily populated and cultivated.

Chemical and physical deterioration are in growth. They, as well, influence primarily most important agricultural areas. However, the level of degradation is still lower than in many of the countries with intensive agriculture in S and SE Asia (Figure 6.2c).

The combination of wind and water erosion is a grand problem in the arid loess plateau, in the Yellow River basin—in the provinces of Saanxi, Sanxi, Gansu, Inner Mongolia, Ninxia, Qinghai, and western Henan. The area of the plateau is 600,000 km^2, which exceeds the size of France plus Switzerland together, and has 155 million people. Poverty is widespread in the region (See Box10.5a).

Figure 6.2b
Soil degradation in China, S Asia and SE Asia
Per cent of total land area, by region (Lynden and Oldeman 1997).

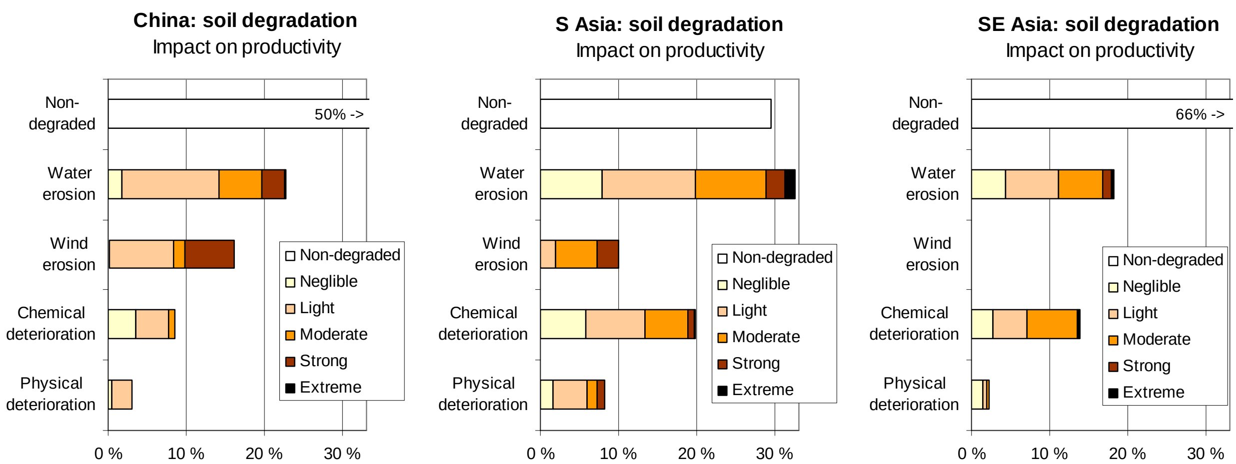
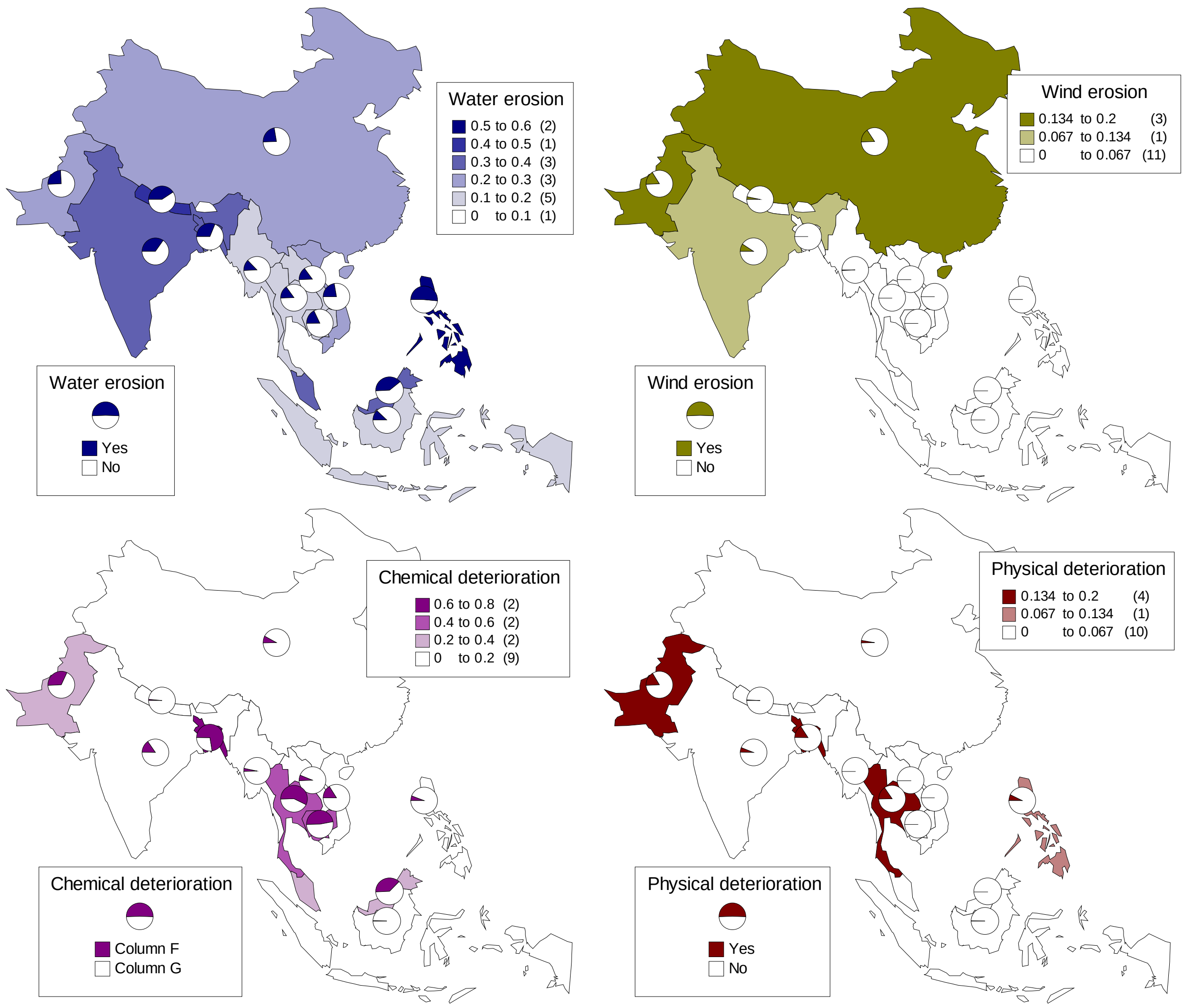


Figure 6.2c
Soil degradation in China, S Asia and SE Asia, by country
Proportion of total land area (Lynden and Oldeman 1997).



The loess plateau belongs to the most severely eroded areas of the world; annual soil losses have exceeded 20,000 tons per km^2 (FAO 1995b), which means 20 kg per m^2. The consequences are seen in the yellow-brownish color of the Yellow River (the river receives 1,600 million tons of silt each year—10 tons per basin dweller—and suspended solids content is up to 60% in some reaches), and in the sand storms of a large share of China, including Beijing.

S Asia

Pakistan suffers severely from all four types of land degradation (Figure 6.2c), as classified by Lynden and Oldeman (1997). India's plague is water erosion, and, in its arid parts, wind erosion. Nepal's main problem is water erosion, and Bangladesh has problems with all degradation types except wind erosion.

The picture is clearer in the FAO (1994) study for arable land degradation in S Asia: India is divided in arid and humid regions, and classification of degradation types is somewhat different (Figure 6.2d).

As Figure 6.2a shows, Pakistan and the western part of India are arid regions, whereas the rest of S Asia is humid. The boundary goes through the states of Gujarat and Rajastan, around the Aravalli Range, approaches Delhi, bends NW, to the direction of Hindu Kush, and includes most of Haryana and Punjab. After FAO (1994), about ¼ of India is arid.

The arable lands of India's arid part suffer from wind erosion, salinization, waterlogging, and water erosion (Table 6.2a, Figure 6.2d). Pakistan has very similar problems, but they are far more severe than in India. Almost 90% of Pakistani arable land is degraded, while for arid India, the share approaches 50%.

Around 1970, 60 kg wheat grew with one kg of nitrogen in Pakistan. In twenty years, till 1990, N fertilization need tripled due to soil degradation: only 20 kg wheat were produced by a kg of N—which has been mostly applied as urea. After Tandon (1993): *"…nitrogen is simply used as a shovel to mine the soil of other nutrients."*

The land degradation is a severe problem for the agricultural lands of humid S Asia as well, yet the dominant degradation types are very different. Bangladesh suffers greatly from soil fertility decline, which means a negative soil nutrient balance. In Nepal and humid parts of India, water erosion dominates.

Figure 6.2d
Agricultural soil degradation in S Asia
The arid—humid divide is clear (FAO 1994).

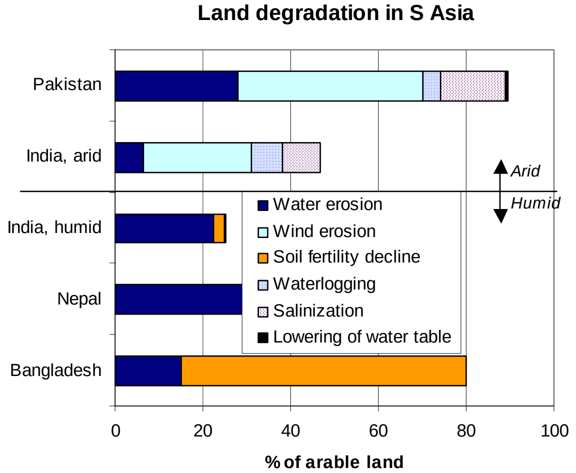
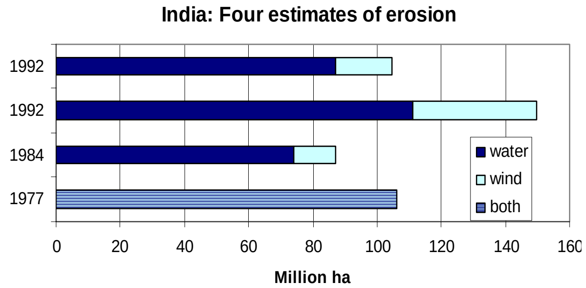


Figure 6.2e
Land degradation data is inconsistent
Four estimates of water and wind caused soil erosion for India. The years of assessment are shown (FAO 1994).



FAO (1995b) points out, that water erosion is the region's most severe land degradation problem, and the figures in Table 6.2a may be underestimates, particularly for India. The estimates from different sources deviate substantially, which is an indication of high uncertainties and definition problems in the data, leading to difficulties when comparing data from different countries (Figure 6.2e).

The economic losses of land degradation were estimated by FAO (1994) to be 2% of GNP of S Asia. The annual losses of agricultural yields were estimated to be 8% for India, 5% for Bangladesh, 3% for Pakistan, and 2% for Nepal.

SE Asia

Being a humid region, SE Asia has virtually no problems with wind erosion (Figures 6.2b and c). In contrary, due to intensive land use, chemical and physical degradation are serious problems in some countries; the former in Malaysia, the latter in the Philippines, and both in Thailand.

All countries have problems with water erosion. Yet, more modest than in China and S Asia, with the exception of the Philippines, Malaysia and Vietnam. The Philippines is seriously impacted by water erosion, and only Nepal can compare with it among the Asian study region countries.

FAO (1995b) estimates that erosion carries away 2 billion m^3 soil each year from the territory of the Philippines. Averaged over the land area, this would mean 7 mm loss each year! Calculated per person, this would be 3 m^3 of eroded land! The economic loss caused by land degradation would amount to 4% of GNP (World Bank 1989, Cruz and Repetto 1992).

The country-averaged data is very kind to Indonesia, which has a huge concentration of people on the island of Java. The island is worse off with land degradation than the Philippines.

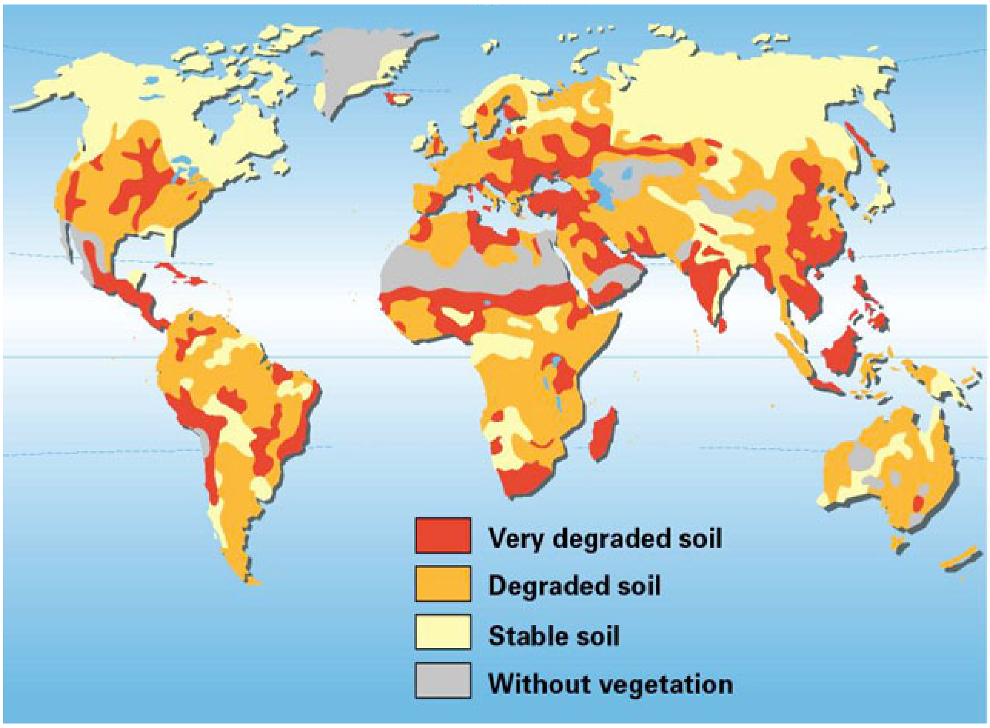
African regions

Similar in-depth studies of land degradation—such as those by FAO (1995b) and Lynden and Oldeman (1997) for Asia—are unfortunately not available for the African continent. However, the problems of the African study regions are equally serious, if not more serious than those of the Asian study regions.

After FAO (1995c): "*Little reliable data is available on the extent of land degradation in Africa. However, anyone who has traveled through the continent has observed that land degradation is widespread and serious.*"

One-third of Africa's land surface area is desert or subjected to desertification. At the southern area of Sahara, an approximated 650,000 km^2 have desertified within the past fifty years (FAO 1990). The desert has been estimated to conquer 50,000 to 70,000 km^2 land each year within that zone.

Figure 6.2f
Land degradation in the world
Data by UNEP/GRID (2001) (reproduced by permission).



It is interesting to compare the region of the most severe land degradation in Africa (Figure 6.2f) with the divide between arid and humid zone that was discussed above (Figure 6.2a). It is striking how well they coincide. Indeed, the edge of the monsoon zone is the most vulnerable climatic region in Africa to land degradation. In this respect, the situation is somewhat different to Asia and other continents.

By this, most of the inhabited areas of Senegal, Mauritania, Mali, Burkina Faso, Niger, Chad, Egypt, the Sudan and Ethiopia have very degraded soils. Also large areas around the great East-African lakes are very degraded.

Scherr and Yadav (1996) summarize, that erosion alone causes yield reductions of 6.2% per year in Sub-Saharan Africa. By 2020, this may increase up to 14.5% if erosion remains unabated.

Causes of land degradation

It is clear, that the causes of land degradation are many. Overgrazing dominates in Africa. Drying climate together with herds that exceed the carrying capacity of the pastoral ecosystems accounts for 60% of soil degradation in Africa. Unsustainable farming practices and deforestation cause 30% and 10%, respectively (Figure 6.2g).

Table 6.2a
Causes of arable land degradation in S Asia
Up to two causes are given for each degradation type (FAO 1994).

	Deforestation (%)	Overgrazing (%)	Agricultural Activities (%)	Overcutting of vegetation (%)
Water erosion	**61**	**67**	2	44
Wind erosion	21	46	1	**98**
Soil fertility decline	25	0	**75**	0
Salinization	34	30	14	**87**
Waterlogging	0	0	**85**	33
Lowering of water table	12	22	**65**	34
All types of degradation	37	46	15	**63**

In Asia, deforestation is far more important than in Africa. Water erosion is the most frequent consequence of deforestation in Asia (Table 6.2a). Asia and Africa dominate in the world scene of land degradation.

Figure 6.2g
Causes of land degradation by continent
Data by FAO (1996).

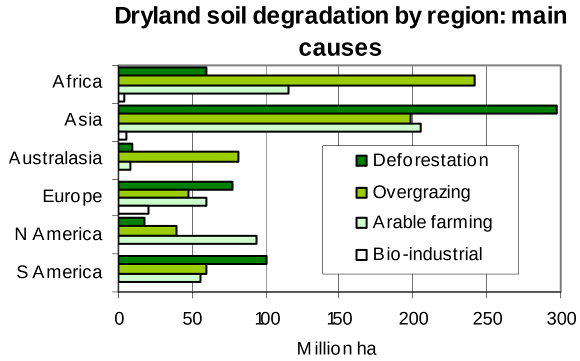
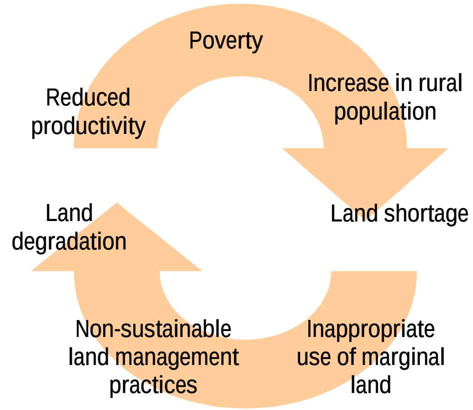


Figure 6.2h
The vicious circle of land degradation
Modified from FAO (1995b).



Mitigation and prevention

The world is rich with various guidelines and suggestions how land degradation should be stopped –and the negative development (Figure 6.2h) reversed to positive direction. The basic idea is that since the causes are very many and mixed, the approaches to reverse the development need also be multidisciplinary.

Due to the fact that there is an immense spectrum of wiser and wiser guidelines, only one example is taken, without an attempt of providing a comprehensive analysis. The example comes from FAO (1995b). The many components to be included in the framework of action against land degradation are listed in Figure 6.2i. The scheme illustrates well the complexity of the issue.

Box 6.2
Acidification by atmospheric depositions
After Kuylenstierna et al. (2001).

Although the acidification of soil and water due to increased concentrations of sulfur and nitrogen compounds that precipitate from the polluted atmosphere is not traditionally counted among the basic land degradation types, it should be. The sensitivity of soils to acidification are a product of the amount of the deposition and the sensitivity of soils to acidification. The latter is governed by the buffering capacity of the soils to tolerate acidic loads.

Among the study regions, the African areas do not need to worry about this problem (Table 6.2b).

China is by far in the most problematic situation, and its problems are expected to grow. China will lead the world also in this respect in the close future, as it passes US, perhaps already on this decade. China's most problematic regions will be in the SE coast between Guangzhou and Shanghai.

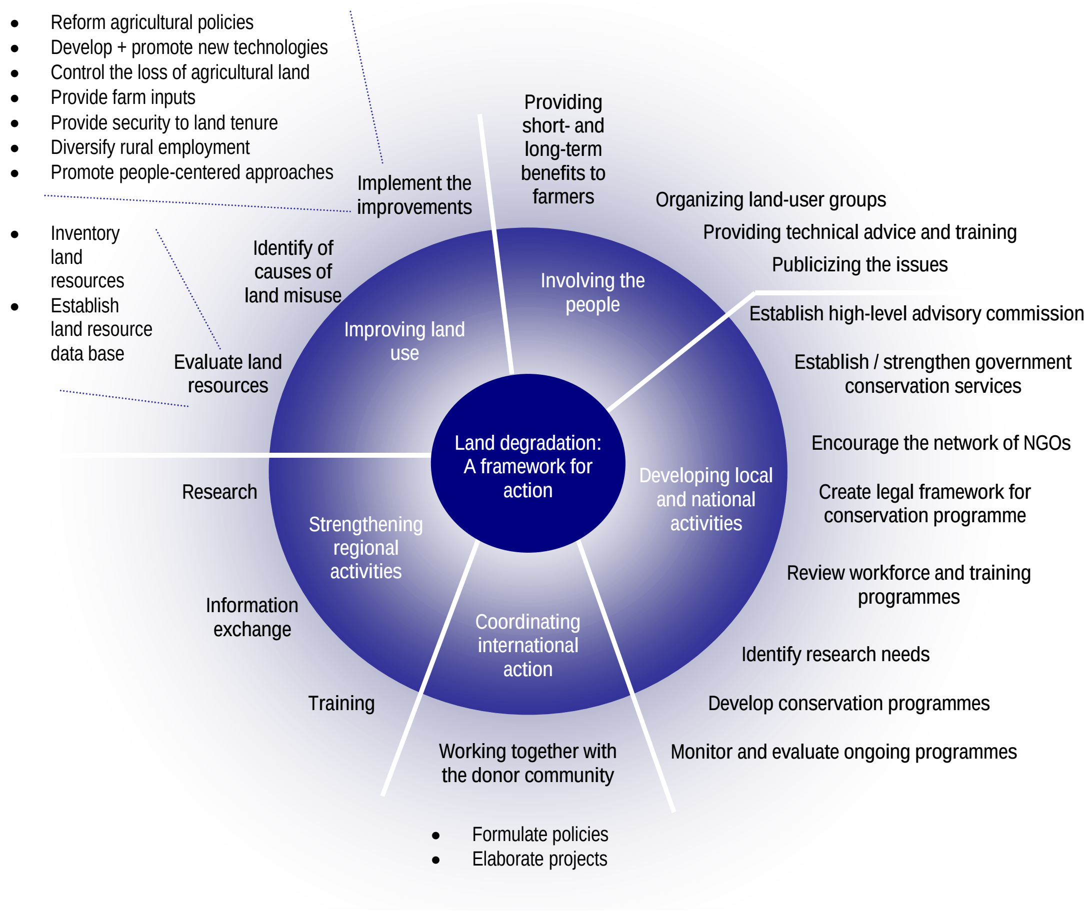
Table 6.2b
China has the most serious acidification problems among the regions, SE and S Asia follow
Depositions and exceedance of critical loads in 1990 and 2050 after Kuylenstierna et al. (2001). Annual total depositions of sulfur (scale: 1: 0-199 mg S m^{-2}, 2: 200-499, 3: 500-999, 4: 1000-1999, 5: > 2000) and exceedance of critical loads (scale: Low: 0-50 meq m^{-2}, Medium: 50-100, High: >100). China is divided into SE and NE regions. The border is a straight line between the Yunnan province and Beijing.

	Deposition 1990	Deposition 2050	Exceedance of critical loads 1990	Exceedance of critical loads 2050
China				
China, SE	4	5	Medium	Medium
China, NW	2	3	No	No
S Asia				
Bangladesh	3	5	No	No
India	2	4	No	Low
Nepal	2	3	No	Medium

Pakistan	1	2	No	No
SE Asia				
Singapore	2	4	No	Medium
Cambodia, Lao PDR, Philippines, Thailand, Viet Nam	2	4	No	Low
Indonesia	2	3	Low	Low
Malaysia	2	3	No	Medium
Myanmar	1	3	No	No
Nile basin				
Burundi, Rwanda, Uganda	2	3	No	No
Egypt, Kenya	2	2	No	No
Ethiopia, Sudan, Tanzania	1	2	No	No
W Africa				
Cameroon, CAR, Côte d'Ivoire, Ghana, Liberia	2	2	No	No
Benin Gambia Guinea Guinea Bissau Nigeria Senegal Sierra Leone Togo	1	2	No	No
Burkina Faso Chad Mali Mauritania Niger	1	1	No	No

S Asia has not serious problems thus far, but Nepal and parts of India will be exposed to acidification in coming decades. India’s most problematic area will be the Western Coast, from Kerala to Mumbai.
SE Asia is also under augmenting acidification problems. This goes almost throughout the region, but sharpest growth in exceedance of critical loads is expected to be in Singapore and Malaysia. Myanmar is projected to have less problems than the other countries.

Figure 6.2i
FAO’s approach to mitigation and prevention of land degradation
Modified from FAO (1995b).



6.3 Surface water degradation

Olli Varis

Streams, lakes, reservoirs and wetlands are used and exploited in a variety of ways. They contain cultural and religious values that are essential. Exploitation of surface waters contributes to the deterioration of water quality and changes in ecology. The natural patterns of seasonality and other variations cause mismatch between supply and demand of water.

Surface water in the hydrologic cycle

Surface water resources – rivers, other streams, lakes, reservoirs, and wetlands – are a very dynamic part of the global water cycle. The climatic variability, both seasonal and annual, affects greatly the quantity and quality of surface waters. Basically, the input comes from rainfall, and the output from evaporation to the atmosphere and flow to the oceans. The water cycle also includes flow and storage in soil, in the ground, as snow and as ice.

In this chapter, quality and quantity issues of surface waters are summarized; the former ones in some more detail, because Chapters 2.3 to 2.5 present an overview of water quantity in the global scale and in the study regions, even by country.

Quantity

Climatic issues determine the input to the surface waters, and partly also the output. Wet and rainy seasons or years cause floods and dry ones are the reason of droughts. In addition, changes in vegetation and land use cause long term changes in the water retention, infiltration, and other properties of watersheds, and therefore also in water quantity. The most marked quantitative changes are, however, due to man-made constructions such as reservoirs, dams, water transfer systems and so forth.

In the global level, the construction of reservoirs has increased the stable runoff—the flow in driest seasons—by 1/3 (Figure 2.2b). By this, the floods have been cut down too, because flood waters can be stored to reservoirs to be used in the dry seasons.

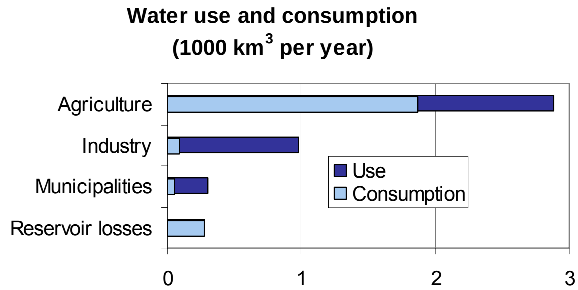
The water consumption, however, has grown to such an extent, that many of the world's big rivers are today exploited so severely that they discharge practically no water at least seasonally to the oceans or seas. Such rivers include Amu-Darya and Syr-Darya in Central Asia, Nile and Niger (Global Water Partnership 2000) in Africa, Colorado in North America, Huang He in China, and Ganges-Brahmaputra in India (Postel 1996). In fact, most of the world's rivers have changed markedly their flow pattern due to man's influence (Figure 10.1d).

Only a part of the water that is withdrawn for human use returns to the watersheds. The rest is evaporated into the atmosphere. Postel et al. (1996) have estimated, that around 51% of all water used by humans will not be available to other end-users (Figure 6.3a). For more discussion on the topic, see Chapters 2.3 to 2.4. Figure 2.3b shows water use vs. withdrawal data for each country in the study regions.

Figure 6.3a

Water use and consumption

Postel et al. (1996) have estimated, that around 1/2 of all the water used will not be available for other users. They call this proportion as consumed water. Agriculture is the greatest consumer, accounting for over 4/5 of the total water consumption.



Many Asian metropolises such as Bangkok, Calcutta, and Dhaka that are practically floating on water, but where the water contamination in almost all conceivable ways makes the water use very difficult (cf. Box 10.3b). Water transfer systems even from distances of hundreds of kilometers are being constructed to meet the urban needs. Large-scale water scarcity problems are created in the regions from which water is conveyed away.

In Thailand's central plain, which is one of the rice bowls of the world, large irrigation systems are these days useless in dry seasons, because their water is drawn away to meet the rapidly growing Bangkok's expanding demands. The city itself is sinking, due to overdraft of groundwater, and its ample surface waters are too heavily polluted for any other use but navigation.

Quality

Surface water quality problems consist of several different issues. This is due to the great diversity of lakes, reservoirs and rivers, the wide range of needs and preferences in society for the utilization of surface water, and the complexity of aquatic ecosystems. The changes are caused by point source polluters such as industries and settlements that have a sewerage system; non-point polluters such as agriculture, or through the atmosphere. The most common water quality problems are:

- *Eutrophication* caused by the abundance of nutrients and other agents of enhanced primary production.
- *Oxygen depletion* caused by degradation of organic matter in water.
- *Hygienic problems* due to pathogenic organisms such as viruses, bacteria or protozoa.
- *Salinization* caused by high concentrations of ions such as calcium, sodium, chloride and sulphate.
- *Acidification* due to atmospheric deposition of SO_2 and NOx or by industrial, mining or natural emissions.
- *Toxic or cumulative compounds* such as heavy metals or other trace elements, radioactive compounds, halogenated hydrocarbons or waterborne toxins.
- *Suspended material* and *turbidity* caused by inorganic or organic matter.
- Changed *thermal conditions* due to thermal pollution, flow control or changed climate.

The principal driving force in water quality management is the need to resolve the potential conflict arising from the specific demands and impacts of various activities on water quality, often under water scarcity. Many water uses suffer from poor quality but have no direct influence on it, while many cause water quality problems but are not harmed by them (Tables 6.3a and 6.3b).

Table 6.3c presents a checklist designed by Varis and Somlyódy (1996). It is applicable to the screening of lake and reservoir water quality problems as a part of the Environmental Impact Assessment (EIA) process. Table 6.3d shows the various interconnections between the numerous factors and driving forces of water quality.

Table 6.3a

Impacts of surface water quality to uses.

Typical influences of water quality problems on most frequent uses: eutrophication, oxygen depletion, hygienic problems, salinization, acidification, toxic / cumulative substances, turbidity and suspended matter, thermal pollution. - = low or occasional influence, -- = marked influence.

Use	Eutrophic.	Oxyg. Depl.	Hyg. Prob.	Salinization	Acidification	Toxic subst.	Turb.&susp.	Therm. Poll.
Conservation	--	--	--	--	--	--	--	--
Recreation	--	--	--	-	-	--	--	-
Fisheries	--	--		-	-	--	-	-
Aquaculture	-	--		-	-	--	-	-
Withdrawal:								
- Households	--	--	--	-	-	--	-	
- Municipalities	--	-	-	-	-	--	-	
- Irrigation, etc.	-	-	--	--	-	--	-	
- Industry	-	-	-	-	-	-	-	
Transport	-						-	
Flood control							-	
Hydropower							-	
Cooling basin								-
Waste transport and disposal	-							

Table 6.3b

Impacts of uses to surface water quality.

Use	+ = low or occasional impact, ++ = high impact							
Conservation								
Recreation			+					
Fisheries								
Aquaculture	++	+					+	
Withdrawal:								
- Households								
- Municipalities								
- Irrigation, etc.	+			+				
- Industry								
Transport			+			++	+	
Flood control	+	+					+	+
Hydropower	+	+		+			++	+
Cooling basin	+	+				+		++
Waste transport and disposal	++	++	++		+	++	++	

For an itemized description of constituents of water quality and water use standards, see Thanh and Tam (1990a) and McCutcheon et al. (1992). Various national and international agencies and authorities release their own standards, which are typically use-specific.

Table 6.3c

Surface water quality impact assessment

*Cross-impact matrix for surface water quality impact assessment: + = same direction, - = opposite direction, * = indefinite, case specific or unknown direction (Varis and Somlyódy 1996).*

Specification	Problem impacted *)							
	Eutrophic.	Oxyg. Depl.	Hyg. Prob.	Salinization	Acidification	Toxic subst.	Turb.&susp.	Therm. Poll.
Climatic inputs								
Temperature	+	+	*	+				+
Humidity				-				+
Solar radiation	*	+		+			+	+
Precipitation				-	+	*		-
Wind	*	-		+	*	*	*	-
Thermal and hydraulic								
Stratification	*	*	*			*	*	*
Ice-free period	+	*	*				*	+
Hydrologic								
Floods	*	*	+	-	*	*	*	-
Droughts	*	*		+	*		*	+
Erosion, loading	+	+	+	+	*	+	+	
Retention time	+	+	*	+	*	+	*	+
Water level	-	-	*	-	*	-	*	-
Chemical								
Oxygen	-	-	-			-	-	
Carbon dioxide	*	*		+	+			
Nutrient enrichment	+	+	*				+	
Salinity				+	-	*		
pH	+	+	-		-	*	*	
Ecological								
Growth season length	+	+	*				*	+
Food chains, succession	*	*	*				*	
Blue-green algae	+	+	+			+	+	
***) Problems**								
Eutrophication (E)		+			-	+	+	
Oxygen depletion (O)	+					+	+	
Hygiene (H)								
Salinization (S)					-	*		
Acidification (A)	-					+	-	
Toxicity (X)								
Turbidity (M)	*	+	+			+		
Thermal (T)	+	+	*	+				

Global comparisons are difficult

It is fairly complicated to carry out any global comparisons on water quality issues and problems, due to the many-sidedness of the question, and given the present data sets. Water quality consists of a number of criteria, and their relation to the very varied water uses, differ greatly.

These comparisons are not as accurate as many national ones, such as (see China's national assessment in Box 6.3a), but they allow regional comparisons. And they are in rapid development all the time. As an example, the water quality indicators for the twenty-one rivers of the study regions (Figure 6.3c) that are among the eighty-two rivers in the world that are included in the summary table of the GEMS/WATER database (GEMStat 2006) are shown in Figure 6.3d.

This system was established in 1976 by WHO, UNESCO, WMO and UNEP, and includes 287 river stations, sixty lake stations, and seventy-six groundwater aquifers. A digital water quality atlas is also available.

Water quality in freshwater assessments

Water quality deterioration has been almost neglected in contemporary global water assessments (Chapter 2.4). This is a severe handicap of those assessments. Water may be abundant, but the decreased quality is often a major obstacle for human uses as well as to the ecological balance in a watershed. No amount of water is sufficient, if its quality is deteriorated.

One exception is the UNEP/GEF study on global international waters. Global Environmental Facility initiated the Global International Waters Assessment (GIWA) project with the aim of providing comparable information on the state of international waters. The methodology was designed to integrate as many problems and their root causes as possible using a causal chain approach. The assessment is based on the result of expert panels that evaluate the status of the waters using a standard protocol. The world is divided into sixty-six regions, which include the major rivers and the adjacent marine areas.

The GIWA project is still ongoing at the time of writing, but the available results with respect to the study regions are collected in Table 6.3e. Among those sixty-six regions, eleven lie in the five study regions China, S Asia, SE Asia, the Nile basin countries and W Africa.

With all respect to GIWA's results, one cannot avoid some cynicism to the results by looking them a bit more carefully: one among myriad examples is that Lake Chad—even though having lost 90% of its surface area—does not seem to be considered as a particularly problematic area by GIWA. One could continue with such strange examples.

Rehabilitation of damaged watersheds

With the intensive exploitation of nature, it is typical that the so-called natural aging processes of the ecosystems are dramatically accelerated. Many water quality problems such as eutrophication, turbidity, and oxygen depletion, change the ecosystems in the same direction as their natural aging. For instance, the eutrophicated Lake Tuusulanjärvi, Finland, ages with a rate of roughly 100 times of the natural rate. In global scale, an example can be taken from the loss of biodiversity (see Chapter 6.5).

Many water quality problems are also related to the opening of material cycles. This issue is discussed in more detail in Chapter 6.1.

Pollution prevention was mentioned as one of the leading contemporary paradigms in water management in Chapter 3.1. With the other mentioned paradigms it addresses the observation from innumerable cases that remediation of damaged watersheds, lakes, rivers, etc., is typically exceedingly more expensive than prevention of the damage beforehand (Box 6.3b). The dilemma is, that usually there is no political pressure to take the actions before the problems turn visible to the society.

In many industrialized countries, formerly constructed rivers and watersheds are being increasingly rehabilitated closer to their natural state. Thus tendency is a response to the recognition of the importance of natural ecosystems in issues such as self-purification of water, flood control, and landscape formation. Naturally, it also reflects the changed values and tastes concerning the exploitation of surface waters.

Box 6.3a

Required reversal of environmental degradation in China

China is extremely short of natural resources, given its dense population. An analysis of the Chinese Academy of Sciences noted that "China's environmental pressures already exceed the critical equilibrium limits of many ecosystems" (Chinese Academy of Sciences 1992; Niu and Harris 1996). Reversing the environmental degradation is an expensive exercise. The World Bank (1997) estimated, that 1-2% of GDP will be required to address water and air pollution. This is a large figure, but it must be seen against the economic losses due to pollution, which equals 8% of GDP.

China has suffered from severe inefficiencies in its production system. A high volume of emissions in relation to produced wealth is a clear indication of this (Box 6.1a).

The consequences of high emissions and high population density are clearly visible in China's water, air and land resources. The nitrate and ammonium concentrations doubled in the Huang He and the Yangtze rivers in the 1980s (Zhang et al. 1995). Frequent, severe eutrophication problems can be observed in all major Chinese river systems. Surface water quality problems are most oppressive in the water-scarce parts of China (Figure 6.3b). This tendency is enhanced by the rapidly deteriorating groundwater situation—both in terms of quality and quantity—in the North China Plain (ADB 2000).

Figure 6.3b

China's Northern Plain suffering from severe water scarcity has also great water quality problems

Water quality in major river basins of China in 1996 (after Shen and Dafoe 1998). The Chinese surface water quality classification was used (classes 1 & 2: good, class 3: moderate, and classes 4 & 5: poor).

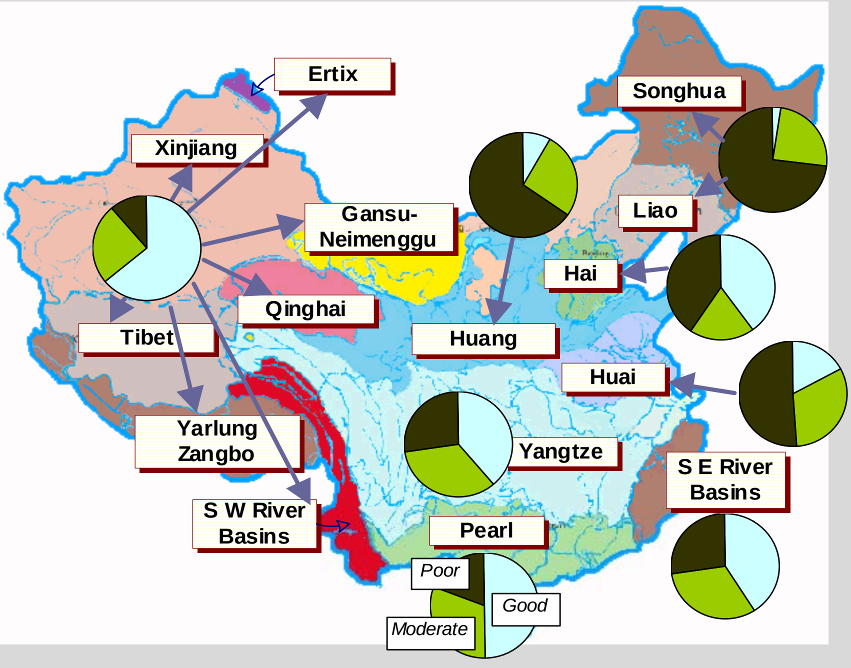


Table 6.3d

Surface water quality interconnections

*Cross-impact matrix for interconnections among factors of surface water quality: + = same direction, - = opposite direction, * = indefinite, case specific or unknown direction (Varis and Somlyódy 1996).*

Influence from		To[a]														
Climatic inputs		St	If	Fl	Dr	El	Rt	Wl	Ox	Ca	Nu	Sa	pH	Gs	Fs	Na
Temperature		*	+	*	*		*	*	*	*		+		+	*	+
Humidity		*		+	-	*	-	+				*			*	
Solar radiation		*	+	*	*				*	*			*	+	*	*
Precipitation		*	*	+	-	+	-	+	*	*	*	-	*		*	
Winds		*	+	*	*	+			*	*	*	*	*		*	*
Thermal & hydraulic	([a])	St	If	Fl	Dr	El	Rt	Wl	Ox	Ca	Nu	Sa	pH	Gs	Fs	Na
Stratification	St		*				*	*	*	*	*		*	*	*	*
Ice free period	If	*		*		*			*	*	*		*	+	*	+
Hydrologic		St	If	Fl	Dr	El	Rt	Wl	Ox	Ca	Nu	Sa	pH	Gs	Fs	Na
Floods	Fl	*	+		-	+	-	+	*	*	*	-	*	*	*	*
Droughts	Dr	*	*	-		*	+	-	*	*	*	+	*	*	*	*
Erosion, loading	El			*	*				*	*	+	+	*		*	*
Retention time	Rt	*	*	-		*		*	*	*	+	+		+	*	+
Water level	Wl	*	*	*	-	*	*		*	*	-	-			*	-
Chemical		St	If	Fl	Dr	El	Rt	Wl	Ox	Ca	Nu	Sa	pH	Gs	Fs	Na
Oxygen	Ox					*				*	-		*		*	*
Carbon dioxide	Ca					*			*			+	-		*	*
Nutrient enrichment	Nu								*	*		+	*		*	+
Salinity	Sa	*	+												*	*
pH	pH					*			*	*	*	*			*	+
Ecological		St	If	Fl	Dr	El	Rt	Wl	Ox	Ca	Nu	Sa	pH	Gs	Fs	Na
Growth season length	Gs								*	*	*		*		*	+
Foodchains, succession	Fs								*	*	*		*			*
Nuisance algae	Na								*	*	+		+		*	

Figure 6.3c

Selected, major rivers of the study regions

1 = Chang Jiang, 2 = Hong He, 3 = Huang He, 4 = Xi Jiang, 5 = Brahmaputra, 6 = Ganges, 7 = Indus, 8 = Cauveri, 9 = Godavari, 10 = Krishna, 11 = Mahanadi, 12 = Narmada, 13 = Tapti, 14 = Chao Phaya, 15 = Irrawaddy, 16 = Mekong, 17 = Salween, 18 = Nile, 19 = Chari, 20 = Niger, 21 = Senegal. For selected data from the GEMS/WATER database, see Figure 6.3d.

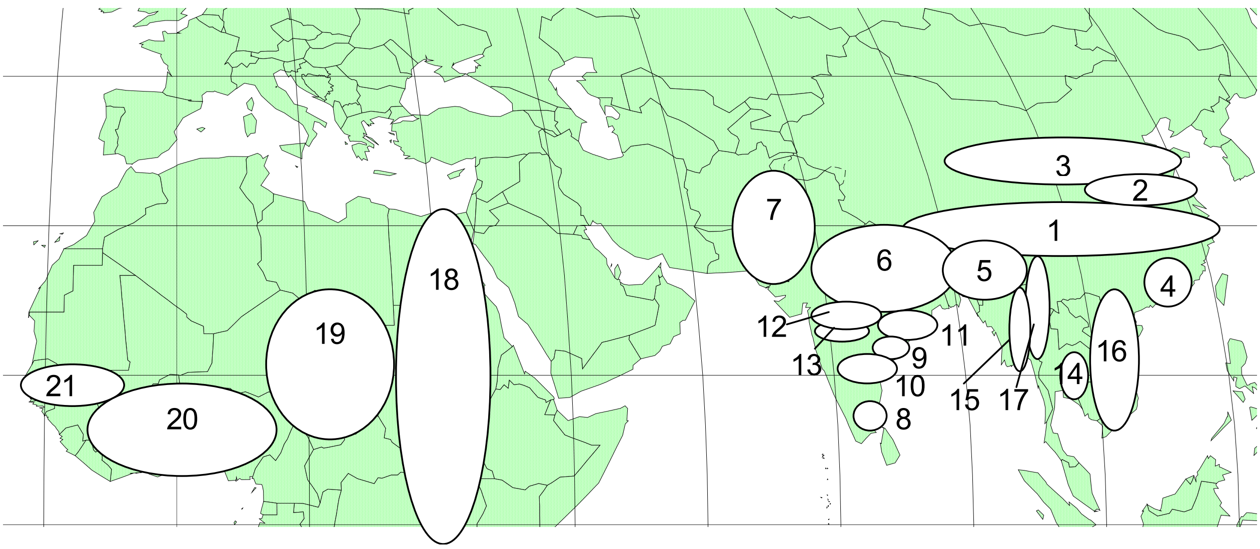


Figure 6.3d

Water quality comparison of the major rivers of the study regions

Water quality and watershed data from the GEMS/WATER database (GEMStat 2006). The data has been scaled to the average situation within the eighty-two world's major rivers included in the summary table of the database. This was done by subtracting the mean value of each indicator from each river's indicator value, and dividing it by the standard deviation of that indicator. For instance, the value eight of the TSS indicator for the Huang He river in China means, that the river contains eight times more TSS than the standard deviation among all the rivers included. All the values that exceed one can be considered exceptional. Area = area of the watershed, Discharge = water flowing through the intersection in which the measurement is made, Runoff = water flow as scaled with watershed area, TDS = total dissolved solids, TSS = total suspended solids, (f) = mass flow, Na = sodium, K = potassium, Ca = calcium, Mg = magnesium, Cl = chloride, SO4 = sulphate, HCO3 = bicarbonate, SiO2 = silicate, PO4-P = phosphate, NO3-N = nitrate.

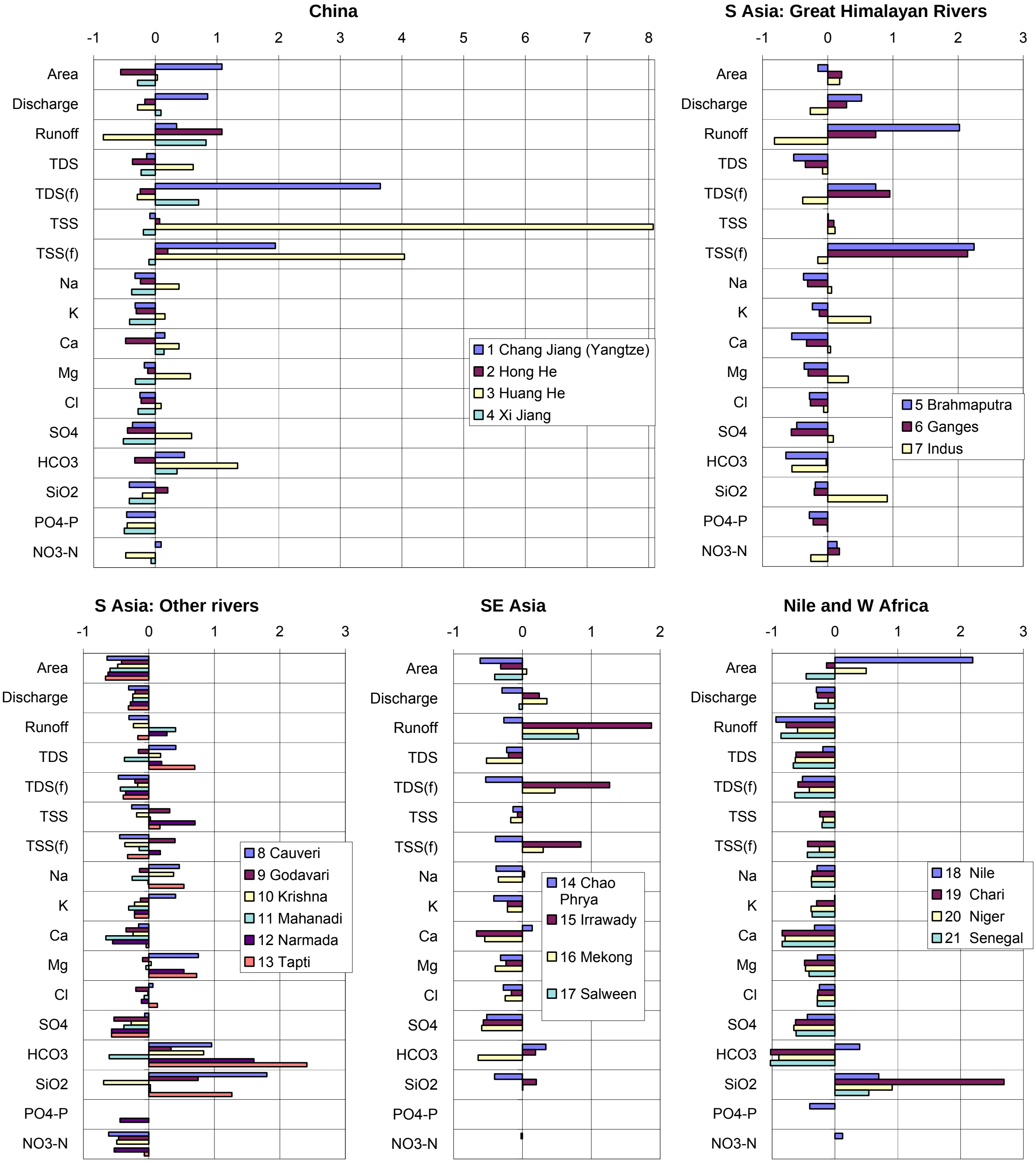


Table 6.3e
Results of GIWA with respect to the areas that fall in the study regions (GIWA 2003)

Legends	
No impact	
Slight impact	
Moderate impact	
Severe impact	

	Mediterranean	Yellow Sea	Bohai Sea	East-China Sea	Canary Current S	Gulf of Guinea	Lake Chad	Arabian Sea	Bay of Bengal	South China Sea	Mekong River	Sulu-Celebes Sea	Indon.Sea, Sunda
I Freshwater shortage		Moderate	Moderate	Moderate	Moderate	Moderate	Moderate			Moderate		Moderate	Moderate
- Modification of stream flow		Moderate	Severe	Slight	Slight	Severe	Severe			Moderate		Moderate	Moderate
- Pollution of existing supplies		Moderate	Moderate	Moderate	Slight	Slight	Severe			Slight		Moderate	Severe
- Changes in the water table		Moderate	Severe	Moderate	Moderate	Slight	Moderate			Moderate		Moderate	Moderate
- Economic impacts		Moderate	Slight	Slight	Moderate	Moderate	Moderate			Moderate		Moderate	Severe
- Health impacts		Slight	Slight	No	Moderate	Moderate	Moderate			Slight		Slight	Severe
- Other social and community impacts		Slight	Slight	No	Slight	Moderate	Slight			Slight		Slight	Severe
II Pollution		Moderate	Moderate	Moderate	Moderate	Moderate	Slight			Moderate		Moderate	Severe
- Microbiological		Moderate	Moderate	Slight	Slight	Moderate	Severe			Moderate		Slight	Slight
- Eutrophication		Severe	Severe	Severe	Moderate	Slight	Slight			Slight		Moderate	Moderate
- Chemical		Slight	Moderate	Slight	Moderate	Slight	Slight			Moderate		Slight	Moderate
- Suspended solids		Slight	Slight	Slight	Moderate	Moderate	Slight			Severe		Severe	Severe
- Solid wastes		Moderate	Moderate	Slight	Moderate	Severe	Slight			Moderate		Moderate	Severe
- Thermal		Slight	Slight	Slight	No	Slight	No			Slight		Slight	Slight
- Radionucleides		No	No	No	No	No	No			No		No	No
- Spills		Slight	Severe	Slight	Slight	Moderate	No			Moderate		Slight	Moderate
- Economic impacts		Moderate	Moderate	Slight	Slight	Moderate	Slight			Moderate		Moderate	Severe
- Health impacts		Slight	Slight	Slight	Slight	Moderate	Slight			Moderate		Moderate	Severe
- Other social and community impacts		Slight	Moderate	Moderate	Moderate	Moderate	Slight			Moderate		Moderate	Severe
III Habitat & community modification		Severe	Severe	Moderate	Severe	Moderate	Moderate			Severe		Severe	Severe
- Loss of ecosystems or ecotones		Severe	Moderate	Moderate	Severe	Moderate	Moderate			Severe		Severe	Severe
- Modification of ecosystems or ecotones		Severe	Severe	No	Severe	Moderate	Moderate			Severe		Severe	Severe
- Economic impacts		Moderate	Severe	Slight	Severe	Moderate	Slight			Severe		Severe	Severe
- Health impacts		No	Slight	No	Severe	Slight	Slight			Slight		Moderate	Slight
- Other social and community impacts		Moderate	Severe	Moderate	Moderate	Moderate	Slight			Severe		Severe	Severe
IV Unsust. exploitation of Fisheries		Severe	Severe	Moderate	Moderate	Moderate	Moderate			Severe		Severe	Severe
- Overexploitation of fisheries		Severe	Severe	Severe	Severe	Moderate	Slight			Severe		Severe	Severe
- Excessive bycatch and discards		Slight	Severe	No	Moderate	Moderate	Moderate			Severe		Severe	Severe
- Destructive fishing practices		Severe	Severe	Severe	Slight	Moderate	Moderate			Severe		Severe	Severe
- Decreased viability of stocks		Slight	Moderate	Moderate	No	No	No			No		Slight	Severe
- Impact on biological & genetic diversity		Moderate	Severe	Slight	Moderate	No	No			Moderate		Severe	Severe
- Economic impacts		Severe	Severe	Moderate	Severe	Moderate	Moderate			Severe		Severe	Severe
- Health impacts		No	Moderate	Slight	Slight	Moderate	Moderate			Moderate		Severe	Slight
- Other social and community impacts		Severe	Severe	No	Moderate	Moderate	Slight			Severe		Severe	Severe
V Global change		Slight	Slight	Slight	Moderate	Moderate	Moderate			Slight		Slight	Slight
- Changes in hydrological cycle		Slight	Slight	Slight	Moderate	No	Moderate			Slight		Slight	Moderate
- Sea level change		Slight	Slight	No	Slight	Slight	Moderate			No		Slight	No
- Increased UV-B radiation		No	No	No	No	No	Slight			Slight		Slight	Moderate
- Changes in ocean CO_2 source/sink		No	No	No	No	No	Slight			No		No	No
- Economic impacts		Slight	Severe	No	Moderate	Slight	Moderate			Slight		Slight	No
- Health impacts		Slight	Slight	No	Moderate	No	Slight			Slight		Slight	No
- Other social and community impacts		Slight	Moderate	Slight	Moderate	No	Slight			Slight		Slight	No
Coverage of the five study regions (+ indicates that also other areas are in-cluded)	Nile Basin +	Central China (Yangze etc.)	North China Plain	SE China	Mauritania, Senegal, Gambia +	W Africa exc. Canary & Chad +	Chad Basin	Pakistan, W India +	E India, Bangladesh +	Vietnam, S China, Philippines +	Mekong Basin	Parts of Indonesia	Parts of Indonesia

Box 6.3b
Environmental vicious circles
An example of lake eutrophication.

Environmental problems—such as deterioration of surface water quality—are often complex consequences of mutually connected processes that perpetuate one another. Such vicious circles tend to be difficult and costly to break, once they are in full force (Varis 1999). Many environmental vicious circles are known well enough in theory. However, over and over again, such circles are set in full speed instead of preventing them beforehand.

Prevention of environmental vicious circles would, though, be in most cases a far more economic option in the long run than the other alternative: letting the problems grow visible, and acting only with a considerable lag after that—a lag that seems to be necessary for political argumentation.

At present, one of the slogans in emerging economies is *first pollute, then clean* (Figure 6.3e). The argumentation goes in the following way: *"…now there is no money to take care of environmental pollution. We have to put all the efforts to build up the economy. Once the money is there, the time is right for environmental investments".*

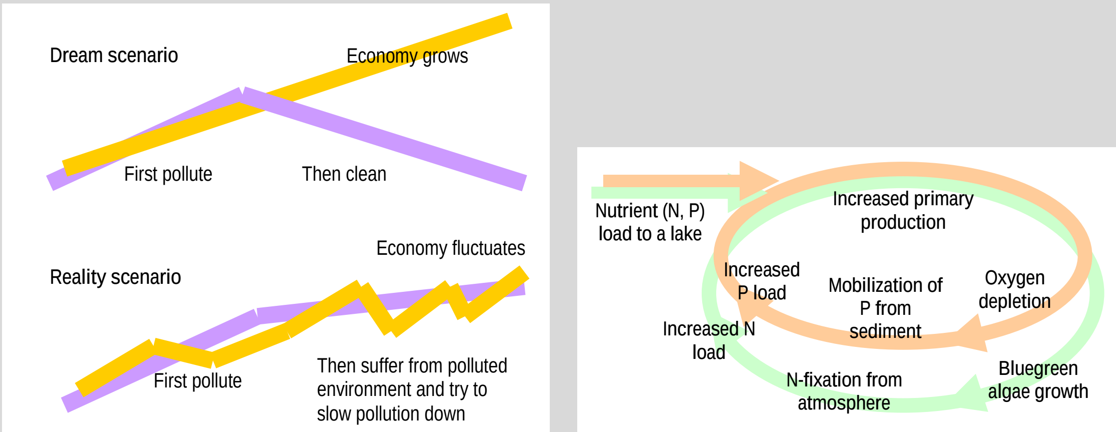
It has been shown too many times, that such solutions become extremely expensive, once the damages have been done, and the vicious circles keep on running although the external conditions have been improved by environmental investments.

One of the myriad of such vicious circles, or actually a pair of circles, is related to the eutrophication process of a lake. External nutrient loading, particularly phosphorus (P) and nitrogen (N), enhances the growth of phytoplankton and macroplants. This causes increased consumption of dissolved oxygen, due to degradation of more and more organic material. In oxygen-poor conditions, P plus many other harmful substances are mobilized from the bottom sediments and they, in turn, further boost primary production.

In parallel, increased nutrient concentrations favor the growth of bluegreen algae (known also as Cyanobacteria), which are able to fix N from the atmosphere to the ecosystem. This fertilizes the lake further, and enhances the growth of primary producers. Many bluegreen algae strains are toxic, being therefore very harmful to almost all uses of water.

Breaking these vicious circles has been found highly expensive in innumerable cases in Europe, North America and increasingly in other continents as well. Despite of that, the investments to wastewater treatment, diffuse pollution control, industrial waste management, etc., tend to come too late. The political will is evidently difficult to raise before the problems emerge visible. In that instant, the vicious circles are already in place.

Figure 6.3e
Pollution first then clean policy often creates vicious circles that are difficult to cut later
Left: The first pollute—then clean philosophy tends to produce problems, which became much more expensive to solve afterwards than prevent beforehand. Right: Once the vicious circles are there, the removal of external load is no longer enough when restoring the ecosystem. The vicious circles must be broken. This tends to be difficult and, in many cases, has proven extremely expensive.



6.4 Groundwater degradation

Tommi Kajander

Groundwater is one of the main sources of freshwater, making up a substantial portion of the supply in many areas. It serves domestic and municipal supplies and irrigation. Its importance of a reliable and high-quality source is rapidly increasing, but the groundwater resources are deteriorating with an alarming rate. This causes, besides widely reaching social and economical problems, also ecological damage such as desertification.

Quantity

Groundwater table is subject to natural variations, depending on seasonal weather patterns, and variations in longer term. Water use has caused wide-reaching changes into these natural patterns; either by causing the sinking or rising of the water table. Both can be harmful, and indeed cause problems, both to nature and to water use in increasing number of locations in the world. As any scarcity, it adds to the conflict potential of the water system and the society.

In the area of Beijing, China, the water table was within five meters in many locations in the 1950s. Now, the water table has sunk to fifty meters due to excess exploitation of the resource: More than 40,000 wells are used to pump the water with a rate that severely exceeds the natural recharge of the aquifer (Smil 1993). In Northern China alone, over 100 million people are living in an area of remarkably lowered groundwater tables (Brown 1996). This type of overexploitation of aquifers is known as *groundwater mining.*

The number and extension of groundwater resources that are overexploited is in rapid and continuous growth. Take two examples from Northern Africa (UNESCO 1995). In 1990, Libya used more than sixfold (644%), and Egypt almost all (92%) of the volume of water which can be considered renewable. The estimates for 2010 are 1900% for Libya and 110-120% for Egypt, and for 2025, they are 2800% and 160-190%. In both countries, irrigation accounts for over 90% of the water use.

India, Pakistan and China, with their annual groundwater use of over 300 km^3, are responsible for nearly half of the world's total annual use (Shah et al. 2001). In the Indus valley in Pakistan, the groundwaters are exploited with over two times the rate, which would be sustainable and would not cause salinization of water and land. In the United States, around 25% of watered land is irrigated by drawing down groundwater tables. In Iran this proportion is 1/3, and in China, 10% (Brown 1996, Gardner 1996). This direction of development is clearly unsustainable, and causes far-reaching changes in the nature and makes groundwater exploitation growingly expensive and demanding.

Many sides of groundwater depletion

Unsustainable extraction of groundwater resources leads to multifaceted problems. Depletion has adverse impacts in economical, social and environmental dimensions. The following describes some of the commonly occurring problems due to the groundwater overexploitation.

In many places the groundwater depletion has resulted in significant increase in pumping costs. In the urban West Java, where the groundwater extraction exceeded the recharge rates in 1970s, the real pumping costs rose by 250% between 1980 and 1988 (Braadbaart 1997). The rapidly falling groundwater table will increase not only the pumping costs but also the construction costs. Shah et al. (2001) note that in Punjab, Pakistan, construction of a tubewell with a depth to water table of fifteen meters costs twice the amount of a well up to six meters. The groundwater depletion has thus lead to social inequity as the poorest farmers cannot afford the rising total costs of groundwater irrigation and suffer in terms of decreased farm income.

Wetland ecosystems (see Chapter 6.5) are often sustained by groundwater discharges. As a result of falling groundwater tables many of the world's major wetlands are threatened (UNEP 1996). Drying out of springs and streams is another adverse environmental effect due to excessive pumping of groundwater resources. Jinan city, the city of springs, in Shandong province, China, has lost significant tourism revenues and urban water supplies consequent upon the drying out of springs (Zaisheng 1998). In Andhra Pradesh, India, overexploitation of groundwater has led to drying out of major portion of Pennar River and some other rivers. This has resulted in low farm incomes (Babu Rao et al. 2001).

Lowering of groundwater table may lead to land subsidence, which increases the threat of flooding and damages infrastructure. Sinking of ground surface has widely occurred and is severe in places. In northern China where overexploitation of groundwater is fierce land subsidence and even collapses are reported. Regions of Tianjin city have subsided to below sea level, which has led to the construction of an embankment to protect the area. In Cangzhou city, Hebei, land subsidence has exceeded 1.5 meters while in Tangshan city karst collapses have occurred in twenty places extending over an area of 20 km^2 in downtown (Zaisheng 1998). Problems of land subsidence have also been faced in e.g. Bangkok, Jakarta, and Mexico City.

One of the troublesome effects of groundwater depletion is the saline intrusion in coastal aquifers. Excess pumping of groundwater reduces the groundwater gradient and outflow. Consequently the sea water starts to flow into the aquifer and the salt concentration of groundwater increases. The problem is of great concern as coastal areas are often densely populated and supplied by groundwater from coastal aquifers.

Pollution of groundwater due to seawater intrusion is occurring nearly in all populated coastal areas of the world (Zaporozec and Miller 2000). Serious problems, which often result in the loss of major water supplies, have been faced in many large cities including e.g. Bangkok, Jakarta, and Manila. Salt-water pollution is widely documented on India's and China's coasts as well.

In the West Indian state of Gujarat the coastal strip generated great prosperity during the 60s and 70s. The agriculture irrigated by overpumping of groundwater faced however rapid collapse due to the expeditious seawater intrusion extending seven kilometers inland. In China the problems are concentrated in the northern coastal parts where an area of 2,000 km^2 has groundwater levels below those of seawater. Due to the seawater intrusion 8,000 wells have been abandoned and over one million people have problems in assessing suitable drinking water (Shah et al. 2000, 2001).

Groundwater degradation in terms of rising water tables may also lead to salinization. Chiefly due to over-use of water in irrigation, the groundwater table is subjected to rising in many locations. For instance, in Punjab, irrigation schemes have raised the groundwater table seven to nine meters above the long-term level (Thanh and Tam 1990b). This type of development often leads to increased evaporation from the soil and to salinization. This causes loss of the soil productivity, and salinized fields have to be abandoned.

Quality

Groundwater quality problems can be caused by many different mechanisms. The contaminants can be clustered into the following categories:

- *Physical*: temperature, changed viscosity, color, etc.
- *Inorganic chemical*: salts (K^+, Na^+, Ca^{++}, Mg^{++}, $SO4^=$, Cl^-, etc.), acidity (pH), hardness, plant nutrients (nitrogen compounds etc.), etc.
- *Trace elements* such as heavy metals and radioactive compounds.
- *Organic chemical*: a variety of substances such as halogenated hydrocarbons and hydrocarbons.
- *Bacteriological*: pathogenic bacteria for humans or animals.

Natural groundwater contamination

When considering the natural contamination of groundwater the contaminants fall into the category of inorganic chemicals. The most widely naturally occurring constituents, which unfortunately are also hazardous for human health, are fluoride and arsenic.

Naturally occurring fluoride contamination of groundwater, originating from earth's minerals, is a global and widely spread problem. The adverse health impacts caused by long-term ingestion of fluoride include dental fluorosis and with heavier doses i.a. skeletal fluorosis, bone cancer, premature aging and mental retardation.

Endemic fluorosis is found in at least twenty-six countries. Countries affected in the study regions include at least China, Bangladesh, India, Pakistan, Thailand, Egypt, Ethiopia, Kenya, Tanzania, Uganda and Senegal (Qian et al. 1999). In China the areas with high occurrence of fluorosis cover 20% of the country, the most severely affected areas being located in the N and NE parts of China. In the Inner Mongolia alone 1.9 million people were suffering from dental fluorosis and 230,000 from the skeletal fluorosis (Wang et al. 1999). In the Hebei and Gansu provinces altogether at least 4.6 million people are suffering from fluoride-induced health problems.

In India the problem is even worse. It is estimated that more than 60 million people are drinking water with fluoride concentration exceeding the WHO guideline value 1.5 mg/l. Badly affected areas are found among others in the western parts of India (i.a. Gujarat, Rajasthan), in the east coast (i.a. Andhra Pradesh, Orissa) and in the state of Assam.

Naturally occurring arsenic contamination of groundwater has arisen to one of the top groundwater quality issues. This is due to the highly toxic and carsinogenic nature of arsenic. Long-term ingestion of arsenic causes skin lesions and may lead to cancer.

Naturally appearing high concentrations of arsenic in groundwater are due to iron compounds, which release arsenic in anoxic conditions (McArthur et al. 2001). So far the worst arsenic contamination of groundwater has occurred in the Bengal Delta in Bangladesh and India (Box 6.4) where millions of people have been exposed to excessive levels of arsenic. More recently, high levels of arsenic have been found in the city of Hanoi in Vietnam (Berg et al. 2001). Out of the tap water samples investigated, half contained arsenic concentrations exceeding the Vietnamese standard of 0.05 mg/l. When additionally considering that water from the tubewells was equally contaminated (48% of the samples above the limit) it can be stated that several million people might be at risk of chronic arsenic poisoning.

The both two naturally occurring arsenic contamination cases summarized above, Bengal Delta and Hanoi, have common factors. These are alluvial sediments rich in iron compounds and anoxic conditions; both found in the aquifers of Bengal Delta and Red River alluvial tract. In consequence there exist potential areas for arsenic groundwater contamination including the Mekong Delta and other deltas, which are composed of organic matter and alluvial sediments.

Anthropogenic contamination

The anthropogenic (human induced) contamination of groundwater can be caused in many ways. Table 6.4 summarizes some typical sources of contamination after which the most common sources including domestic, agricultural and industrial are discussed. More details on groundwater quality, see McCuthcheon et al. (1992) and on transport of contaminants, see Mercer and Waddell (1992).

Box 6.4

Arsenic contamination of groundwater in Bangladesh

As a highly toxic chemical, arsenic is threatening the health of millions in Bangladesh. The arsenic problem is widely spread and as a natural process has occurred for decades in the groundwater. The good intentions of UNICEF, i.e. funding of 900,000 tubewells, have had unforeseen results.

The arsenic problem was recognized for the first time in the Indian state of West Bengal in 1983, when the first arsenicosis patients were identified. Not until 1993 was the arsenic contamination of groundwater discovered in Bangladesh. Gradually the scale of the problem started to become evident.

According to the DPHE-UNICEF testing program, with 51,000 sampled tubewells, arsenic concentrations exceeded the national drinking water standard of 0.05 mg/l in 29% of the tubewells (UNICEF 1999). The greatest number of high-arsenic wells is located in the south and southeastern parts of the country. The highest percentage of contaminated wells is found in the lower aquifer between 28 and 45 m (McArthur et al. 2001). Out of the deep wells with a depth exceeding 150 m just 1% were contaminated.

In terms of the population exposed, the situation can be considered as a national health hazard. BGS and DPHE (2001) give an estimate of 35 million people, who rely on contaminated drinking water. The long-term use of polluted water has led to severe health problems. The number of seriously affected people, suffering mainly from melanosis and keratosis, has risen to 7000 (Karim 2000).

The actual cause of the contamination has been explained by three differing theories, until McArthur et al. (2001) indicated that the oxyhydroxide (FeOOH) reduction theory was accurate. Under anoxic conditions FeOOH is microbically reduced and releases its sorbed load of arsenic to groundwater. The reducing conditions emerge when organic matter in the sediments is microbically degraded and the dissolved oxygen is depleted. Hence, in the case of Bangladesh, human activities have an insignificant effect on the arsenic concentrations in groundwater.

The contamination of the groundwater has many intractable aspects. Due to the considerable well to well variability over the scale of few kilometers, predicting of arsenic concentrations in unsampled wells is difficult. Additionally, spots with unusually high concentration of arsenic occur in areas where As concentrations are generally low (British Geological Survey 2000). The aquifer flushing is very low due to the extremely low hydraulic gradients. This means that the disappearing of arsenic from the groundwater takes tens of thousands of years.

The arsenic contamination of groundwater is a difficult problem for the poor Bangladesh to solve by its own. This is realized by numerous international organizations, which are involved in the arsenic mitigation activities; the largest project being the World Bank financed BAMWSP with a budget of US$ 32.4 million. The arsenic mitigation activities target e.g. to raise the common awareness about the dangers of arsenic, provide safe water by new water supply facilities and simple filter devices, test existing tubewells, and promote health care.

Table 6.4.
Groundwater contamination.
*Major sources of groundwater contamination and types of contaminants and their relative significance. P = physical, I = inorganic chemical, T = trace elements, 0 = organic chemical, B = bacteriological. Empty cell = minor, + = secondary, ++ = primary, and * = variable impact (Todd et al. 1976, Mackay 1990).*

Source	P	I	T	O	B
Municipal					
Sewer leakage		++	+	++	++
Sewage effluent		++	+	++	++
Sewage sludge		++	++	++	++
Urban runoff		+	*	++	
Waste disposal		++	++	++	+
Septic tanks and cesspools		++		+	++
Agricultural					
Leached salts		++			
Fertilizers		++	+	+	
Pesticides				++	
Animal waste		++		+	++
Industrial					
Cooling water	++		++		
Process waters	*	++	++	*	
Water treatment, plant effluent		++	+		
Hydrocarbons	+	+	+	++	
Tank and pipeline leakage	*	*	*	*	
Oilfield wastes					
Brines	++	++	++		
Hydrocarbons	+	+	+	++	
Mining		++	*		
Miscellaneous					
Surface water	*	*	*	*	*
Sea water intrusion	++	++	++		
Transport				++	*

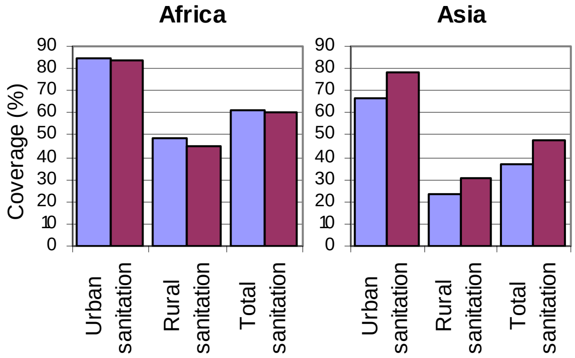
Urban groundwater pollution

High population growth and urbanization are increasingly loading the urban environments. The quantities of sewage are growing while the sewerage and waste water treatment facilities are still underdeveloped. Over half of the Asian population is living without sanitation facilities (Figure 6.4a). Sewage is often discharged in open drains, surface waters or directly on the soil, which causes leaching of contaminants (e.g. pathogens, nitrate) and thus pollutes the groundwater (See also Chapter 10.3).

Another major factor contributing to groundwater pollution as a municipal source is waste disposal. In developing countries the dumping places are often poorly constructed or non-existent although the volume of waste is increasing rapidly. Waste masses produce leachate that pollutes groundwater.

Groundwater quality deterioration is common in the vicinity of large cities in the developing world. In Karachi, the largest city in Pakistan with twelve million residents, the contaminated groundwater is inducing health hazards as it has became a major source for water supply. The groundwater is so polluted that it contaminates the municipally supplied piped water through the worn-out distribution system (Rahman 1996). No wonder, as the sewage from the sewerage shortfall and leakage from the water and sewerage lines forms over half of the groundwater recharge. Similar problems of water contamination are noted in other Asian megacities like Jakarta and Manila as well.

Figure 6.4a
Sanitation coverage in Africa and Asia in 1990 and 2000.
The proportion of population with access to excreta disposal facilities during the last decade has increased significantly in Asia. Meanwhile in Africa the sanitation coverage has decreased (WHO and UNICEF 2000).



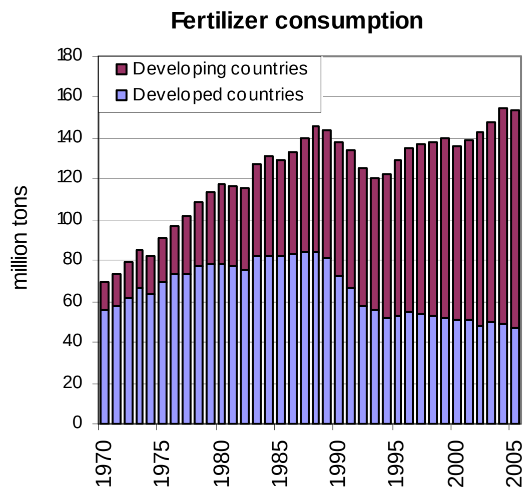
Urban wastewater recharge containing high amounts of organic substances produces readily reducing conditions in shallow groundwater. Lawrence et al. (2000) report about groundwater contamination beneath the city of Hat Yai in Thailand due to the strongly reducing conditions in the upper layer of the aquifer attributable to urban wastewater seepage from canals. This has led to elevated concentrations of ammonium, bicarbonate, iron and manganese, and to very high concentrations of arsenic. In Merida, Mexico, dissolved oxygen concentrations of groundwater in the upper part of the aquifer, have significantly been reduced in places (Graniel et al. 1999). Thereupon ammonium (NH_4^+) concentrations have increased.

Groundwater pollution of domestic origins is arising in Africa. In W Africa, the bacteriological pollution of groundwater caused by inadequate sanitation is considered the most important problem concerning groundwater quality (Ministère de l´Environnement et de l'Eau 2000). A study carried out in Burkina Faso in 1985 showed that 10-20% of the boreholes and 70% of the traditional wells were contaminated. In suburban areas of Dakar, Senegal, nitrate concentrations in the groundwater were on the average fourfold compared to the national drinking water standard (Tandia et al. 1999).

Agricultural groundwater pollution

As a major cause of groundwater degradation, agriculture does have a significant effect on groundwater quality. Population growth and the degradation of cultivated areas are creating a severe pressure on agricultural production in the developing world. To achieve increased crop yields, intensification of farming practices has widely taken place (see Chapter 9.1). Unfortunately this has meant the use of larger quantities of chemical fertilizers and pesticides (Figure 6.4a), which often leads to the pollution of groundwater resources. At present developing countries are using seven times more fertilizers than three decades ago.

Figure 6.4b
Fertilizer consumption in the developed and developing countries.
Fertilizer consumption in developing countries exceeded the consumption of the developed countries in the early 1990s and is growing fast (IFA 2006).



When considering the fertilizer consumption per hectare of arable land by countries in 2001 (World Bank 2004) it can be noticed that SE Asia is well represented. Out of the study region's countries Malaysia is leading the statistics with 628 kg of fertilizers used per hectare followed by Egypt (457 kg/ha), Vietnam (308 kg/ha), China (246 kg/ha) and Bangladesh (168 kg/ha). However high fertilizer application rates do not necessarily signify groundwater pollution as the leaching of agro-chemicals depends also on precipitation, soil properties, methods and rates of fertilizer applications, and crop cover. For example in Asia and Pacific regions 70% of the fertilizers are used to grow wetland rice. The soils of paddy fields have low percolation rates and the leaching of fertilizers is minimal (Bijay-Singh et al. 1995). Besides the use of fertilizers, pesticides contaminate the groundwater resources.

The deterioration of groundwater quality has already occurred in places by the excessive use of agricultural chemicals. Novotny (1999) states that the most severe water quality problems have occurred in Central Europe, Belgium, the Netherlands, the United Kingdom and in some parts of North America. With the considerably increased fertilization rates, groundwater quality problems have been reported in the developing countries as well.

In China the nitrate pollution of groundwater by agriculture has became a serious problem. Li and Zhang (1999) indicate that nitrate leaching and subsequently increased NO_3-N concentrations is the main cause of the deterioration of groundwater quality in China. The problem is particularly bad in northern China. A study conducted in the mid-90s found that at over half of the locations investigated the nitrate concentration in ground and drinking water exceeded 50 mg/l, the allowable limit for drinking water (Zhang et al. 1996). The adverse effects of excessive NO_3 use on human health have already occurred in the 80s. Cancers were ranked ninth as a cause of death in the 50s but were among the first three in 90s. The groundwater pollution is worst in the vegetable producing areas, where the use of N-fertilizers is the most intensive. With the constantly growing use of fertilizers the situation is likely to get worse.

Agricultural groundwater pollution is rising in Africa as well. In Egypt, high concentrations of fertilizer induced nitrate, phosphate, sulfate, and potassium have been detected in groundwaters. Highest concentrations, exceeding the permissible drinking water levels in places, are found in the Nile Aquifer, Nile Delta, and Nile Valley (Shamrukh et al. 2001). The risk for further groundwater contamination of the Nile Aquifer is apparent especially in the reclaimed desert areas, where the hydraulic conductivity is high due to the absence of the clay-silt cap.

South Asia with intensively cultivated areas is facing groundwater quality problems due to the leaching of fertilizers. For example in the NW Indian states of Punjab and Haryana, the granaries of India, nitrate levels rising above the national standard of 45 mg/l, have been detected in one third of the groundwater samples (Malik 2000).

The agricultural pollution of groundwaters has reached a global scale. Especially excess concentration of nitrate in drinking water is of great concern as it is a risk factor for human health causing methemoglobinemia, various cancers and birth defects. As the removal of NO_3-N from groundwater requires costly and advanced technology, the prevention of agricultural pollution plays a crucial role. To minimize the agricultural contamination of groundwater resources, optimal irrigation and fertilizer regimes, combining high yields, minimal leachates production, and reduced pollution risks, should be defined and applied (Hadas et al. 1999). The optimal regimes are conditional on site, weather, crop-sequence, and agronomic-practice.

Industrial groundwater pollution

Discharging of untreated industrial wastewater and disposing of solid waste in streams and canals or directly on the ground pollutes groundwater. The worst polluters are usually small industries without wastewater treatment facilities, which produce paper and textiles, process leather, metals and other materials, and repair vehicles (UNEP 1996).

Degradation of groundwater resources due to industrial activities has occurred all around the globe. At present however the greatest potential of aquifer pollution is in the developing countries where industrialization has taken place but environmental aspects are less considered. Out of the reported contamination cases most of all are found in India. In the arid zone of Rajasthan an area of 219 km^2 along Bandi River has been contaminated by industrial effluents from textile units. Along the river course most of the wells have been abandoned due to highly polluted groundwater. In some wells the total dissolved solids (TDS) concentrations were tenfold in 1996 compared to the level of mid-60s (Khan 2001). Due to the industrial effluents severe pollution of groundwater including aquifers to a depth of 50 m has also been reported in Andhra Pradesh (Babu Rao et al. 2001).

Pollution of groundwater resources by industrial activities poses a particular threat to human health. Effluents contain frequently solvents and heavy metals, which are toxic or carcinogenic even in small concentrations.

Summary

The significance of groundwater resources cannot be undervalued. At least 1,500 million people use groundwater as drinking water (UNEP 1996). In addition groundwater is largely used for irrigation. For example in India 60% of the irrigation water is pumped from aquifers (Shah et al. 2001). The situation is however problematic. Groundwater use is increasing but its quality is deteriorating and has in many places already led to the abandonment of wells.

In China groundwater related problems have reached vast dimensions. The problems are mainly culminated in the North China Plain where severe overexploitation of aquifers is occurring. As a result adverse environmental impacts including e.g. land subsidence and drying out of springs and wells have been reported whereas seawater intrusion is polluting aquifers in the coastal areas. Natural contamination of groundwater by excess concentrations of fluoride causing high occurrence of fluorosis is a common problem in north and northeastern parts of China. In terms of groundwater quality agricultural pollution by fertilizers has became one of the main causes of groundwater degradation in northern China.

Out of the study regions S Asia is facing the most serious groundwater degradation. Overexploitation of aquifers is taking place at least in the Indus Valley, Pakistan and in western and southern India where the groundwater mining is causing salinity and increasing the pumping costs. Severe naturally occurring fluoride contamination of groundwater has widely been reported in India. Arsenic pollution and poisonings in the Bengal Delta in India and Bangladesh have gained wide attention as well. Degradation of groundwater by municipal and industrial pollution is common in the urban and semi-urban areas.

In SE Asia groundwater degradation is mainly concentrated in large cities. For example Bangkok is struggling with land subsidence and salinization of aquifers. Groundwater quality problems have also occurred e.g. in Manila and Jakarta due to municipal pollution and overexploitation of aquifers. High natural arsenic concentrations have been detected in Hanoi, Vietnam.

Groundwater pollution and its distribution in Africa is not well known. However leaching of fertilizers into groundwater is found at least in Egypt. Seawater intrusion into aquifers is becoming a problem in the Nile Delta and coastal areas of W Africa. In W Africa the bacteriological pollution of groundwater due to inadequate sanitation facilities is considered the most important problem concerning groundwater quality. Salinity is widespread as well.

6.5 Other ecosystems and the loss of biodiversity

Tommi Kajander and Olli Varis

The driving forces to global changes cause various pressures to wildlife, forests, other ecosystems, and the natural biodiversity. The daily, global rate of deforestation is 430 km^2, chiefly due to land acclamation to agricultural use. 24% of world's mammal species—and 65% of all freshwater mammals—are under threat of extinction. Biodiversity is one of the key elements of sustainability of the earth's ecological system.

Overview

In terms of their genetic and ecological diversity, both natural and cultivated ecosystems are under various pressures. This is due to many factors including modernization of agriculture, pollution, erosion, poverty and population growth, exploitation of ecosystems, climatic change, changes in land-use patterns, and many more. The loss of biodiversity, genetic erosion of cultivated species, forests and wildlife are discussed below after which freshwater and coastal ecosystems are dealt with.

Loss of biodiversity

According to UNEP's (1995) first global bodiversity assessment, the total number of currently identified species is around 1.7 million. Estimates on the actual number of species range from 3 to 111 million, and the current "best estimate" is 14 million.

50,000 species disappear each year in the world (Flavin 1997). Various other estimates suggest that between 1975-2015, 1-11% of all species will extinct (WRI 1996). Among the most threatened ecosystems are freshwater lakes and streams, coastal mangroves and coral reefs, and temperate rain forests (Wilson 1992). Biological resources of freshwaters are very rich, accounting for 12% of all animal species, 20% of which have already disappeared or are under severe threat (Abramovitz 1996).

The concept of aging of ecosystems was discussed in Chapter 6.3. In the context of biodiversity, it can be used as an illustrative manner: the rate of species extinction has been estimated to range between 100-1,000 times the "natural" rate. In the coming decades, it may still grow with one order of magnitude.

The major causes to biodiversity loss include:

- Pollution and sedimentation
- Species introduction
- Intense overexploitation
- Habitat loss

Loss of biodiversity weakens the capacity of ecosystems to adapt to changing conditions or extreme situations such as climatically exceptional years or periods, constituting a destabilizing factor.

An example of this is the widely distributed damages in Central and Eastern European forests due to acid rain in 1980s and also later. Monoculture forests have shown great sensitivity to combined effects of increased air pollution and dry seasons. In more general terms, it is a very risk prone approach to allow the biodiversity of ecosystems to decrease.

The strategies to the protection of biodiversity include separation of ecosystems species, and genetic resources from human activity by creating protected areas, prohibitions on harvesting threatened species, and the preservation of germ plasm through gene banks or cryogenic storage (UNEP 1995, WRI 1996).

The preservation strategies must include a variety of strategies such as creating controlled environments and policies to minimize the loss of biodiversity of natural environments. This calls for integrated approaches to conservation (for more details, see UNEP 1995 and WRI 1996).

Besides the ecological importance of biodiversity, FAO (1995a) underlines the crucial economic role of wildlife, indigeneous species and varieties, and traditional products and skills in utilizing them. More than 6,000 forest plants have traditionally been used as natural medicines. Many of them form a basis of modern products.

An estimate of US$ 100 billion each year has been presented as the economic value of this activity. The potential of all the unknown species as herbal plants is immeasurable, and of unquestionable importance.

Genetic erosion of cultivated species

The genetic biodiversity of cultivated plants and domestic animals has been under heavy manipulation during the last decades. Whereas plant and animal breeding—including genetic technology—aims at producing varieties that best meet the criteria of modern agriculture and forestry, an erosion of the genetic diversity follows.

This is because the new varieties push away the traditional, genetically less uniform varieties and species, which typically are less productive but offer great robustness. Since 1900, about 3/4 of the genetic diversity of agricultural crops has been lost (FAO 1995a).

Rhoades (1991) mentions that in Sri Lanka, the farmers grew some 2000 local rice varieties in 1959. Today, only a few principal varieties are grown, and most of the old varieties have extinct. In India, the number of rice varieties has been as high as 30,000, though nowadays most of the production comes from fewer than ten varieties.

Genetically uniform varieties, despite of many highly positive sides, have been the reason to widely distributed disasters due to unexpected epidemics, insect invasions, etc., that keep attacking new varieties. The importance of the conservation of traditional and wild species has been emphasized increasingly.

Forests

Before human influence, over 1/2 of the earth's land area was forested. Now, forests cover around 34 million km^2, less than 1/3 of the land area (Figures 6.5a, b). In the 1980s, the world's forested area diminished with over one million km^2, and between 1990-95, 650,000 km^2 were deforested (Figure 6.5c). The daily rate of deforestation is 430 km^2 (FAO 1995a).

The causes to these changes are many. Since 1980, the major cause in Africa and Asia has been rural population growth with agricultural expansion. In Latin America, economic development programs have accounted for the greatest forest cover changes.

These pressures will continue. FAO (1997) estimates, that by 2010, around 0.9 million km^2 of land will be added to agricultural use. Around 50% of this will be present-day forest. Other important stresses to forests are due to industrial pollution and firewood use by the poor in many parts of the world.

It is important to realize that the demand for forest products has been and will continue to be in sharp increase. In 1960-1995, the consumption of fuelwood rose 2.5 times, of saw-wood three times, and of paper more than tripled.

Many reverse trends are also to be noted. In some Asian countries, China and South Korea in particular, extensive afforestation programs have been realized.

China has been able to cut down the decreasing trend in deforestation, and been successful in limiting soil erosion by planted forests, which protect the soil from wind and water caused erosion. Almost 60% of these forests have been planted by taking the industrial use of wood into primary consideration. In South Korea, forests were largely destroyed during the war, but today, forests cover again over 2/3 of the land area.

Figure 6.5a
Forested and unforested area in 2000.
The percentages of forested area of total land area are also shown. Source: World Bank (2004).

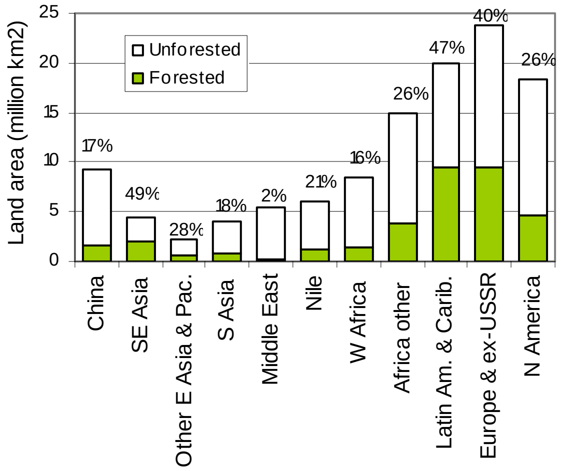
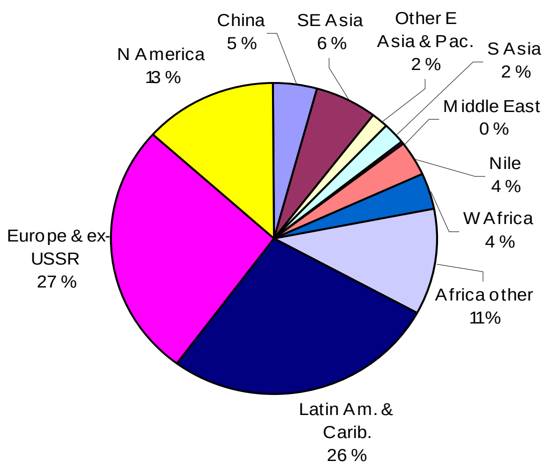


Figure 6.5b
World's forests by region in 2000.
Source: World Bank (2004).



Problems related to biodiversity and wildlife occur in many planted forests due to the selection of species (e.g. eucalyptus-species in Asia that are not indigenous), and 15-20% of China's plant and animal species are under extinction threat. In many N European and N American countries, remarkable areas of marginal agricultural land have been afforested.

Environmental concerns increasingly influence national forest policies and practices, and even the international trade. Still, the markets have still a long way to develop before they would take enough responsibility of all social and environmental problems due to unsustainable forestry practices.

The condition of forests can be measured in many ways, which include (WRI 1996):

- *The degree of degradation:* the extent of fragmentation and biomass removal.
- *The degree of naturalness:* how much human activity has modified the forest structure and species composition.
- *Management intensity:* how much of the (economic) potential of the forest is utilized.
- *Forest health:* the relative health of tree species.

No global assessment exists on these. Forest degradation is a particular concern in the tropics; although not reflected in deforestation statistics directly, degradation is the reason why the state of tropical forests is in many places alarming (FAO 1993). Temperate forests suffer in particular of the loss of undisturbed areas, fragmentation, and declining health.

In relation to the fact that deforested areas are taken continuously into agricultural use, the connections between food security and forests are the following. Forests and wood are an important constituent of livelihood and economy of many farmers: a source of income, fuel, etc., and it offers a protection to the land resource. Trees and forests are an important part of many farming and agroforestry systems such as intercropping practices (FAO 1997).

Deforestation by region

SE Asia is famous due to deforestation and decline of mangroves. Solely in the period of 1990-2000, SE Asia lost 9.9% of its forest cover (FAO 2001). With this rate, it is holding the second position in the world in terms of deforestation after W Africa (Figure 6.5c). Between 1990 and 2000, the annual deforestation rates varied from 0.4% in Lao PDR to 1.4% in Myanmar and the Philippines. Vietnam was the only country in the region which reforested 0.5% per year.

The forest area per capita has dropped around one quarter in ten years in SE Asia (Figure 6.5d).

Even if SE Asia is so famous of its dramatic deforestation, the situation is still worse in the African regions in terms of decreasing forest area per capita (Figure 6.5e). Clearly, the African situation is worsened by the very high population growth. In 2000, SE Asia had lost 24% of its forests since 1990 while in the Nile region the decrease was 28%.

Figure 6.5c
Change in the forest cover area 1990-2000.
Regional data from FAO (2001). The percentual change of total forested area is also shown.

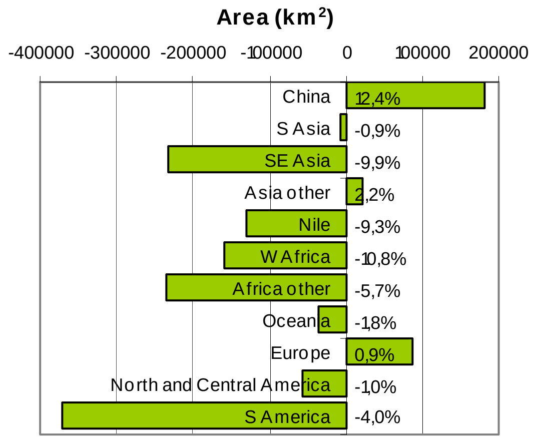
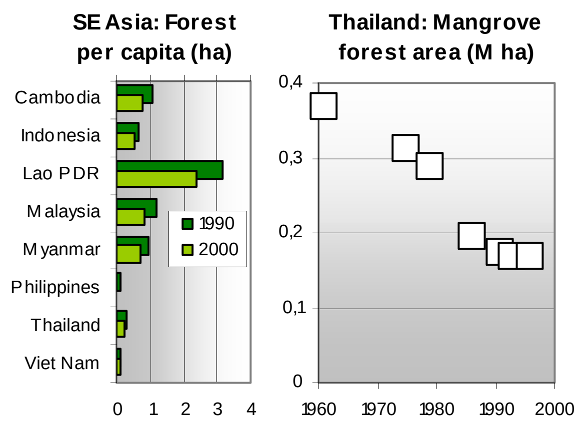


Figure 6.5d
SE Asia used to be rich with forests
Left: Forest per capita in SE Asian countries (World Bank 2004, FAO 2001). Right: The decline of Thailand's mangrove forests (FAO 2000).



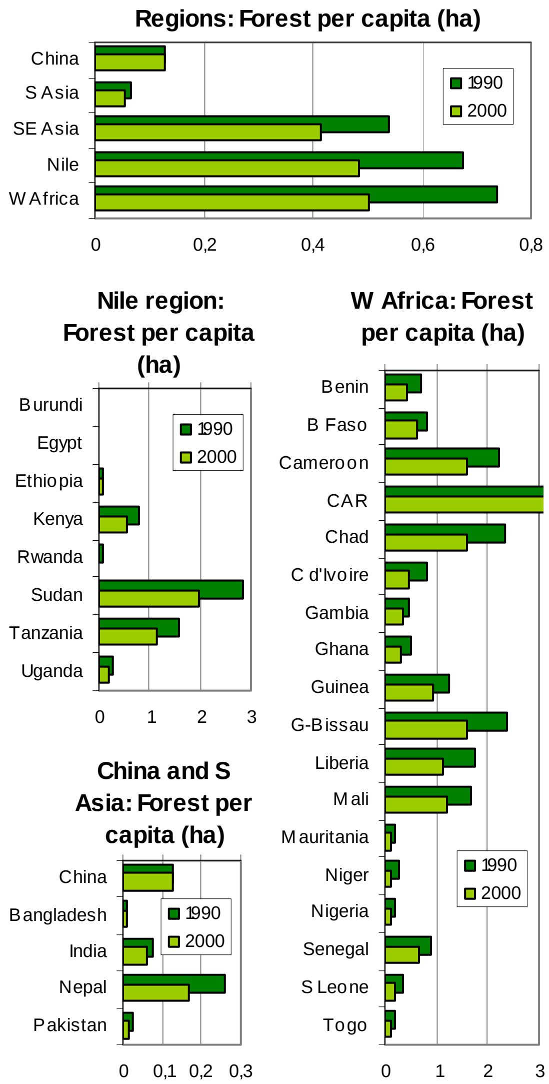
W Africa is richest in forests among the regions. However, the decline in per capita forest area has been dramatic: from over 0.7 ha to 0.5 ha, with an absolute decline of 10.8%.

China and S Asia suffer less from deforestation. Between 1990 and 2000, their forested areas stayed virtually unchanged. The other side of the coin is that they have very limited amount of forest per capita, one order of magnitude less than the other study regions. Pakistan's small forest area declined by 1.5% per year between 1990-2000. In Nepal the figure was 1.8%. Bangladesh and India were able to increase their forest area by 1.3% and 0.1% annually.

Figure 6.5e

China and SE Asia are forest scarce

Forest per capita in the study regions (World Bank 2004, FAO 2001). The data for Central African Republic (CAR) is 8 ha in 1990 and 6 ha in 2000.



Wildlife

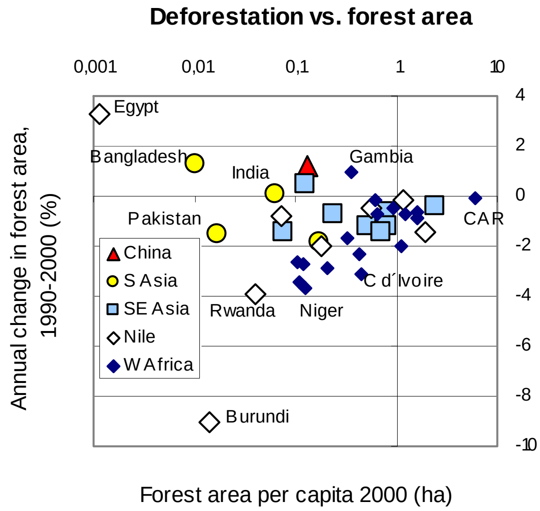
As a part of ecosystems wildlife has important roles. Wildlife has a direct value to people who rely on hunting as a source of food, clothing and income. Indirectly diverse wildlife promotes tourism, which is a significant source of income for numerous nations. The recreational value of wildlife cannot be bypassed.

Besides the benefits provided by wildlife, animal species can be used as environmental indicators. Species richness is one useful indicator among others to assess biodiversity. The more animal species a region hosts the more it is biologically diverse. The number of endangered species gives some indicative information on the pressure faced by selected species.

Figure 6.5f

Pressure on declining forests

Deforestation does not stop even if forests get scarce. The situation is alarming in the Nile region and W Africa. Source: FAO (2001).



World's wildlife is living under increasing pressure. Population growth and agricultural expansion cause habitat loss. Collection and use of firewood together with pollution further destruct the wildlife habitats. In addition illegal trade, overhunting, the effects of climate change and economic development increase the number of threatened and extinct animal species.

Mammals are more vulnerable to environmental changes and other threats, than birds, reptiles, and amphibians. Globally the total number of known mammal species is 4,629 out of which 1,096 or 24% are threatened (Figure 6.5g). Corresponding percentages for birds, reptiles, and amphibians are 11%, 4%, and 3%.

When comparing the number of threatened mammal species to the total number of known mammals by regions it can be noticed that the highest rates are found in the Asian countries (Figure 6.5h).

In SE Asia the situation is most alarming. Out of the 158 mammal species living in the Philippines, 31% are threatened. This is mainly explicable by the loss of habitat due to the high deforestation rate.

Indonesia, which is the richest study region country in number of mammal and bird species, is facing a serious problem too. The country's wildlife is extremely diverse and valuable as nearly half of the mammal species are endemic, thus not found elsewhere. However 28% of the mammals or 128 species are endangered despite the fact that 10% of Indonesia's land area is protected. In spite of the intense deforestation (Figure 6.5c) the percentage of threatened mammals in Thailand and Malaysia has stayed below 15%.

In terms of nationally protected area, Cambodia and Thailand are leading the statistics with 15.8% and 13.8% of protected land area, respectively. The environmental destruction and loss of wildlife habitat in Lao PDR and Myanmar may get alarming as the countries' protected areas are nearly non-existent. From the perspective of wildlife, the situation is neither good in S Asia or China. With 400 species, the latter is the richest in total number of mammals. Although China's forested area has increased and protected areas cover no less than 594,000 km^2, one fifth of the mammal species are threatened.

Figure 6.5g
Mammals are the most threatened vertebrates.
Data from WRI (2001). Fish species are excluded.

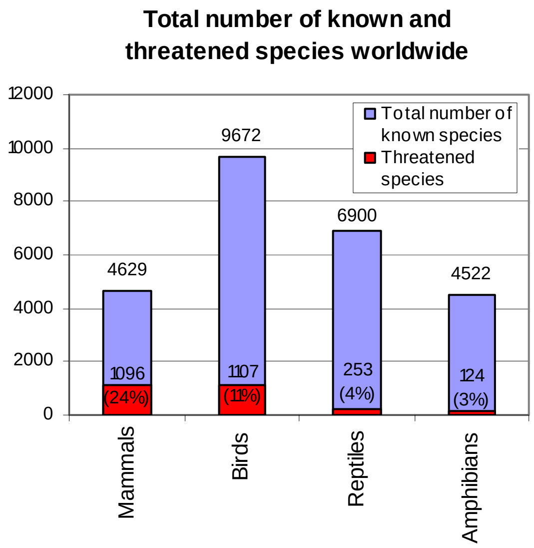
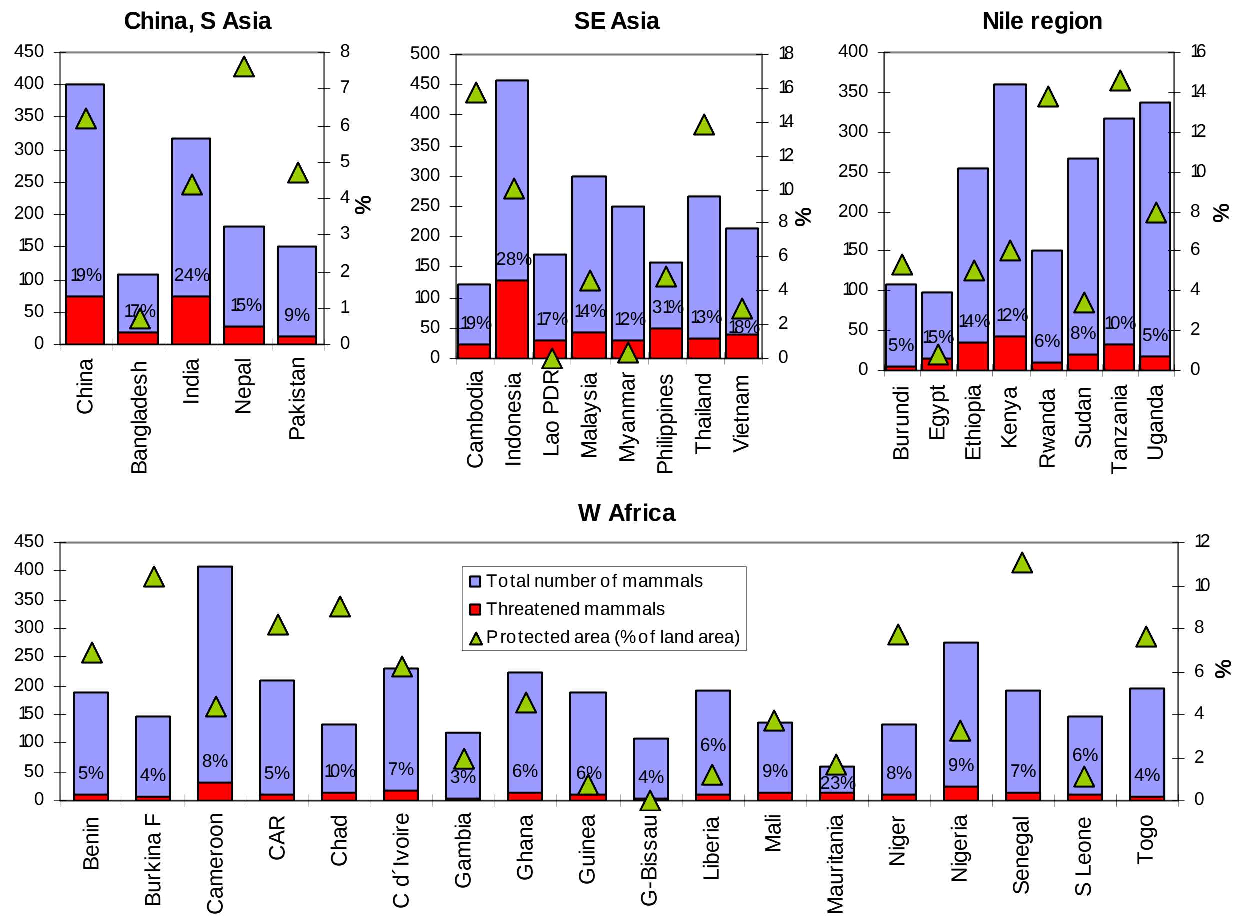


Figure 6.5h
Mammals are facing growing pressure especially in Asia.
Total number of mammals, threatened mammals and nationally protected areas by countries in the study regions. The values above the bars indicate the percentual share of the threatened mammals vs. the total number. Source: WRI (2001).



India’s situation is somewhat similar. Wildlife is living under high pressure as 1/4 of the mammals are endangered although forest cover has not decreased. In both cases, the high number of threatened mammals is due to the enormous human population and its activities. In places pollution is extreme as well.

Among the study regions Africa’s wildlife is least threatened but diverse. Alone in the Nile region three countries including Tanzania, Uganda, and Kenya (from down to top) have over 300 species of mammals. Cameroon, with its 409 mammal species, is the richest country out of the African study regions. When considering the proportion of endangered mammals and protected areas in the Nile region, Egypt is the first and last, respectively, in the statistics. Out of the mammals 15% are threatened whereas just 0.8% of the land area is protected.

W African wildlife is in a good position. In all the countries excluding Chad and Mauritania, less than 10% of the mammal species are threatened. In Chad the figure is 10%. With sixty-one species Mauritania has the lowest total number of mammals among the countries of the study regions. However, out of these as many as fourteen or 23% are endangered.

Freshwater ecosystems

Aquatic ecosystems can be divided into freshwater and marine ecosystems. The former include lakes, rivers, reservoirs, ponds, and wetlands. Saltwater ecosystems are located either in the coastal zone or open sea. This section focuses on the freshwater ecosystems. The next section discusses coastal zone habitats including i.a. estuaries, coastal wetlands, and coral reefs.

Freshwater ecosystems provide several times higher economic benefits per unit area than terrestrial ecosystems. It is estimated that global wetlands alone are worth about US$ 4.0 trillion annually (Klaphake et al. 2001). Unfortunately freshwater ecosystems are also more threatened than terrestrial ecosystems.

River and lake ecosystems are essential for human life. Water is needed to satisfy the growing needs of domestic, agricultural and industrial sectors. Freshwater ecosystems are used among other things for water supply, irrigation, hydropower generation, navigation, fisheries and recreation.

Water is equally critical for nature which functions are dependent on freshwater availability. Species richness in relation to habitat extent is extremely high in many freshwater systems although the total number of species is low compared with marine and terrestrial ecosystems. It is estimated that about 40% of the known fish species live in freshwater although just 0.013% of the global annual water quantity is surface water in lakes and rivers (FAO 1995a, Groombridge and Jenkins 1998).

The state of the freshwater ecosystems is of great concern in many places the world over. Pollution is one of the most severe threats to river and lake ecosystems. Water quality is deteriorating (Chapter 6.3) which limits the well-being of populations of aquatic animals and the use of water for human consumption. Another limiting factor is the quantity of water. Water use is increasing sharply while water stress is already facing several countries (Chapters 2.2 and 2.3). Out of the 2465 threatened species worldwide, 25% are related to freshwater ecosystems whereas around 65% of the freshwater mammals are threatened.

Species introduction is a widely recognized threat to freshwater ecosystems. Especially lake ecosystems are vulnerable to exotic species. One well-known example is the Lake Victoria in the upper parts of the Nile region. Half of the lake’s cichlid species became extinct due to the introduction of the Nile perch.

The Global 2000 system, developed by WWF, is a science-based global ranking of the Earth's most biologically outstanding terrestrial, freshwater and marine habitats (Olsson et al. 2000). It encompasses the most significant examples of each major habitat type from each continent, which are represented as ecoregions. From the total of thirty-three freshwater ecosystems listed in the Global 2000, sixteen are found in the study regions.

In terms of biodiversity Asia is well represented in the category of river ecosystems considered as ecoregions (Table 6.5a). Mekong River in SE Asia and Yangtze River in China belong to the most outstanding large river ecosystems found in Asia. W Africa is represented with three river ecosystems including the Congo Basin Piedmont Rivers and Streams, the Niger River Delta, and the Upper Guinea Rivers and Streams.

The study regions comprise several unique lake ecosystems in terms of biodiversity (Table 6.5b). SE Asia alone includes three ecoregions out of the seven listed in the category of small lake habitat type; Lake Lanao in the Philippines, Lake Inle in Myanmar, and the Central Sulawesi Lakes in Indonesia. As a large lake habitat, the Rift Valley Lakes found partly in the Nile Region sustain some particularly notable lake biotas.

Table 6.5a

River ecosystems considered as ecoregions located in the study regions

The table is compiled from Olsson et al. (2000)

ASIA	**Large Rivers**
China	*Yangtze River and Lakes* **Features:** Numerous fish, mammal, and plant species which are adapted to the dynamic water regime of the rivers and lakes. In winter, a large number of waterbirds are dependent on the lakes. **Threats:** Construction of dams, inter basin water transfers, fish farming, deforestation, cultivation of surrounding land for farming and grazing, pollution, oil drilling, industrialization, urbanization, and introduced diseases from domestic waterfowl.
SE Asia	*Mekong River (Cambodia, China, Laos, Myanmar, Thailand, and Vietnam)* **Features:** The most diverse and distinctive large river fauna of tropical Asia. The ecoregion provides base for large scale fish migrations. **Threats:** Deforestation, dams and overfishing. Growing urban, industrial, and agricultural pollution.
AFRICA	**Large River Headwaters**
W Africa	*Congo Basin Piedmont Rivers and Streams* Mainly located in Central Africa with parts of W Africa (in Cameroon, CAR, and the Sudan). **Features:** Africa's richest freshwater fauna is in the Congo basin. 80% of the fauna may be endemic. **Threats:** Sewage and other pollution from the growing urban centers and few mining operations.
ASIA	**Large River Deltas**
S Asia	*Indus River Delta (Pakistan, India)* **Features:** A productive large river delta which is territory to large populations of migratory species. **Threats:** Dams, water extraction for irrigation, runoff of chemicals, and introduced species.
AFRICA W Africa	*Niger River Delta (Nigeria)* **Features:** Consists of the Niger Delta, which is one the largest delta in the world with 50,000 km^2. The ecoregion is a biogeographical crossroads for African ichthyofauna supporting nearly 200 fish species. **Threats:** Threatened by oil pollution, coastal urbanization, oil and gas exploitation, industrialization, domestic and industrial waste discharges, the water hyacinth, coastal erosion and aquaculture.
ASIA	**Small Rivers**
SE Asia and China	*Xi Jiang (Pearl) Rivers and Streams (Vietnam, China)* **Features:** High richness in fish species (380) in a temperate region with significant endemism. **Threats:** Dams, changed landscape, and population growth/urbanization in the delta area.
	Salween River (China, Myanmar, and Thailand) **Features:** 1/3 of the fish species are endemic. Supports the world's most diverse turtle community. **Threats:** Intensive agriculture, fishing, mining and the proposed dams.
SE Asia	*Sundaland Rivers and Swamps (Brunei, Malaysia, Indonesia, and Singapore)* **Features:** Likely the richest freshwater faunas in Asia with much island and local endemism. Borneo has 149 endemic fish species. **Threats:** Deforestation, agriculture, overfishing, exotics, aquaculture industry, and mining pollution.
S Asia	*Western Ghats Rivers and Streams (India)* **Features:** Isolated, and characterized by small coastal drainages. Over 100 endemic fish species. **Threats:** Deforestation which causes sedimentation, deteriorate water quality and alter the flow regimes. Other threats include over fishing, urbanization, water diversions and dam construction.
AFRICA W Africa	*Upper Guinea Rivers and Streams (Côte D'Ivoire, Guinea, Liberia, and Sierra Leone)* **Features:** The Upper Guinea rivers contain high fish richness including many endemic species. **Threats:** Deforestation, mining of iron ore and diamonds and political instability which weakens the management of the natural resources in the area.

Wetlands are the third type of freshwater ecosystems to be discussed here. Wetlands provide several functions, services and benefits to people including:

- groundwater recharge and discharge
- flood control
- water quality and quantity
- water purification
- sediment, toxicant and nutrient retention

The water purification capacity of wetlands can be significant. Folke and Jansson (2000) indicated that the existing wetlands of the Baltic Sea basin create a nitrogen sink corresponding to nearly 15% of the total nitrogen load to the Baltic Sea. The figure is eminent when considering that over 60% of the basin's wetlands have already been drained.

Table 6.5b

Lake ecosystems considered as ecoregions located in the study regions

The table is compiled from Olsson et al. (2000).

AFRICA	**Large Lakes**
Nile Region	*Rift Valley Lakes* Located in East-central Africa and include parts of the Nile region (parts of Burundi, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda) **Features:** The ecoregion encompasses i.a. Lake Malawi, Tanganyika, and Victoria. Globally outstanding adaptive radiations of fish in tropical lakes. Extraordinary levels of endemism. **Threats:** The introduction of exotic fish, overfishing, urban runoff, industrial pollution, deforestation.
ASIA	**Small Lakes**
SE Asia	*Central Sulawesi Lakes (Indonesia)* **Features:** Encompasses distinctive and highly endemic biota of tropical lakes. Significant radiations of species occur. **Threats:** Lakeshore nickel mining, commercial fishery, species introductions, population growth.
	Philippines Freshwater (Philippines) **Features:** The ecoregion has high levels of endemism. In addition one of the most remarkable radiations of tropical lake fish in Asia exists. **Threats:** Introduction of exotic species, logging and erosion. Mining, and agriculture are considered as minor threats.
	Lake Inle (Myanmar) **Features:** Outstanding levels of endemism for lake fauna of Indochina **Threats:** Land reclamation has significantly modified the lake. Runoff of pesticides and fertilizers from the floating gardens, sedimentation from cattle grazing, and sewage from surrounding lands.
China	*Yunnan Lakes and Streams* **Features:** There is an unusual level of endemism for subtropical lakes in Southern Asia. **Threats:** Silt and fertilizer from rice fields, domestic and industrial waste, aquaculture and fisheries.
AFRICA W Africa	*Cameroon Crater Lakes (Cameroon)* **Features:** Over 3/4 of the fish species and one third of the aquatic insects are endemic. **Threats:** Lake Barombi Mbo is threatened by overfishing, deforestation, and excessive water extraction. Others remain relatively undisturbed.

Common benefits and attributes provided by wetlands include:

- medicinal and biomedical products
- water supply
- pollution clean-up
- fish nurseries and fisheries products
- forage products
- agricultural products
- transport

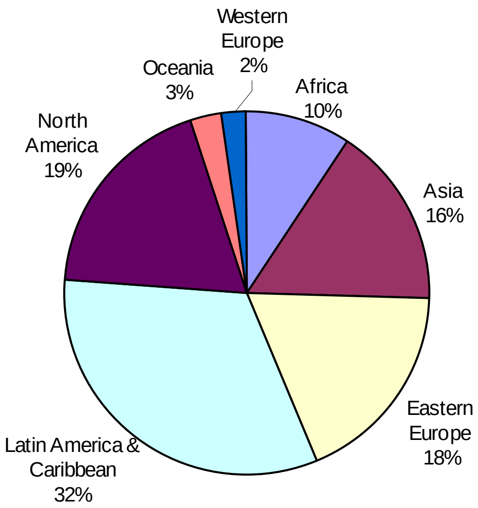
In addition to the functions, services and benefits the wetlands provide to human beings, these ecosystems are essential to the nature. Wetlands sustain diverse populations of wildlife being breeding grounds and habitats for waterfowls and other wildlife.

Few global assessments of wetlands exist. Estimates of the surface area of wetlands are diverging and vary from 5.6 million km^2 to 9.7 million km^2. The variability of the estimates is due to the different definitions of wetlands used and the lack of data. According to Finlayson and Spiers (1999) most of the world's wetlands are located in the Latin America and Caribbean while just one tenth is in Africa (Figure 6.5i).

Since 1900, half of the world's wetlands have been destroyed. In the early 20^{th} century the degradation of wetlands focused in the northern temperate zone. Since the 1950s tropical and sub-tropical wetlands have increasingly been lost.

Agriculture is considered the principal cause for wetland loss. By 1985 it was estimated that 56–65% of available wetland had been drained for intensive agriculture in Europe and N America. For Asia, S America and Africa the figures are 27%, 6% and 2% respectively (Finlayson and Spiers 1999). Water management activities, water allocation and distribution, are linked with the wetland losses. In particular large-scale irrigation schemes and large dams, which alter the natural flow regime of rivers are destructive for the vulnerable wetlands.

Figure 6.5i
World's wetlands by continent
Source: Finlayson and Spiers (1999).



The protection of wetlands took a long step when the Ramsar Convention on Wetlands, an intergovernmental treaty, was signed in 1971. It provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. At present the number of contracting parties is 152. The Ramsar List of Wetlands of International Importance includes 1,346,933 km^2 of wetlands (Ramsar 2006). Ramsar is the only global environmental treaty, which deals with a particular ecosystem.

Nations' attitudes toward wetland protection can be assessed by contemplating the countries which have not contracted with the Ramsar Convention. In total there are two countries in the study regions which have not signed the treaty. These are Lao PDR in SE Asia, and Ethiopia in the Nile region.

Coastal ecosystems

Coastal zone is defined as inter-tidal and subtidal areas on and above the continental shelf to a depth of 200 meters and immediately adjacent lands (Burke et al. 2001). As a consequence coastal ecosystems comprise a very diverse array of habitats including among others coral reefs, mangroves, estuaries, tidal wetlands, seagrass beds, barrier islands, and peat swamps. These ecosystems are important in many ways to humans and animals. Primary goods and services provided by coastal ecosystems are summarized in Table 6.5d.

As critical transition zones (CTZs) coastal ecosystems link land, freshwater habitats and sea. Due to this unique role, coastal wetlands and estuaries provide, besides the above-mentioned goods and services, substantial ecological functions, which include decomposition, nutrient cycling and nutrient production. In addition the CTZs regulate the fluxes of nutrients, water particles, and organisms flowing from the land and rivers to the ocean. Although coastal wetlands and estuaries are very productive in terms of higher plant and animal biomass, they are characterized by low species richness and particular sensitivity to hydrologic modifications (Levin et al. 2001).

Table 6.5d
Coastal ecosystems provide diverse goods and services
Source: WRI (2000).

Goods	Services
• Fish and shellfish • Fishmeal (animal feed) • Seaweeds for food and industrial use • Salt • Genetic resources	• Moderate storm impacts (mangroves, barrier islands) • Provide marine and terrestrial wildlife habitat • Maintain biodiversity • Dilute and treat wastes • Provide harbors and transportation routes • Provide human habitat • Provide employment • Provide esthetic and recreational values

Coastal ecosystems are under severe pressure. In the middle of 90s, 39% of the world's population lived within 100 km of coast, an area which covers just 20% of the global land area. The population in the coastal area is further increasing along the migration and population growth.

Although coral reefs cover less than 0.2% of the total area of oceans they contribute one quarter of the total fish catch in developing countries. Besides seafood coral reefs provide new medicines and services including tourism and coastal protection. It is estimated that the overall economic value of coral reefs is about US$ 375 billion each year (Bryant et al. 1998).

Over one half of the world's coral reefs are potentially threatened by human activities. The situation is most alarming in Southeast Asia where the most diverse coral reefs in the world, located in the Philippines and Indonesia, contain at least 2,500 species of fish. Over 80% of the SE Asian reefs are under medium or high threat. The coral reefs of Pacific are least threatened. The major causes to coral reef degradation from the most severe are over exploitation and destructive fishing practices, coastal development, inland pollution and erosion, and marine pollution.

References to Section 6

Abramovitz, J.N. 1996. Strengthening freshwater ecosystems. In: Brown L.B. (Ed): *State of the World 1996.* Norton, New York and London.

ADB 2000. *Strategic Options for the Water Sector: PRC.* Hydrosult, SOGREAH and IWHR, Beijing for Asian Development Bank, Manila.

Alexandratos, N. 1995. *World Agriculture: Towards 2010 – An FAO Study*. Food and Agriculture Organization of the United Nations (FAO) and John Wiley & Sons Ltd., Chichester. www.fao.org/docrep/V4200E/V4200E00.htm (4.5.2006).

Babu Rao, P., Subrahmanyam, K. & Dhar, R.L. 2001. Geoenvironmental effects of groundwater regime in Andhra Pradesh, India. *Environmental Geology* 40(4-5): 632-642.

Barrow, C.J. 1991. *Land Degradation*. Cambridge University Press, Cambridge.

Berg, M., Tran, H., Nguyen, T., Pham, H., Schertenleib, R. & Giger, W. 2001. Arsenic Contamination of Drinking Water in Vietnam: A Human Health Threat. *Environmental Science & Technology* 35(13): 2621-2626.

Bijay-Singh, Yadvinder-Singh & Sekhon, G.S. 1995. Fertilizer-N use efficiency and nitrate pollution of groundwater in developing countries. *Journal of Contaminant Hydrology* 20(3-4): 167-184.

Braadbaart, O. & Braadbaart, F. 1997. Policing the Urban Pumping Race: Industrial Groundwater Overexploitation in Indonesia. *World Development* 25(2): 199-210.

BGS (British Geological Survey) and DPHE (Department of Public Health Engineering) 2001. *Arsenic contamination of groundwater in Bangladesh. Vol. 1: Summary*. BGS Technical Report WC/00/19. BGS, Keyworth. www.bgs.ac.uk/arsenic (5.5.2006).

Brown, L.B. 1995. *Who Will Feed China: Wake-Up Call for a Small Planet.* The Worldwatch Environmental Alert Series. Norton, New York and London.

Brown, L.B. 1996. *Tough Choices, Facing the Challenge of Food Scarcity.* The Worldwatch Environmental Alert Series. Norton, New York and London.

Bryant, D., Burke, L., McManus, J. & Spalding, M. 1998. *Reefs at Risk: A Map-Based Indicator of Threats to the World´s Coral Reefs.* A joint publication by World Resources Institute (WRI), International Center for Living Aquatic Resources Management (ICLARM), World Conservation Monitoring Centre (WCMC), and United Nations Environment Programme (UNEP). WRI, Washington D.C.

Burke, L., Kura, Y., Kassem, K., Revenga, C., Spalding, M.,& McAllister, D. 2001. *Pilot Analysis of Global Ecosystems: Coastal Ecosystems.* WRI, Washington D.C. http://pdf.wri.org/page_coastal.pdf (8.5.2006).

Chinese Academy of Sciences, 1992. *Survival and Development.* Science Press, Beijing.

Cruz, W. & Repetto, R. 1992. *The Environmental Effects of Stabilization and Structural Adjustment Programs: The Philippines Case.* World Resources Institute (WRI), Washington D.C.

FAO 1990. *La Conservation et la Restauration des Terres en Afrique.* Food and Agriculture Organization of the United Nations (FAO), Rome.

FAO 1993. *Forest Resources Assessment 1990: Tropical Forests.* FAO Forestry Paper 112. FAO, Rome.

FAO 1994. *Land Degradation in South Asia: Its Severity, Causes and Effects upon the People.* FAO, Rome. www.fao.org/docrep/V4360E/V4360E00.htm (4.5.2006).

FAO 1995a. *Dimensions of Need: An Atlas of Food and Agriculture.* FAO, Rome.

FAO 1995b. *The Conservation of Lands in Asia and the Pacific—A Framework for Action.* FAO, Rome. www.fao.org/docrep/V9909E/V9909E00.htm (4.5.2006).

FAO 1995c. *Land and Environmental Degradation and Desertification in Africa.* FAO, Rome.

FAO 1996. *The State of Food and Agriculture 1996.* FAO, Rome.

FAO 1997. *State of the World's Forests 1997.* FAO, Rome.

FAO 2000. *Asia and the Pacific National Forestry Programmes: Update 34.* FAO Regional Office for Asia and the Pacific, Bangkok.

FAO 2001. *Global Forest Resources Assessment 2000 – Main Report.* FAO Forestry Paper No. 140. FAO, Rome.

FAO 2005. *AQUASTAT database – FAO´s Information System on Water and Agriculture.* FAO, Rome. www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/dbase/index.stm (8.5.2006).

Finlayson, C.M. & Spiers, A.G. (eds). 1999. *Global review of wetland resources and priorities for wetland inventory*. Supervising Scientist Report 144. Supervising Scientist, Canberra.

Flavin, C. 1997. The legacy of Rio. In: Brown, L.B., Flavin, C. & French, H. (Eds.) *State of the World 1997.* Norton, New York and London.

Folke, C. & Jansson, O. 2000. Wetlands as nutrient sinks. In: Gren, I-M., Turner, K. & Wulff, F. (Eds.): *Managing a Sea – the Ecological Economics of the Baltic*. Earthscan, London.

Gardner, G. 1996. Preserving agricultural resources. In: Brown L.B. (Ed): *State of the World 1996.* Norton, New York and London.

GEMStat 2006. *Global Environment Monitoring System. Global Water Quality Data and Statistics.* United Nations Global Environment Monitoring System Water Programme, Burlington, Canada. www.gemstat.org (5.5.2006).

GIWA 2003. Global International Waters Assessment, Kalmar, Sweden. www.giwa.net (5.5.2006).

Global Water Partnership 2000. *West African Water Vision.* The 2nd World Water Forum, 17-22 March, The Hague.

Graniel, C.E., Morris, L.B. & Carrillo-Rivera, J.J. 1999. Effects of urbanization on groundwater resources of Merida, Yucatan, Mexico. *Environmental Geology* 37(4): 303-312.

Groombridge, B. & Jenkins, M. 1998. *Freshwater Biodiversity: a preliminary global assessment.* WCMC Biodiversity Series No. 8. World Conservation Monitoring Centre (WCMC), Cambridge.

Hadas, A., Hadas, A., Sagiv, B. & Haruvy, N. 1999. Agricultural practices, soil fertility management modes and resultant nitrogen leaching rates under semi-arid conditions. *Agricultural Water Management* 42(1): 81-95.

van Hofwegen, P. & Svendsen, M. 2000. *A Vision of Water for Food and Rural Development.* The 2nd World Water Forum, 17-22 March, The Hague.

IFA 2006. *Fertilizer Indicators: Total fertilizer nutrient consumption – million tonnes nutrients, N + P_2O_5 + K_2O.* International Fertilizer Industry Association (IFA), Paris. www.fertilizer.org/ifa/statistics/indicators/tablenpk.asp (23.8.2006).

IWMI 1999. PODIUMSim. Model for National Level Water and Food Policy Dialogue. International Water Management Institute (IWMI), Colombo. www.iwmi.cgiar.org/tools/podium_sim.htm (4.5.2006).

IWMI 2000. *World Water Supply and Demand.* IWMI, Colombo. www.iwmi.cgiar.org/pubs/WWVisn/WWSDOpen.htm (4.5.2006).

Karim, M. 2000. Arsenic in groundwater and health problems in Bangladesh. *Water Research* 34(1): 304-310.

Khan, M.A. 2001. Pollution of water resources due to industrialization in arid zone of Rajasthan, India. *Journal of Environmental Sciences* 13(2): 218-223.

Klaphake, A., Scheumann, W. & Schliep, R. 2001. *Biodiversity and International Water Policy: International Agreements and Experiences Related to the Protection of Freshwater Ecosystems.* Technical University of Berlin, Berlin.

Kuylenstierna, J.C.I., Rodhe, H., Cinderby, S. & Hicks, K. 2001. Acidification in developing countries: Ecosystem sensitivity and the critical load approach on a global scale. *Ambio* 30(1): 20-28.

Lawrence, A.R., Gooddy, D.C., Kanatharana, P., Meesilp, W. & Ramnarong, V. 2000. Groundwater evolution beneath Hat Yai, a rapidly developing city in Thailand. *Hydrogeology Journal* 8(5): 564-575.

Levin, L., Boesch, D., Covich, A., Dahm, C., Erseus, C., Ewel, K., Kneib, R., Moldenke, A., Palmer, M., Snelgrove, P., Strayer, D. & Weslawski J. 2001. The Function of Marine Critical Transition Zones and the Importance of Sediment Biodiversity. *Ecosystems* 4(5): 430-451.

Li, Y. & Zhang, J. 1999. Agricultural diffuse pollution from fertilisers and pesticides in China. *Water Science & Technology* 39(3): 25-32.

Lynden, G.W.J. & Oldeman, L.R. 1997. The assessment of the status of human-induced soil degradation in South and Southeast Asia. International Soil Reference and Information Centre (ISRIC), Wageningen.

Mackay, R. 1990. Groundwater quality management. In: Thanh, N.C. & Biswas, A.K. (Eds.): *Environ-*

mentally Sound Water Management. Oxford University Press, Delhi.

Malik, R.P.S. 2000. Agriculture and water quality in India towards sustainable management. In: *Water Quality Management and Control of Water Pollution: Proceedings of a Regional Workshop*, Bangkok, Thailand, 26-30 October 1999. Food and Agriculture Organization of the United Nations (FAO), Rome.

McArthur, J.M., Ravenscroft, P., Safiulla, S. & Thirlwall, M.F. 2001. Arsenic in groundwater: Testing pollution mechanisms for sedimentary aquifers in Bangladesh. *Water Resources Research* 37(1): 109-107.

McCutcheon, S.C., Martin, J.L. & Barnwell, T.O. 1992. Water quality. In: Maidment, D.R. (Ed.): *Handbook of Hydrology*. McGraw-Hill, New York.

Mercer, J.W. & Waddell, R.K. 1992. Contaminant transport in groundwater. In: Maidment, D.R. (Ed.): *Handbook of Hydrology*. McGraw-Hill, New York.

Ministère de l´Environnement et de l'Eau. 2000. *West African Regional Action Plan for Integrated Water Resources Management.* Ministère de l'Environnement et de l'Eau, Secreteriat General, Ouagadougou.

Niemczynowicz, J. 1993. New aspects of sewerage and water technology. *Ambio* 22(7): 449-455.

Niu, W.-Y. & Harris, W.M. 1996. China: the forecast of its environmental situation in the 21st Century. *Journal of Environmental Management* 47(2): 101-114.

Novotny, V. 1999. Diffuse pollution from agriculture – a worldwide outlook. *Water Science & Technology* 39(3)*: 1-13.*

Qian, J., Susheela, A.K., Mudgal, A. & Keast, G. 1999. *Fluoride in water: An overview*. WATERfront 13: 11-13.

Olsson, D.M., Dinerstein, E., Abell, R., Alnutt, T., Carpenter,C., McCleanachan, L., D´Amico, J., Hurley, P., Kassem, K., Strand, H., Taye, M. & Thieme, M. 2000. *The Global 2000, A Representation Approach to Conserving the Earth´s Distinctive Ecoregions.* World Wildlife Fund (WWF), Washington D.C.

Palo, M. & Mery, G. (eds.) 1996. *Sustainable Forestry Challenges for Developing Countries.* Kluwer Academic Publishers, Dordrecht / Boston / London.

Pimentel, D. 1995. The Global Population, Food, and the Environment. In: Westra, L. & Lemons, J. (Eds.): *Perspectives on Ecological Integrity*. Kluwer, Dordrecht.

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Shpritz, L., Fitton, L., Saffouri, R. & Blair, R. 1995. Environmental and economic cost of soil erosion and conservation benefits. *Science* 267(5201): 1117-1123.

Pimentel, D., Houser, J., Preiss, E., White, O., Fang, H., Mesnick, L., Barsky, L., Tariche, S., Schreck, J. & Alpert, S. 1997. Water resources: Agriculture, the environment, and society. *BioScience* 47(2): 97-106.

Postel, S. 1996. Forging a sustainable water strategy. In: Brown L.B. (Ed): *State of the World 1996.* Norton, New York and London.

Postel, S.L., Daily, G.C. & Ehrlich, P.R. 1996. Human appropriation of renewable fresh water. *Science* 271(5250): 785-788.

Rahman, A. 1996. Groundwater as a source of contamination for water supply in rapidly growing megacities of Asia: Case of Karachi, Pakistan. *Water Science and Technology* 34(7-8): 285-292.

Ramsar 2006. *Key Documents of the Ramsar Convention: Contracting Parties to the Ramsar Convention on Wetlands (as of 2 May 2006).* Ramsar Convention Bureau, Gland. www.ramsar.org/key_cp_e.htm (8.5.2006).

Rhoades, R.E. 1991. The world's food supply at risk. *National Geographic,* April 1991.

Scherr, S.J. & Yadav, S. 1996. *Land Degradation in the Developing World: Implications for Food, Agriculture, and the Environment to 2020.* Food, Agriculture, and the Environment Discussion Paper 14. International Food Policy Research Institute (IFPRI), Washington, D.C.

Shah, T., Molden, D., Sakthivadivel, R. & Seckler, D. 2000. *The Global Groundwater Situation: Overview of Opportunities and Challenges.* International Water Management Institute (IWMI), Colombo.

Shah, T., Roy, A. D., Qureshi, A. S. & Wang, J. 2001. *Sustaining Asia's Groundwater Boom: An Overview of Issues and Evidence.* German Development Institute (GDI)/IWMI, Bonn.

Shamrukh, M., Corapcioglu, M.Y. & Hassona, F. 2001. Modeling the Effect of Chemical Fertilizers on Ground Water Quality in the Nile Valley Aquifer, Egypt. *Ground Water* 39(1): 59-67.

Shen, D. & Dafoe, T. 1998. *Strategic Options for the Water Sector—Environmental Planning and Analysis*. Hydrosult/China Institute of Water Resources and Hydropower Research (IWHR), Beijing.

Smil, V. 1993. *China's Environmental Crisis: An Inquiry into the Limits of National Development*. M.E. Sharpe, New York.

Tandia, A.A., Diop, E.S. & Gaye, C.B. 1999. Pollution par les nitrates des nappes phréatique sous environnement semi-urbain non assaini: exemple de la nappe de Yeumbeul, Sénégal. *Journal of African Earth Sciences* 29(4): 809-822.

Tandon, H.L.S. 1993. Assessment of soil nutrient depletion. In: *Proceeding of the regional FADINAP Seminar on Fertilization and the Environment, Chiang Mai, Thailand*. United Nations, New York.

Thanh, N.C. & Tam, D.M. 1990a. Surface water quality management. In: Thanh, N.C. & Biswas, A.K. (Eds.): *Environmentally Sound Water Management*. Oxford University Press, Delhi.

Thanh, N.C. & Tam, D.M. 1990b. Water systems and the environment. In: Thanh, N.C. & Biswas, A.K. (Eds.): *Environmentally Sound Water Management*. Oxford University Press, Delhi.

Todaro, M. 1997. *Economic Development*. 6th Ed. Longman, London and New York.

Todd, D.K., Tinlin, R.M., Schmidt, K.D. & Everett, L.G. 1976. *Monitoring Groundwater Quality: Monitoring Methodology*. U.S. EPA, Report No. EPA/600/4-76-026. U.S. Environmental Protection Agency (EPA), Nevada.

UNEP (United Nations Environment Programme) 1992. *Desertification, Land Degradation – Definitions.* Arnold, London.

UNEP 1995. *Global Biodiversity Assessment.* Cambridge University Press, Cambridge.

UNEP 1996. *Groundwater: a threatened resource.* UNEP, Nairobi.

UNEP/GRID 2001. *Maps and graphics.* United Nations Environment Programme (UNEP) / Grid-Arendal (GRID), Arendal, Norway. http://maps.grida.no (5.5.2006).

UNESCO 1995. *Les Ressources en Eau des Pays de l'OSS: Èvaluation, Utilization et Gestion.* United Nations Educational, Scientific and Cultural Organization/International Hydrological Programme (UNESCO/IHP), Paris.

UNICEF 1999. *Arsenic Mitigation in Bangladesh: Mediabrief.* United Nations Children´s Fund (UNICEF), New York.

Varis, O. 1999. Water resources management: Vicious and virtuous circles. *Ambio* 28(7): 599-603.

Varis, O. & Somlyódy, L. 1996. Potential impacts of climatic change on lake and reservoir water quality. In: Kaczmarek, Z., Strzepek, K., Somlyódy, L. and Priazhinskaya, V. (Eds.): *Water Resources Management in the Face of Climatic/Hydrologic Uncertainties.* Kluwer, Dordrecht / International Institute for Applied Systems Analysis (IIASA), Laxenburg.

Varis, O. & Somlyódy, L. 1997. Global urbanization and urban water: can sustainability be afforded? *Water Science and Technology* 35(9): 21-32.

Wang, X.C., Kawahara, K. & Guo, X.-J. 1999. Fluoride contamination of groundwater and its impacts on health in Inner Mongolia area. *Journal of Water Supply: Research and Technology – Aqua* 48(4): 146-153.

von Weizsäcker, E.U., Lovins, A. & Lovins, H. 1997. *Factor Four: Doubling Wealth, Halving Resource Use*. Earthscan, London.

WHO and UNICEF 2000. *Global Water Supply and Sanitation Assessment 2000 Report*. World Health Organization (WHO) and United Nations Children´s Fund (UNICEF), New York. www.who.int/water_sanitation_health/monitoring/jmp2000.pdf (5.5.2006).

Wilson, E.O. 1992. *The Diversity of Life*. Norton, New York and London.

World Bank 1989. *Philippines: Environment and Natural Resource Management Study*. World Bank, Washington D.C.

World Bank 1997. *Clear Water, Blue Skies: China's Environment in the New Century*. World Bank, Washington D.C.

World Bank 1999. *World Development Indicators 1999 on CD-ROM*. The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2003. *World Development Indicators 2003 on CD-ROM*. The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2004. *World Development Indicators 2004 on CD-ROM*. The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

WRI 1996. *World Resources 1996-97: A Guide to the Global Environment.* A Joint publication by World Resources Institute (WRI), United Nations Environment Programme (UNEP), United Nations Development Project (UNDP), and World Bank. Oxford University Press, New York and Oxford.

WRI 2000. *World Resources 2000-2001: People and Ecosystems: The Fraying Web of Life.* A Joint publication by WRI, UNEP, UNDP, and World Bank. Oxford University Press, New York and Oxford.

WRI 2001. *Earth Trends: The Environmental Information Portal.* World Resources Institute, Washington D.C. http://earthtrends.wri.org/ (5.5.2006).

Zaisheng, H. 1998. Groundwater for urban supplies in northern China – An overview. *Hydrogeology Journal* 6(3): 416-420.

Zaporozec, A. & Miller, J. 2000. *Ground-water Pollution.* United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris.

Zhang, J., Yan, J. & Zhang, Z.F. 1995. Nationwide river chemistry trends in China: Huanghe and Changjiang. *Ambio* 24(5): 275-279.

Zhang, W.L., Tian, Z.X., Zhang, N. & Li, X.Q. 1996. Nitrate pollution of groundwater in northern China. *Agriculture, Ecosystems and Environment* 59(3): 223-231.

7 POLICY TOOLS: THE HUMAN DIMENSION

The international development targets agreed by the International Development Assistance Committee in 2000 include the following issues:

- The proportion of people living in extreme poverty should be reduced by at least 50% by 2015.
- There should be universal primary education in all countries by 2015.
- Progress towards gender inequality and the empowerment of women should be demonstrated by eliminating gender disparity in primary and secondary education by 2005.
- The death rates for infants and children under five should be reduced in each developing country by 2/3 the 1990 level by 2015.
- The rate of maternal mortality should be reduced by 3/4 by 2015
- Access should be available through the primary health care system to reproductive health services for all individuals of appropriate ages, no later than the year 2015.
- There should be a national strategy for sustainable development, in the progress of implementation, in every country by 2005, so as to ensure that current trends in the loss of environmental resources are effectively reversed at both global and national levels by 2015.

These targets are relevant across this theme on policy tools. Clearly, it is important to set ambitious policy targets, and aim at reaching them. There are regions, however, where these targets are obviously unrealistic. For instance, to meet the first goal in Sub-Saharan Africa would require unrealistically high economic growth and very efficient wealth distribution policies. Neither of these is in place at the moment, and even if some signs of improvement are evident in many countries, the changes needed to reach the goal are far too large to be realistic.

After all, the accumulation of social problems and the erosion of the capacity of the countries to deal with those problems tends to be more and more the issue of the least developed countries, particularly in Sub-Saharan Africa. The low-income countries do not perform equally; China with most of S Asia and many other countries has shown ability to tackle several of their problems. A gap widens between these emerging countries and the stagnated, poorest countries grows rapidly.

7.1 Population policy

Olli Varis

Although the first issue that comes into mind when thinking about population policy, family planning, is a key component in reducing excess population growth, the issue is more complex and manifold, both in terms of influencing factors and policy options. Direct and indirect policy tools are available. The latter includes many political and consumption-related issues.

Demographic transition

Population growth is a result of high fertility compared to mortality. In some situations immigration or emigration plays a role, but usually their volume is far smaller than that of fertility and mortality.

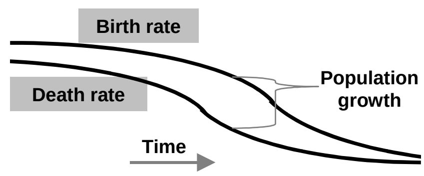
It is typical to the process of economic and social development that the mortality rate decreases well before the fertility goes down. The lag is typically several decades, even a century. It is commonly known as demographic transition (Figure 7.1a, b). The bigger the difference between birth and death rates, the faster the population grows. The longer the transition persists, the longer the population growth phase takes place.

Population policy overview

Population policies target the birth rates either indirectly or directly. Policies addressing them directly—in the short run—include (Todaro 1997):

- *Persuade people to have smaller families* through the educational process and through the media.

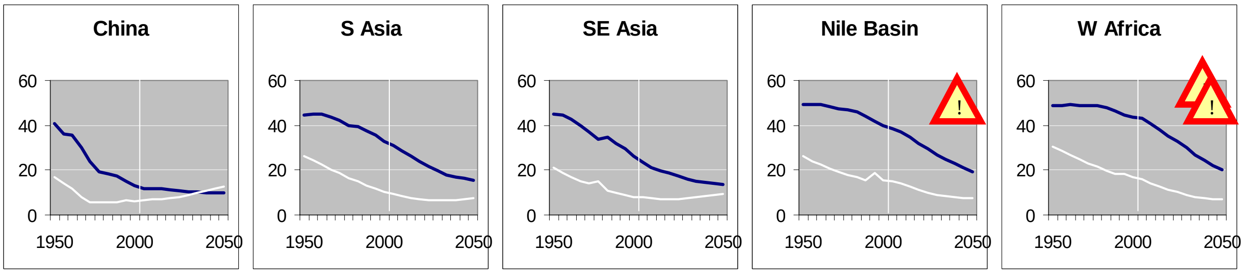
Figure 7.1a
The demographic transition
In the process of development, typically birth rate goes down several decades after the death rate. This lag is the principal cause of population expansion.



- *Establish family planning programs* by contraceptive and health services in order to encourage smaller families. Such programs exist in almost all developing countries, with exception of, for instance, Myanmar, Ethiopia, Zaïre, and Nigeria.

- *To provide economic incentives* to not having many children through maternity benefits, child-labor laws, imposing penalties or economic disincentives for having children beyond certain number, establishment of old-age security programs, etc. Such policies have been efficient in e.g. Singapore, South Korea, Taiwan, and China.

Figure 7.1b
Birth and death rates in the study regions
The demographic transition is very clear in all study regions (the dark line shows crude birth rates (births per 1,000 people) and the white line shows crude death rates (deaths per 1,000 people)). The length of the lag between these two rates as well as the actual phase of transition varies though. In China, the lag is only a few decades, whereas in the African regions, it exceeds 60 years. An alert is well in place due to the high birth rates in the African regions (cf. Figures 7.1f to j). Source: UN (2001b).



- *Coerce people by legislation and penalties* to have smaller families. These policies – for instance India's government-forced sterilization programs and China's one-child policy – have been effective but encountered wide resistance, and have caused plenty of unwished side-effects (Figure 7.1c). India's wide sterilization programmes have been efficient as well, but the resistance has been massive also.

- *Controlling the population distribution and movements* within a country, especially by controlling urbanization through rural development programs and other approaches to balance out economic and social opportunities between rural and urban areas.

- *Raising the economic and social status of women.* This has been mentioned as the prerequisite of the success of any of the above mentioned policy alternatives. This includes equitable opportunities for education, employment, self-sufficiency, etc.

In more general terms, and with an indirect influence, the following features in development policies are particularly crucial in working towards a low-growth population in a country: eliminating absolute poverty, lessening income equalities, providing better educational opportunities (for women in particular), expanding job opportunities, increasing the availability of preventive health care services (water and sanitation to rural and urban poor in particular), maternal and health care improvements, and equitable social services.

Whereas the justification for the application of such active policies is indisputable, many skeptics propose that the television—and more recently the Internet—have been more efficient in population control than most of the population policies.

Direct financial assistance to family planning programs, public education, and national population policy has been growing rapidly during recent decades, being around US$ 3 billion (over 7% of all ordinary development assistance). The importance of this aid is unquestionable.

Other assistance areas such as improved trade relations, appropriate technology transfers, research on more appropriate sharing of world's resources are among the often mentioned ones in this context.

Regional summary

The United Nations Bureau of Economical Affairs (UN 2001a) has accomplished a comprehensive data set and summary of the concerns and adopted policies on the population issue. The data covers 164 countries including all the study countries except Chinese Hong Kong. The data is from the years 1976, 1986, 1996 and 2001.

The results of this report are summarized in the following with respect to the five study regions. The variables taken into closer look are birth rate, death rate, Government's perception of the population growth rate, fertility rate, and adolescent fertility rate. Moreover, the actual, realized policies in fertility control, population control and in terms of support to contraceptive use are analyzed.

Chapter 9.4 on decentralization includes further data from the UN (2001a) study, namely data on regional distribution of population, and Governments' concern on this matter.

Figure 7.1c

More boys than girls in China

Roughly 5%, or 8.7 million female babies are missing in the period of 1979-1995. In the 1990s, the percentage is 10%. Sources: World Bank (1997) and Economist (1998).

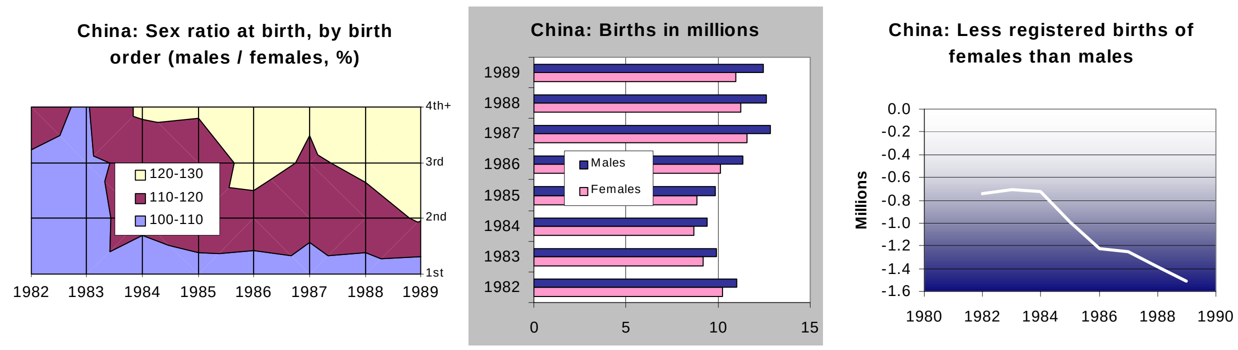
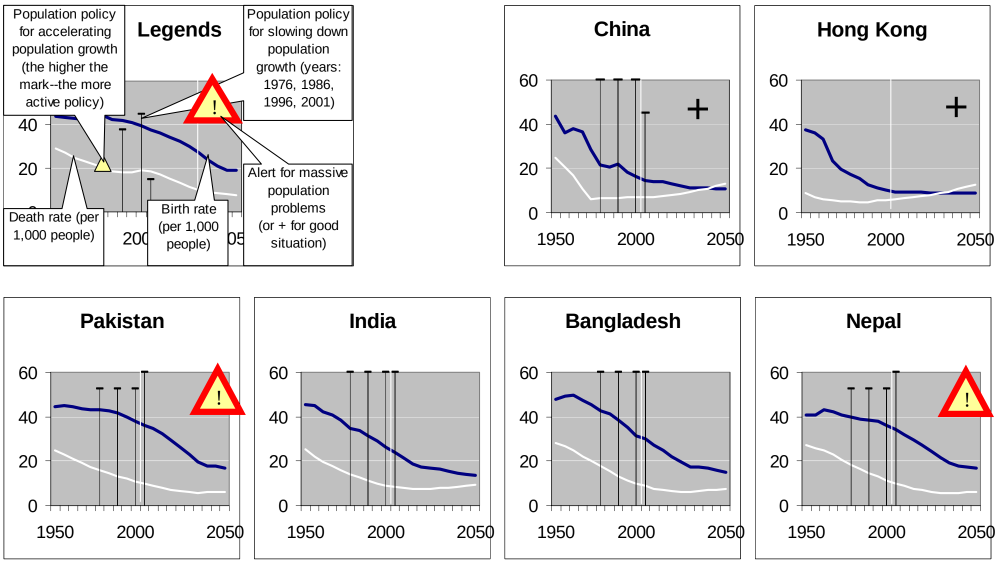


Figure 7.1d
The demographic transition and population policies in China and S Asia
Source: UN (2001a, b).



China and S Asia

China's concern on the growth of its mighty population has been high during the past few decades. The population policies have been efficient as well. Besides some side effects mentioned above, the positive end result has been that the demographic transition has been cut very rapidly and is already virtually over (Figure 7.1d). In fact, China can now afford some relaxation in its population policies (Figure 7.1e).

The S Asian countries have a far broader gap between birth and death rates, which translates continuously into massive population growth (Figure 7.1d). India has been more successful in reducing the fertility than the other countries. Bangladesh follows. Pakistan and Nepal have still very high birth rates.

All the region's countries have imposed population policies over several decades (Figure 7.1e). Obviously, India's policies have been more lucrative than those in the other region's countries. Naturally though, India's economic and social development has also been ahead of the others and this might contribute to the situation. Also the religions might have some influence but such issues are very difficult to detect with analyses such as the one used here (UN 2001a).

Figure 7.1e
A summary of population policies in China and S Asia
Source: UN (2001a).

China	1	2	3	4
A	+	+	.	.
B	\	\	\	\
C	+	+	+	+
D			+	~
E			+	+
F	+	+	.	+
G	\	\	\	\

Pakistan	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			.	.
E			.	+
F	+	+	+	+
G	\	\	\	\

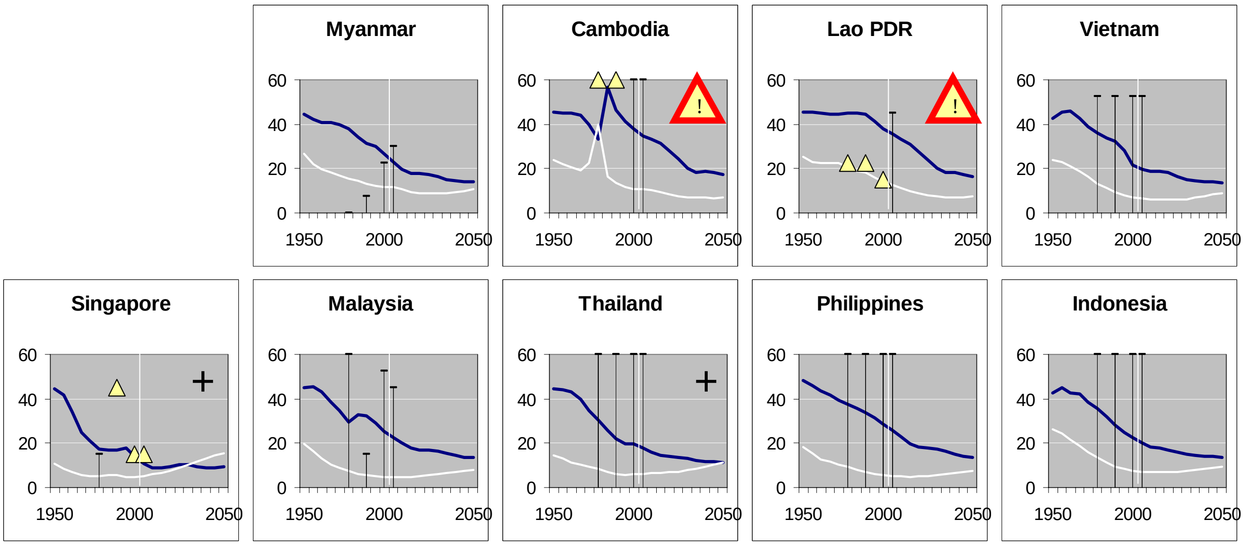
India	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			+	+
E			+	+
F	+	+	+	+
G	\	\	\	\

Bangladesh	1	2	3	4
A	+	+	.	.
B	\	\	\	\
C	+	+	+	+
D			+	~
E			+	+
F	+	+	.	+
G	\	\	\	\

Nepal	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			~	+
E			+	+
F	+	+	+	+
G	\	\	\	\

Legends		Years of evaluation: 1 = 1976, 2 = 1986, 3 = 1996, 4 = 2001			
	Variable	Possible outcomes			
A	View on fertility level	- too low	. satisfactory	+ too high	Grey shading:
B	Policy to modify fertility	/ raise	. no intervention, maintain	\ lower	missing data
C	Access to contraceptive methods	- limit	. no support	~indirect support	+ direct support
D	Level of concern on adolescent fertility	. not a concern	~minor concern	+ major concern	
E	Policies and programmes addressing adolescent fertility	- no	+ yes		
F	View on population growth	- too low	. satisfactory	+ too high	
G	Policy on population growth	- limit	. no support	~indirect support	+ direct support

Figure 7.1f
The demographic transition and population policies in SE Asia
For legends, see Figure 7.1d. Source: UN (2001a, b).



SE Asia

The diversity of population policies and demographic patterns among the SE Asian countries is considerable (Figures 7.1f and g). Singapore has had a very low fertility since the 1970s, and it has shifted its population policies from controlling fertility to enhancing it.

The middle-income countries Malaysia, Thailand, the Philippines and Indonesia have all been able to reduce the birth rates considerably during the last decades of the 20th Century, and the demographic transition is no longer as massive as it used to be. Malaysia and Thailand have already relaxed their population policies to certain extent.

Among the low-income countries, Myanmar and Vietnam have been far more successful in birth control than Cambodia and Lao PDR. Strangely though, in the recent past, the two latter ones have had policies that enhance birth rate instead of lowering it. Cambodia's situation is, of course, very extraordinary due to the bloody times of the late 1970s when the Khmer Rouge slaughtered over one million people in the country. This massacre was followed by a strong peak in the birth rate, as is often the case after wars.

Figure 7.1g
A summary of population policies in SE Asia
For legends, see Figure 7.1e. Source: UN (2001a).

Myanmar	1	2	3	4
A	.	.	+	.
B	.	.	.	.
C	.	~	+	+
D			.	+
E			.	+
F	.	.	.	.
G	.	.	.	.

Cambodia	1	2	3	4
A	-	-	+	+
B	/	/	\	\
C	-	-	+	+
D				
E				
F	-	-	+	+
G	/	/	\	\

Lao PDR	1	2	3	4
A	.	.	.	+
B	.	.	.	\
C	-	-	.	.
D				
E				
F	-	-	-	.
G	/	/	/	\

Vietnam	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			~	~
E			+	+
F	+	+	+	+
G	\	\	\	\

Singapore	1	2	3	4
A	.	-	-	-
B	.	/	/	/
C	+	+	+	+
D			~	~
E			+	+
F	.	-	.	.
G	.	/	.	.

Malaysia	1	2	3	4
A	+	.	+	+
B	\	.	\	\
C	+	+	+	+
D			~	+
E			+	+
F	+	.	+	.
G	\	.	\	.

Thailand	1	2	3	4
A	+	+	+	+
B	\	\	\	.
C	+	+	+	+
D			+	+
E			+	+
F	+	.	+	.
G	\	\	\	.

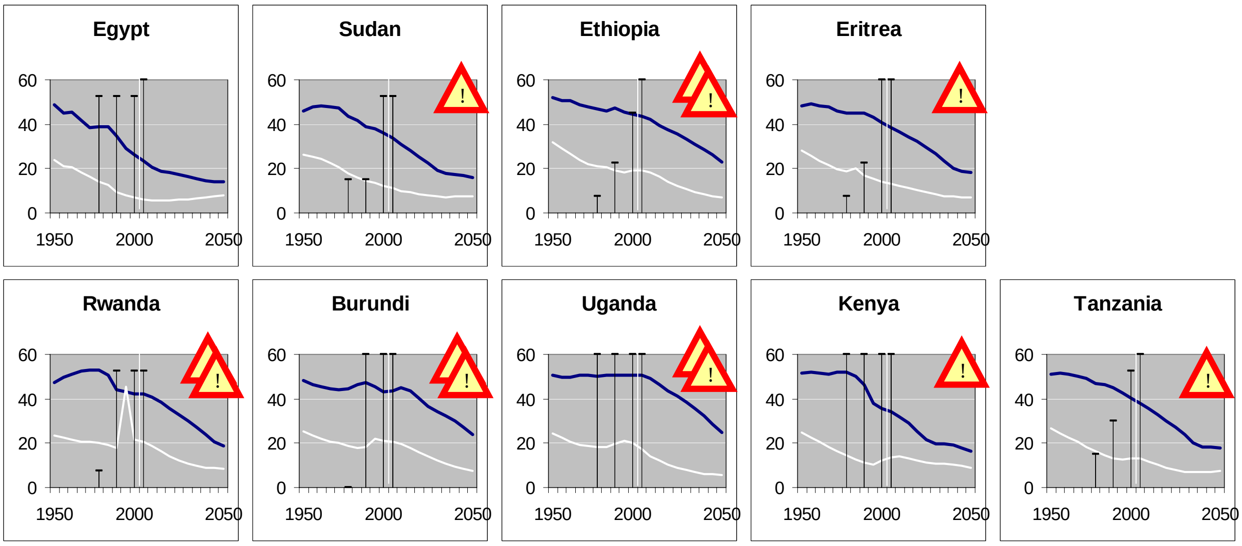
Philippines	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			+	+
E			+	+
F	+	+	+	+
G	\	\	\	\

Indonesia	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			+	+
E			+	+
F	+	+	+	+
G	\	\	\	\

Figure 7.1h

The demographic transition and population policies in the Nile basin countries

For legends, see Figure 7.1d. Source: UN (2001a, b).



The Nile basin countries

As in so many other respects, Egypt is very different from the other Nile basin countries what comes to demographics and population policies (Figures 7.1h and i). Its demographic transition is a few decades ahead of that in the other countries.

Among the other countries, Kenya has had the most efficient population control. In the other countries the population seems to be bound to grow rapidly still for many decades. All countries have already a population program unlike in W Africa (see below).

W Africa

Most of the region's countries have very loose population policies, and some countries have even made attempts to enhance birth rates which is strange given the situation those countries have been in (Figure 7.1j).

Each country will face notable population growth several decades ahead. They should implement far more strict population programs as they have had by now. The Sahelian countries Chad, Niger, Burkina Faso, and Mali are perhaps the most problematic countries, given their economic situation.

Figure 7.1i

A summary of population policies in the Nile basin countries

For legends, see Figure 7.1e. Source: UN (2001a)

Egypt	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			+	+
E			.	+
F	+	+	+	+
G	\	\	\	\

Sudan	1	2	3	4
A	.	.	+	+
B	.	.	\	\
C	+	+	+	+
D			.	.
E			.	.
F	.	.	+	+
G	.	.	\	\

Ethiopia	1	2	3	4
A	.	+	+	+
B	.	.	\	\
C	~	+	+	+
D			+	+
E				+
F	.	+	+	+
G	.	.	.	\

Eritrea	1	2	3	4
A			+	+
B			\	\
C				+
D				
E				
F			+	+
G			\	\

Rwanda	1	2	3	4
A	+	+	+	+
B	.	\	\	\
C	.	+	+	+
D			~	~
E			+	+
F	.	+	.	+
G	.	\	\	\

Burundi	1	2	3	4
A	.	+	+	+
B	.	\	\	\
C	.	+	+	+
D			.	.
E			.	.
F	.	+	+	+
G	.	\	\	\

Uganda	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			+	+
E			+	+
F	+	+	+	+
G	\	\	\	\

Kenya	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			+	~
E			+	+
F	+	+	.	+
G	\	\	\	\

Tanzania	1	2	3	4
A	.	+	+	+
B	.	.	\	\
C	+	+	+	+
D			~	+
E			+	+
F	.	+	+	+
G	.	.	\	\

Figure 7.1j
The demographic transition and population policies in W Africa
For legends, see Figures 7.1d and e. Source: UN (2001a, b).

Mauritania	1	2	3	4
A	.	.	.	.
B	.	.	.	.
C	.	.	+	+
D			.	.
E			.	.
F	.	.	.	.
G	.	/	.	.

Mali	1	2	3	4
A	.	.	+	+
B	.	.	\	\
C	+	+	+	+
D			~	~
E			+	+
F	.	.	+	+
G	.	.	\	\

Burkina Faso	1	2	3	4
A	.	.	+	+
B	.	.	\	\
C	.	~	+	+
D			+	+
E			+	+
F	.	.	+	+
G	.	.	.	\

Niger	1	2	3	4
A	.	+	+	+
B	.	\	\	\
C	.	+	+	+
D			.	+
E			.	+
F	.	+	.	+
G	.	\	.	\

Chad	1	2	3	4
A	.	.	.	.
B	.	.	.	.
C	-	.	~	~
D				
E				
F	.	.	.	.
G	.	.	.	.

Senegal	1	2	3	4
A	+	+	+	+
B	.	\	\	\
C	.	+	+	+
D			+	+
E			+	+
F	+	+	+	+
G	.	\	\	\

Gambia	1	2	3	4
A	.	+	+	+
B	.	\	\	\
C	~	+	+	+
D			~	~
E			+	+
F	.	+	+	+
G	.	\	\	\

Guinea-Bissau	1	2	3	4
A	.	.	+	+
B	.	.	.	.
C	~	+	+	+
D			+	+
E			+	+
F	.	.	.	.
G	.	.	.	.

Guinea	1	2	3	4
A	.	+	+	+
B	.	.	\	\
C	.	+	+	+
D			+	+
E			.	.
F	.	.	+	+
G	.	.	\	.

Sierra Leone	1	2	3	4
A	+	+	+	+
B	.	.	\	\
C	+	~	~	~
D			+	+
E			+	+
F	+	+	+	+
G	.	.	.	.

Liberia	1	2	3	4
A	+	+	+	+
B	.	.	\	\
C	+	~	+	+
D			+	+
E			+	+
F	+	+	+	+
G	.	.	\	\

Côte d'Ivoire	1	2	3	4
A	.	.	.	+
B	.	/	/	\
C	.	.	~	+
D				
E				+
F	-	.	.	+
G	/	/	/	\

Ghana	1	2	3	4
A	+	+	+	+
B	\	\	\	\
C	+	+	+	+
D			+	+
E			+	+
F	+	+	+	+
G	\	\	\	\

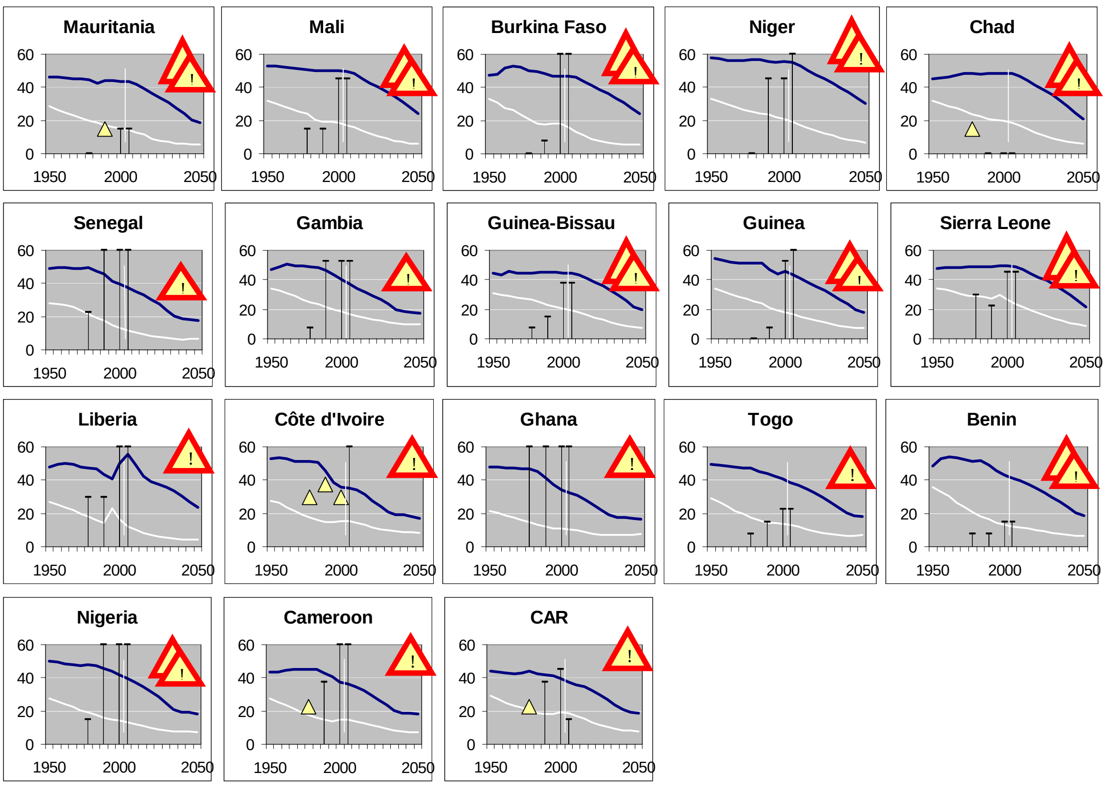
Togo	1	2	3	4
A	.	.	.	.
B	.	.	.	.
C	~	+	+	+
D			+	+
E			.	.
F	.	.	+	+
G	.	.	.	.

Benin	1	2	3	4
A	.	.	.	.
B	.	.	.	.
C	~	~	+	+
D			~	~
E			.	.
F	.	.	.	.
G	.	.	.	.

Nigeria	1	2	3	4
A	.	+	+	+
B	.	\	\	\
C	+	+	+	+
D				
E				
F	.	+	+	+
G	.	\	\	\

Cameroon	1	2	3	4
A	-	+	+	+
B	.	.	\	\
C	~	+	+	+
D			+	+
E			+	+
F	-	+	+	+
G	/	.	\	\

CAR	1	2	3	4
A	-	+	+	.
B	.	.	.	.
C	.	+	+	~
D			.	~
E				+
F	-	+	+	.
G	/	.	.	.



7.2 Education

Tommi Kajander and Olli Varis

Education and development are linked through many mechanisms. The educational system reflects the society and social norms in inequality, gender, rural/urban biases, etc. It provides a major vehicle for tackling these issues in a longer time frame. All education levels – from primary level to university education – are necessary facilitators to development.

Overview

The absolute, quantitative growth in education has been tremendous during the last few decades. Between 1960 and 1990, there was an annual increase of 5% of people enrolled in the three levels of basic education (primary, secondary, and tertiary) in developing countries. The total number augmented from 163 million to 440 million during this period (Todaro 1997).

Although the access to education has significantly increased, the number of children not enrolled has decreased just by fourteen million between 1990 and 1998. There are still 113 million children out of school, out of which 97% live in less developed countries and 60% are girls. The situation is particularly bad in Sub-Saharan Africa where the number of children not in school has increased from 39 million in 1990 to 42 million in 1998 (UNESCO 2000). Tremendous efforts are needed to achieve the ambitious goal set by the UN countries in 2000 to provide universal primary education by year 2015 (Box 7.2a). Some countries are working hard though, as can be seen in the case of Uganda (Box 7.2b).

Box 7.2a

Education for all by 2015 – a millennium goal

The Universal Declaration of Human Rights of 1948 proclaimed that elementary education is a human right and shall be free and compulsory for everyone. However, global efforts promoting universal primary schooling have begun just one decade ago. The international community agreed for the first time to strive for universal primary schooling at the World Conference on Education for All in Jomtien, Thailand, in 1990. More recently, in September 2000, the UN countries adopted the eight Millennium Development Goals out of which one is to achieve universal primary education by 2015.

Strong political will and intensive commitment by the governments is required. Generally governments are still spending too little on primary education. The Millennium Goal for Education has the following keys:

- It creates a massive demand for teachers.
- Diminishing status of teachers and the deteriorating working conditions are main causes for teacher shortage.
- The value and merits of education must be well understood by parents.
- Demand for education and employment possibilities must occur. Relationship between education and increased income level must exist.
- Empowerment of parents and communities is important to achieve transparency and accountability in the education system.
- Education must be free.
- Reallocation of public funds. On average, countries channeling more funds to education can reach more children.
- Curriculum reform.

Box 7.2b

Uganda's education reform doubled the number of primary school entrants in four years.
Inter alia strong political and financial commitment by the government, comprehensive studies and broad communication and consultation with all the stakeholders have been crucial in the process.

In the late 1980s Uganda's education sector was in a severe disorder. Due to the two decades of turmoil and dictatorships, the social, economic and political infrastructure of the country was at the breaking point. Almost 70% of the school buildings were destroyed or had fallen into disrepair. Teachers were demoralized and spending less than 60% of the expected time in the school premises. More than half of the teachers were untrained, syllabus was lacking and one textbook was shared by fifteen pupils. The gross enrollment rate had fallen to 50% while the retention rate in the primary school was even lower. Less than 30% of the children completed their primary education (Makubuya 2002).

It was rapidly realized that a massive reform in the education sector focusing on primary education was needed to restore Uganda's economic growth and human development. Before preparing and implementing concrete plans of the education reform, comprehensive studies were executed to update the sector knowledge. In addition wide consultations with stakeholders were conducted. Meanwhile the government carried out rehabilitation and reconstruction activities.

The Universal Primary Education (UPE) program launched in 1997 included several measures to improve the state of the education system. One of the most efficient ways to increase enrollment rates was the removal of tuition fees. Government provided free education for four children per household. Teachers' motivation and attendance was improved by rising their salary over tenfold between 1992 and 2001. The quality of teaching was further ameliorated through teachers' in- and pre-service education and training programs. The lack of textbooks was alleviated by liberating their production and distribution through a separate policy reform. In addition the primary school curriculum was amended to include more teaching of basic and vital skills enabling the learners to earn a living.

Uganda's education policy reform has been a success. The number of enrolled children has increased from 2.7 millions in 1996 to 6.6 millions in 1999 out of which 47% were girls. Between 1990 and 1999 the number of schools and classrooms has increased by 38% and 78% respectively (Nannyonjo 2001). Although the primary school completion rate has increased, it is still low being just 45%.

The key factor enabling such a reform is the strong commitment – political and financial – of the government. The funding for education has more than doubled since 1986 and was 33% of the overall national budget in 2001. Additionally focus has moved more on the primary education, which receives at present 70% of the national education budget. The increasing funding on education has greatly been facilitated by the HIPC debt relief initiative and other bilateral financial support.

This chapter starts by discussing the links between education and development. The educational outcomes in the study countries are touched by comparing the educational levels, illiteracy rates and primary school drop-outs. Contemplation of the factors affecting the educational outcomes follows. Finally ideas on higher education on water are discussed.

Education and development

There is a wide-reaching selection of interlinkages between education and development. The educational system should provide people with skills that are balanced with the (future) needs of the society. Therefore, all the levels from primary education to universities are needed for a balanced system (Box 7.2c).

Todaro (1997) clusters the links between education and development in five groups:

- *Economic growth*: It cannot be denied that an educated and skilled labor is a necessary condition to sustained economic growth. The importance of the growth of human capital has been emphasized widely – as being more instrumental than the growth of physical capital – as a factor that has determined the growth of economies. Both economic growth and education are, however, very manifold topics, and analyses should go beyond simple statistical studies to scrutinize patterns and structures of the issue.

- *Inequality and poverty*: The educational system should be a vehicle in the alleviation of poverty and inequality, and it should be developed to meet these challenges. However, the educational systems tend to increase inequalities than decrease them in some developing countries. This is because the relative opportunity costs of children from poor families – who often need to earn money – are much higher than for more affluent families. Therefore, the poor have less incentive and possibilities to participate in education. This disparity has been observed to grow with the level of education, being highest among University students.

- *Brain drain*: Educated people have been observed to be prone to migrate, both within and between countries. The rural-urban migration of

Box 7.2c

All levels of education are necessary for balanced development

The case of lack of highly educated people as one of the obstacles of the development of The Democratic Republic of Congo.

In Congo, at the time of early independence, illiteracy was among the lowest of African countries: in 1965, the rate of enrollment in primary education was 70% (World Bank 1992). It also had an exceptionally high standard of living compared with its neighbors, and a developed health care system. The problem was the almost complete lack of highly educated, local people: there were no doctors, lawyers, engineers, etc. besides foreigners. This has been proposed as one of the key reasons to the very bloody post-independence history of the present-day Democratic republic of Congo (formerly Zaire) – the country has not been able to develop institutional capacity to develop the country, and, despite of its enormous natural resources, it is apparently one of the least developed countries of the world – although it had a low Illiteracy rate already many decades back. Congo is just one example of this phenomenon.

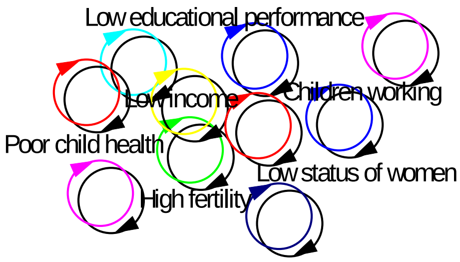
educated people (often with the unfortunate consequence of reducing job opportunities to urban poor), and the migration of the most skilled and educated people from poor to rich countries, are both well known phenomena. However, neither of them is a solely negative issue to the society that educates these people.

- *Women, fertility, and child health*: It has been shown in many studies (e.g. World Bank 1992, Todaro 1997) that women's education is an efficient tool in breaking the multigenerational vicious circle of poor child health, low educational performance, low income and high fertility, which circle back to poor child health (Figure 7.2a). However, the educational system should in this respect be in balance with the society's real needs, and the job opportunities. Otherwise, the results in, e.g., combating against high fertility rates can be discouraging. Plenty of evidence exists also on the important role of rural female education in increasing rural-urban migration, much more than is the case with male education.

Figure 7.2a

Multigenerational vicious circle of fertility, gender, poverty and education

There exist multiple handles to the problem because the vicious circle consists of many interlinked issues. However, none of the handles may appear too efficient alone; many of them must be approached in parallel.



- *Rural development*: According to Todaro, the school system exhibits a strong urban bias in many developing countries. It should place much more emphasis than at present to applied areas such as improving agricultural skills or to function more effectively in the process of rural development. This would mean that besides the traditionally emphasized general/basic education, there should be strong components of family improvement education, community improvement education, and occupational education.

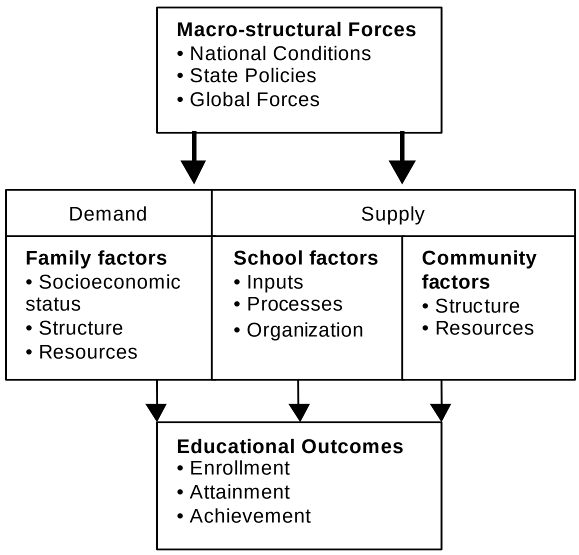
Educational outcomes

As stated above, education has various effects on societies promoting the economic and human development of nations. How significant these effects are depend largely on the educational outcomes, which can be determined in various ways including i.a. enrollment rates, school attainment and achievement.

Figure 7.2b

Factors affecting educational outcome

Macro-structural forces shape educational stratification by affecting the demand for education and the provision of educational opportunities or supply (adapted from Buchmann and Hannum 2001).



There are several factors affecting the educational outcomes of school systems but can be divided in three main categories (Buchmann and Hannum 2001). These are the family, school and community factors. The former is commonly referred to as demand whereas the school and community factors are referred to as supply. Finally there are the macro-structural forces which affect the demand and supply for education (Figure 7.2b). Obviously the Figure 7.2b is simplified as all the factors are interconnected and affect each other.

In the following two sections the educational outcomes in the study regions are compared by analyzing the gross enrollment rates, literacy rates, and primary school completion rates. Subsequently the factors, which affect the educational outcomes are discussed.

Regional comparison

Education and literacy are the most important prerequisites for development, whether it is measured by economic or human criteria (e.g. UNDP 1996). If levels of education and literacy are low, development of water resource management and agriculture are slow, too, and it is unlikely that outside aid will improve the situation permanently.

In considering educational levels (Figure 7.2c) the differences in the countries of the study areas are large. In China and SE Asia, except Laos and Cambodia, almost everybody completes at least the lower level of comprehensive school. In S Asia, except in Pakistan, the situation will gradually become similar. There are, however, several countries in Africa, e.g., Sudan, Burundi, Ethiopia, Guinea, Burkina Faso, Niger, Liberia and Mali, where only one half of all children begin school.

Even more variation can be seen in the educational level for twelve to seventeen year-olds than for the youngers. At best the gross enrollment rate is about 80% in Singapore, the Philippines and Egypt, while it is lower than 20% in many African countries and in Bangladesh. Also in these countries the rate of growth is almost zero. It is also interesting to notice the large variations in Chinese statistics due to different political orientations.

The educational level for eighteen to twenty-three year-olds is very low in most countries and the growth rate is not high either. There are exceptions: several SE Asian countries, Hong Kong and Egypt. The best-educated people educate the rest of the population and develop the means of livelihood and national institutions. Without them the country is incapable of helping itself out of the treadmill of poverty and famine.

A rapid progress can be seen in literacy in all the study countries (Figure 7.2d). The education level will affect the average illiteracy of the adult population, with a delay of decades. In China and SE Asian countries except Laos and Cambodia illiteracy is less than 20%. Illiteracy rates exceeding 70% are the highest found in the study countries. In the W African countries of Niger and Burkina Faso, 85% and 77% of the populations are illiterate. In almost all the countries studied the literacy gap between gender is wide. Women's educational level is closely linked to population growth and its control (UNDP 1996).

As summed up in Figures 7.2c and 7.2d above, access to education and literacy rates have steadily grown. The enrollment rate gives however a one-sided picture of the state of the education as it includes repeat students and tell nothing about the quality of schooling. Besides improving the access to education, its beneficiation and the increasing of completion rates play a central role in effective education policies.

The percentage of primary school entrants reaching grade five is one applicable indicator when assessing the functionality of primary education. The indicator is important as it is generally considered that at least four years of good quality education are needed to attain permanent literacy and numeracy (Watkins 2000). In addition the primary education (or commonly the first five grades) has a significant role as it is the only schooling for a major part of the children in the Third World. On the other hand it is the ground and prerequisite for further schooling.

As illustrated in Figure 7.2e the percentage of children reaching grade five or inversely the drop-out rate varies considerably among the study countries. The highest completion rates are found in Egypt, China and Indonesia (Malaysia and Thailand with completion rates of 99% and 97% respectively are excluded). These countries have high enrollment rates and high GNP/capita as well. However China's good educational performance can be probably explained partly by its millennium old schooling tradition. It is interesting to notice that in Philippines, which has the highest GNP/capita and high enrollment, just 69% of the primary school students reach grade five.

Also noteworthy are the very high gross enrollment rates but remarkably low retention rates in the S and SE Asian countries. In Nepal, India, Cambodia and Lao PDR the enrollment figures exceed 100% while the completion rates vary between 44% and 57%. The situation tells inter alia about the high repetition rates, which increase the gross enrollment but decrease the completion rates. In Pakistan the situation is bad as well. Just half of the enrolled children reach the grade five. The enrollment is however low (74%) as well.

Figure 7.2c

Access to education by regions

Gross enrollment ratios (%). The situation is worst in Sub-Saharan Africa, and the progress there has been slower than elsewhere (source: World Bank 2001).

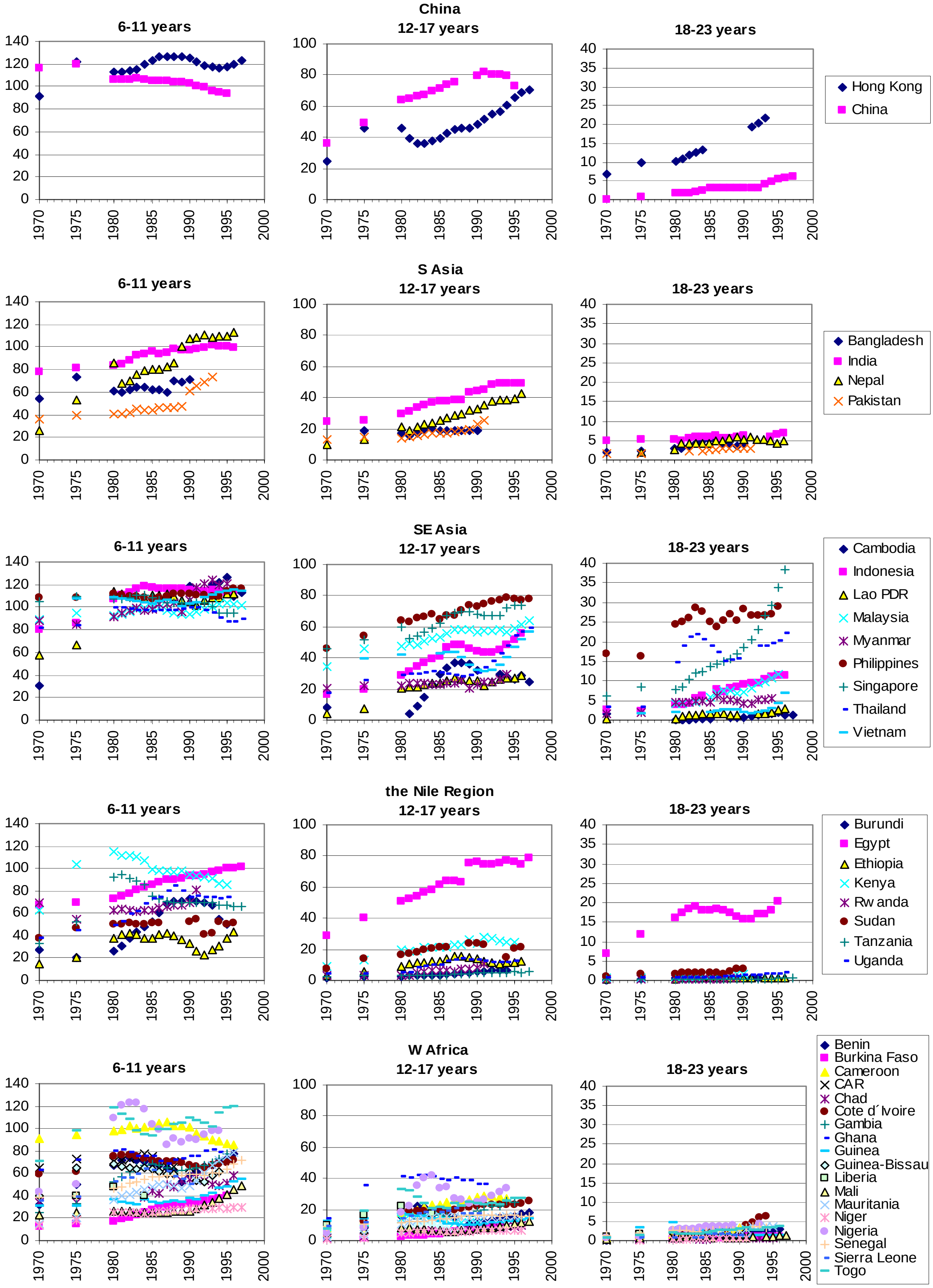
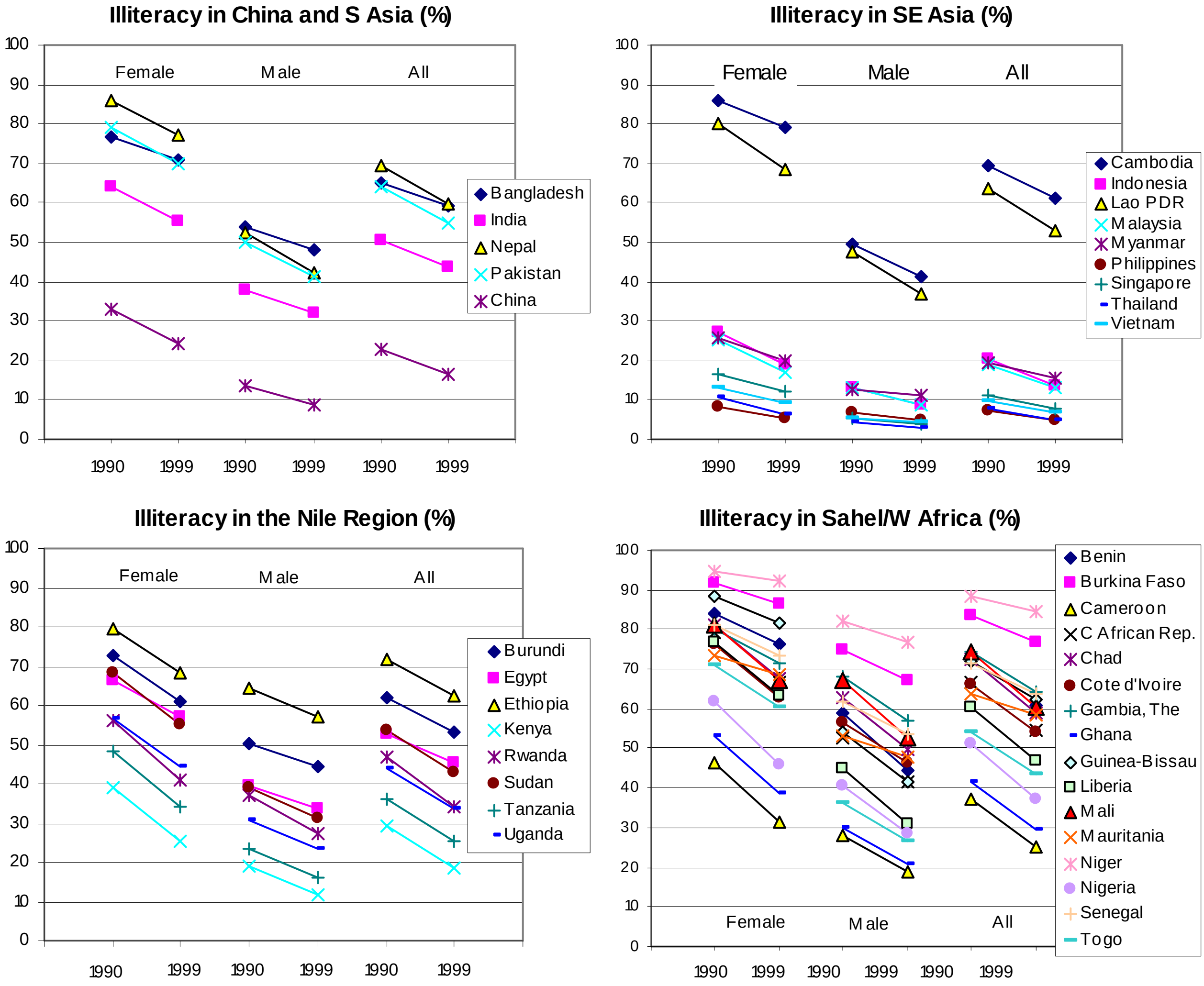


Figure 7.2d
Illiteracy goes down, but the gender disparity is big in all regions
Adult illiteracy (over 15 years) of women, men, and the total population by the regions (source: World Bank 2001).



Out of the S Asian countries Bangladesh seems to perform better as 70% of the children reach grade five despite the fact that just 72% are enrolled.

Biggest divergence in terms of the drop-outs is found in W Africa. The lowest efficiency of education systems occur in Central African Republic and Guinea-Bissau where nearly 80% of the primary school students quit before reaching grade five. On the other hand in Guinea and Mali the primary school retention rates are high being 78% and 84%, respectively, although the gross enrollment rates are below 50%.

The figures given above are country averages and give some idea about the state of primary education in the study countries. It should be however kept in mind that variations at national level exist. Gender gap and rural/urban bias are often prominent. Girls in the remote rural areas are most vulnerable to miss primary education or drop-out.

It is clear that industrialized countries with high GNI per capita can provide extensive educational opportunities and witness negligible drop-out rates. The analysis above substantiate however that when considering the low-income countries, GNI per capita does not determine the primary school drop-out rates nor the gross enrollment rates. Neither can the primary school completion rate be explained by the gross enrollment rate.

Factors affecting educational outcomes

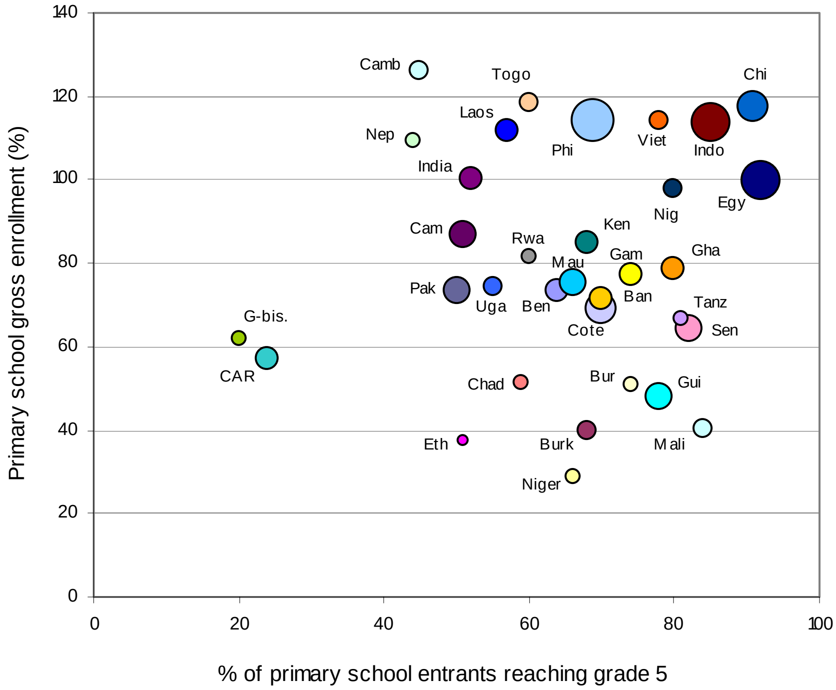
First of all there are the macro-structural forces which shape the educational outcomes by affecting the demand and supply for education. Macro-structural forces comprise the national and global levels including national conditions, state policies and global forces.

States use educational policies to determine the structure of the educational system and to shape the provi-

Figure 7.2e

High enrollment rates delineate rarely the actual state of the education in the developing countries

Primary school gross enrollment rate and the % of primary school entrants reaching grade five in the study countries. The size of the ball indicates to the GNP/capita of the country. For Liberia, Myanmar, Sudan, and Sierra Leone data was not available. Thailand and Malaysia with a GNI per capita of US$ 2820 and US$ 4110 were excluded to keep the figure illustrative. Their primary school completion rates are high being 97% for Thailand and 99% for Malaysia (sources: World Bank 2001 and UNICEF 2002).



sion of educational opportunities. The demand for education can be nourished e.g. by ameliorating the quality of schooling, enacting a law on compulsory school attendance, or expounding the benefits of edu cation. However it is often difficult as governments in the third world have strongly limited economic and organizational resources. Consequently the educational institutions might be ineffective and unstable (Fuller and Rubinson 1992, Fuller 1991; cited in Buchmann and Hannum 2001).

At the global level education in the developing countries is affected by the preferences and policies of the international organizations and the expansion of Western ideology and organizational forms. It is the external pressure of the global political culture related to the modern ideals of individual and national development, which partly creates the convergence of the educational systems in the developing countries (Inkeles and Sirowy 1983, Meyer et al. 1992; in Buchmann and Hannum 2001). It is also argued that educational opportunities in the Third World are curtailed by its dependence on multinational corporations and international financial organizations. Debt servicing of indebted developing countries allocates resources away from basic education (Watkins 2000).

Besides the individual characteristics of the child, the family, school and community factors, which are shaped by the macro-structural forces, determine the educational outcomes. According to the present day understanding family factors are the most important predictors of educational outcomes (Buchmann and Hannum 2001).

The demand for education emerges in the families. Parents decide about the educational level of their children. If education is considered useless or of poor quality and the nexus between schooling, employment and improved standard of living is nonexistent there is little reason to put children at school. This is particularly true if schooling costs. Lack of financing and the direct benefits gained from the children’s work contribution keep them out of school.

In addition to the household’s wealth, school participation and grade attainment depend on several other issues. Drèze and Kingdon (1999) found that household variables including parental education and motivation, social background and dependency ratios had significant effect on school participation in rural India.

Craig and Henevald (1996) have identified eighteen key factors that affect the quality of primary education and thus the student outcomes. These factors can be clustered in four groups, which are the supporting inputs, school climate and enabling conditions and teaching/learning processes (Table 7.2a). When considering the school climate and enabling conditions as organization, the framework is identical with the school factors illustrated above in Figure 7.2b.

Table 7.2a
Priority factors affecting the quality of primary education and thus student outcomes
Source: Craig and Henevald (1996)

Supporting inputs	• Parent and community support • Support from the education system • Teacher development activities • Textbooks and other materials • Facilities
School climate	• Expectations of students • Teacher attitude • Order and discipline • Organized curriculum • Rewards and incentives
Enabling conditions	• Effective leadership • Capable teaching force • Flexibility and autonomy • High time-in-school
Teaching/ learning processes	• Learning time • Teaching strategies • Homework • Student assessment and feedback

Traditionally the project designs have mainly focused on the supporting inputs. During the last two decades efforts have commonly been put on e.g. textbook projects (UNESCO 1997), teacher training, school construction and school feeding programs while the other clusters have received less attention. Definitely the inputs such as textbooks and school facilities are fundamental. However the other three clusters determine how efficiently the inputs are converted to educational outcomes.

School climate can have a considerable effect on the educational outcomes. Ackers et al. (2001) state that in the primary schools of Kenya the teaching styles is the key factor besides the paucity of the school environment which contrive the drop-outs at grade one. In addition the low motivation of teachers is a major problem in Kenyan primary schools. Lloyd et al. (2001) found that teacher treatment and attitude is one of the most significant factors explaining the grade levels attained in Egypt and Kenya.

Whatsoever the effect of the curriculum is on the educational outcomes it is the core of schooling and deserves some attention. UNICEF (2000) adduce the content of curriculum as one of the five points concerning quality education. It states that: *"Quality education includes content that is reflected in relevant curricula and materials for acquisition of basic skills, especially in the areas of literacy, numeracy and skills for life, and knowledge in such areas as gender, health, nutrition, HIV/AIDS prevention and peace."*

Where is the environmental aspect? One of the means to tackle environmental degradation and to promote sustainable development is definitely education – at all educational levels from primary schools to tertiary education. As children assume easily manners and knowledge environmental education can be effective and should be included in the curriculum of primary schools.

As illustrated in Table 7.2a there are many factors determining the school quality that affects the educational outcomes. These are interconnected. Additionally the features of school quality that matter the most are context-specific and differ between boys and girls. Quality improvement of education needs a holistic approach. In addition the participation and cooperation of students, parents, teachers and communities is essential to achieve sustainable results.

There are numerous papers concerning the quality of education. For further information see e.g. Williams (2001) and UNICEF (2000).

The other element forming the supply of education besides the school factors are the community factors. Communities can play a major role in providing educational opportunities. Schools managed and created by communities increase access to education where public schools are not available. Participation of communities often improves the quality of schooling, its cost-effectiveness and student achievement as well. For an extensive literature review of community schools in Africa see Miller-Grandvaux and Yoder (2002).

Higher education on water

Primary education has received a lot of attention in the sections above. It is after all essential for the development of the society. The other end of the education system – the institutes of higher education – is equally important. In the following a discussion is provided on the higher education on the water sector, that underlines the multidisciplinarity concept.

The academic world has undergone and is perhaps increasingly experiencing a tendency of specialization. The education is splitting into more and more specific, narrow, and profound disciplines. This process is usually, very unfortunately though, followed by the erosion of generalistic views over the society and the nature. Academic incentives, resource constraints and many other factors contribute to this development. Societies and other levels of education come along; sectorial approaches to development have dominated, too much in many ways.

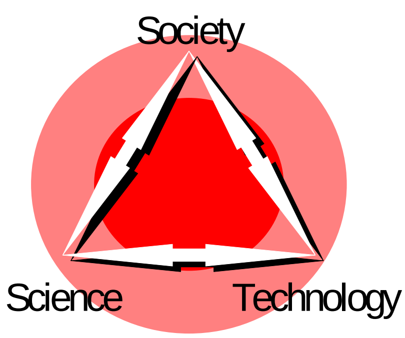
When discussing the present challenges to human resource development to support sustainable infrastructure development, with special reference to higher education in the water sector, we argue that profound changes in paradigms of water management, education, infrastructure, etc., are needed to meet these challenges with success. The issue is discussed, with emphasis on the importance of holistic views to the social, political, natural, economic, and technical complexity and interactions. Education — at the university level in particular — should take these views into account much more than is done at present.

The two focal issues to be considered in higher education to better cope with the water issue in cities are

(1) each individual with higher education should possess a generalistic view to the society, science and technology, and feel responsibility which should go hand in hand with the power and privilege due to education (Figure 7.2f),

(2) the educational system should encourage and teach the individuals to include the question *why* in their personal agenda, besides the question *how*, which is too dominant, and even dangerous without the concern of the question *why* (Figure 7.2g).

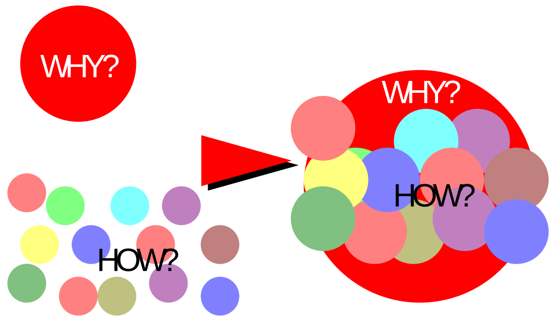
Figure 7.2f
Generalistic views needed.
Higher education should provide, in addition to discipline-specific expertise, a generalistic view over society, technological possibilities and options, as well as scientific facts and approaches (Varis 1998).



Higher education is just one part of human resources development. Clearly, it should fit the rest of the society, yet being hopefully somewhat ahead of the overall development, in a leadership position in a long term. All levels of education are needed, and the primary education is clearly the prerequisite for balanced development. Public awareness and participation which is increasingly emphasized today, requires education at very principal level. Yet, organization of primary education is impossible without universities.

Water related education at higher levels has traditionally been split into several disciplines including several engineering subjects (hydraulic engineering, water resources management, water supply, sanitation, etc.), a number of subjects in applied sciences (limnology, hydrogeology, etc.), and in pure science (hydrobiology (botany, zoology, etc.), hydrophysics, aquatic chemistry, etc.). Though it is mandatory to go further and further into details in these important fields, the overly reductionistic approach should be balanced by providing more of general topics to individuals. In engineering education, for instance, this means more education in science (natural, social and political) and in pragmatic issues such as institutions and law. This would change the approach from one profound technological focus (vertical) to include another, horizontal dimension, not as a by-product as is typical today, but as a field of strong expertise, not a most profound one, but rather a holistic view.

Figure 7.2g
Know-how and know-why.
Higher education should provide, in addition to discipline-specific expertise ("know-how"), also enough background to comprehend the driving forces and consequences of the development ("know-why") (Varis 1998).



In hydraulic engineering, for instance, the comprehension over water has traditionally been restricted to the convey of water through a technical or semi-natural system in a desired way (minimize energy loss, seepage, erosion, etc.). This is no longer enough. A view on environmental issues, water quality, resource management, project evaluation (financial, technical, economical, environmental, social, informational, and institutional, cf. Munasinghe 1993) is necessary. Not at the level of knowing all details, but to understand the issue (project, plan, policy, program) as an entity. At the contingency planning level, such as city development, this is still more crucial. The world has evidenced too many cases that have been fully successful at detailed levels, but disasters as a whole. One could continue to other disciplines, and the same outline would apply to them as well.

7.3 Poverty reduction

Olli Varis

The dilemma of poverty reduction is that the poorest countries have the lowest economic growth, the most unequal income distribution, and the most limited possibilities for distributing anything to their poor. W Africa and the Nile Region have extremely few possibilities for poverty reduction through economy. First, they must invest in human development and develop institutional structures to allow economy to function. In contrary, China, SE Asia and S Asia have more promise to poverty reduction due to positive economic development and at least some level of equity in their societies.

Overview

Chapter 5.5 gave an overview of the poverty problem, its indicators, and its incidence in the study regions. This chapter summarizes some basic concepts of poverty reduction policies.

Being macroeconomics-oriented, this analysis is more relevant to urban conditions than rural ones since the measure unit used—money—is typically more relevant to the urban context than to the rural one. In contrary, many aspects of the distribution of assets such as land tenure are more relevant to rural conditions. Moreover, the informal sector in the rural economy of the poorest countries and the livelihood environment of the rural poor is dominant in general. The activities of this sector do not come visible in contemporary economic statistics.

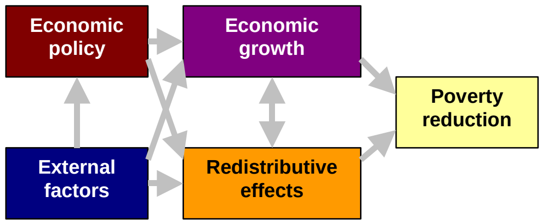
According to many studies, a prevailing attitude in the last decades has been that urban poverty has been understated in comparison to rural poverty (de Haan 1997). This disregards the fact that it has grown in volume and severity in many parts of the world during the last decades. The trickle-down effect of economic growth—to be discussed in detail below—is far more beneficial to the urban than the rural poor, and this is seemingly a major reason to this phenomenon.

In what follows, some basic economic concepts of poverty alleviation and reduction are presented. They do not relate solely to urban poverty eradication, but far more strongly to urban issues than to rural ones. After that, some specifically urban policies are briefly summarized.

Figure 7.3a

Macroeconomic view to poverty reduction

Macroeconomists emphasize economic growth and redistributive effects in poverty reduction.



Growth and wealth distribution

In macroeconomics, the basic ground to allow poverty alleviation is economic growth (Figure 7.3a). Without growth, there is not more to distribute to the poor than before. The hot perennial theme for discussion is the dilemma between economic growth and income distribution within the economy.

The liberalistic "trickle-down" argument is that redistribution of wealth and income distorts the economy and growth declines. Growth is typically assumed to be distribution-neutral, which means that all benefit "equally" from growth.

Others claim that this is a far too slow approach to poverty eradication. Wealth and income should be redistributed to the poorer echelons of the society for many reasons. Political, social, and economic stability are increased, fertility rate tends to go down along with better schooling possibilities and other social conditions that follow from redistributive policies.

Redistributive policies were taken as self-evident in the west for over decades, yet the boom of liberalistic thoughts in the 1990s, and particularly in the early 2000s, has vitalized the myth of neutral growth of the distribution of income and wealth.

Many are convinced, that too high economic disparities within a country are harmful to development, both in social and economic terms. Equally, many arguments against too even wealth distribution appear convincing. The latter ones say that some level of disparity is necessary for rational economic behavior, and accelerates thus economic development.

Accordingly, it seems that a compromise has to be found between too low and too high disparities in order to create a good economic growth environment. So, that the process of growth would benefit the whole society and stabilize the economy and political system. These both legs are necessary for sustainable economic growth and, consecutively, to poverty alleviation that has possibilities to sustain in the long term.

There are various means to redistribute wealth (Table 7.3a). It is important to note, that for the poorest countries almost all what remains possible is to invest in education and health of the population (Chapter 7.2). Infrastructure and public works construction are the second major possibility for improving the livelihood of the poor.

Table 7.3a
Not many possibilities besides education remain for the poorest countries for poverty alleviation
Summary of feasibility of redistribution instruments (source: Dagdeviren et al. 2005).

Redistributive instrument	**Redistribution of current income & assets**	**Growth with redistribution policies**	**Growth without redistribution policies**
Relevant country category	Middle income	Middle & most low income	Very low income
Progressive taxation	Yes	Yes for some countries	No
Transfer payments	Yes	Yes for some countries	No
Consumer subsidies	Yes	Yes	Yes for some countries
Public employment schemes	Yes	Yes	No
Land reform	Yes, but not always relevant	Yes	Not for most countries
Education & health	Yes	Yes	Yes
Infrastructure & public works	Yes	Yes	Yes

Levels of wealth distribution

One could think that the problem of knowing whether income distribution has changed along with economic progress would be an easy topic of research. Just go back to historical data and check out what has happened in the past in different parts of the world.

Unfortunately, things are not so simple. The most comprehensive inequality data of today is the WIID Database by UNU/WIDER and UNDP (2000). It reports Gini Index values from 149 countries that have been compiled from numerous sources.

Gini Index is a commonly used indicator for inequality in income and expenditure. It can graphically be defined as in Figure 7.3b (Todaro 1997). The theoretical extremes are the values 0 and 1. In the former case, the income or expenditure is distributed absolutely equally among the population, and in the latter case, somebody gets all and the others nothing.

After Todaro (1997), countries with highly unequal income distributions tend to have Gini index values between 0.5 and 0.7, whereas countries with relatively equitable distributions lie between 0.2 and 0.35. Percentage values are often used without any notice, e.g., the last values would thus be expressed as 20 and 35.

Figure 7.3b
Graphical definition of the Gini index
This index is the most used indicator for inequalities in income and expenditure within and between economies (source: Todaro 1997).

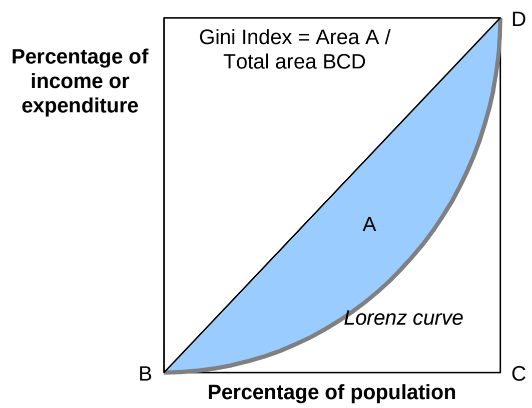
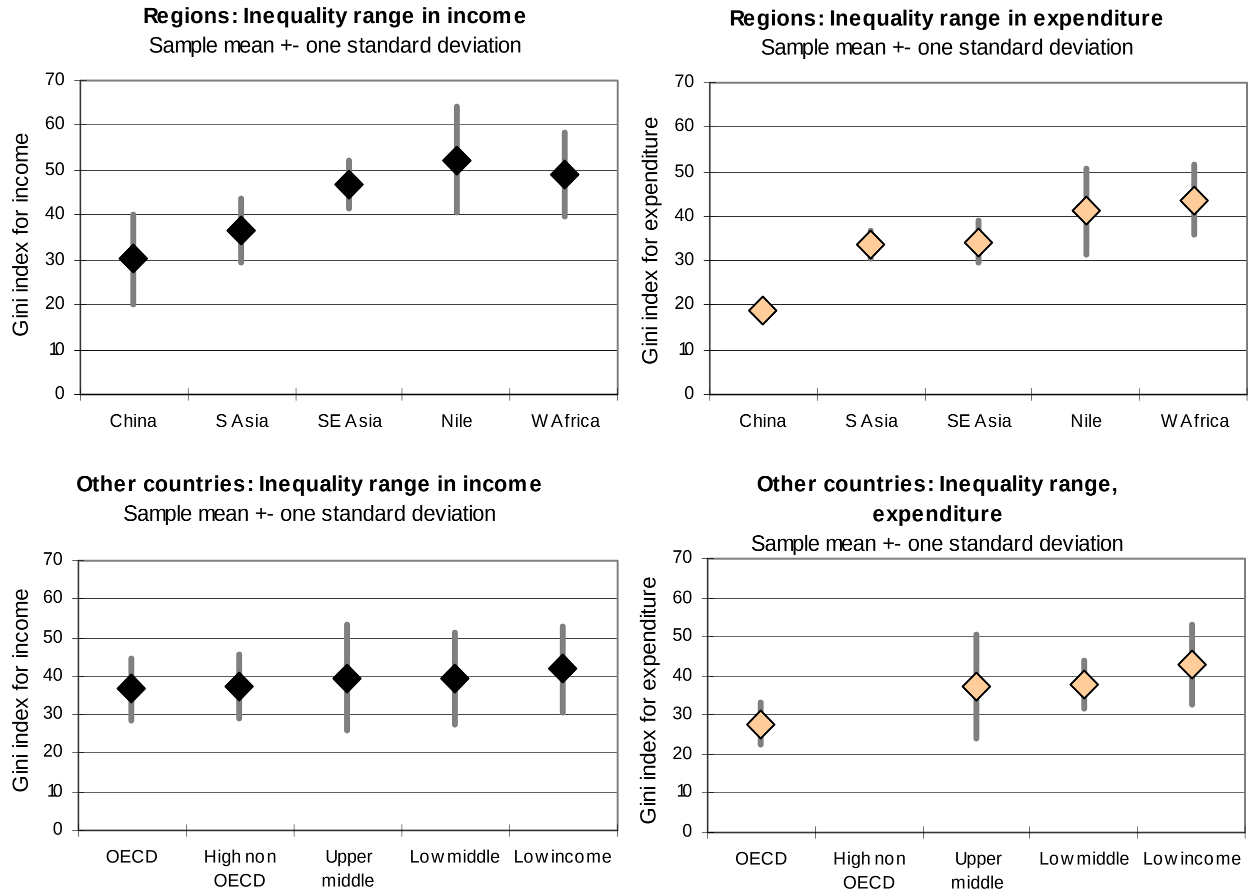


Figure 7.3c

China has a very low, S Asia a low, and African regions have high Gini index values

Gini index values (various concepts): averages and ranges for income inequality and expenditure inequality in study regions and in other countries of the world, classified according to income category (source: UNU/WIDER and UNDP 2000).



Expenditure distributions are typically slightly more egalitarian than income distributions due to various policy-related factors that attempt to balance out income differences.

Figure 7.3c shows, that China is by far the most egalitarian among the study regions. It has less inequalities in income and expenditure than the OECD countries. Surprisingly though, S Asia's Gini index values are very similar to those of OECD countries. SE Asia's values are much higher in terms of income, yet when coming to expenditure, the differences are small. The African regions have markedly higher Gini index values than the other regions.

The Gini index seems to grow slightly but only slightly when proceeding from high-income to low-income countries (Figure 7.3c).

Trends in wealth distribution

The starting point for this analysis was the disputed argument whether economic growth should remain distribution-neutral or not. Clearly, this is a political issue of prime importance. Many countries and ideologies have attempted to cut inequalities down, some with success, some not.

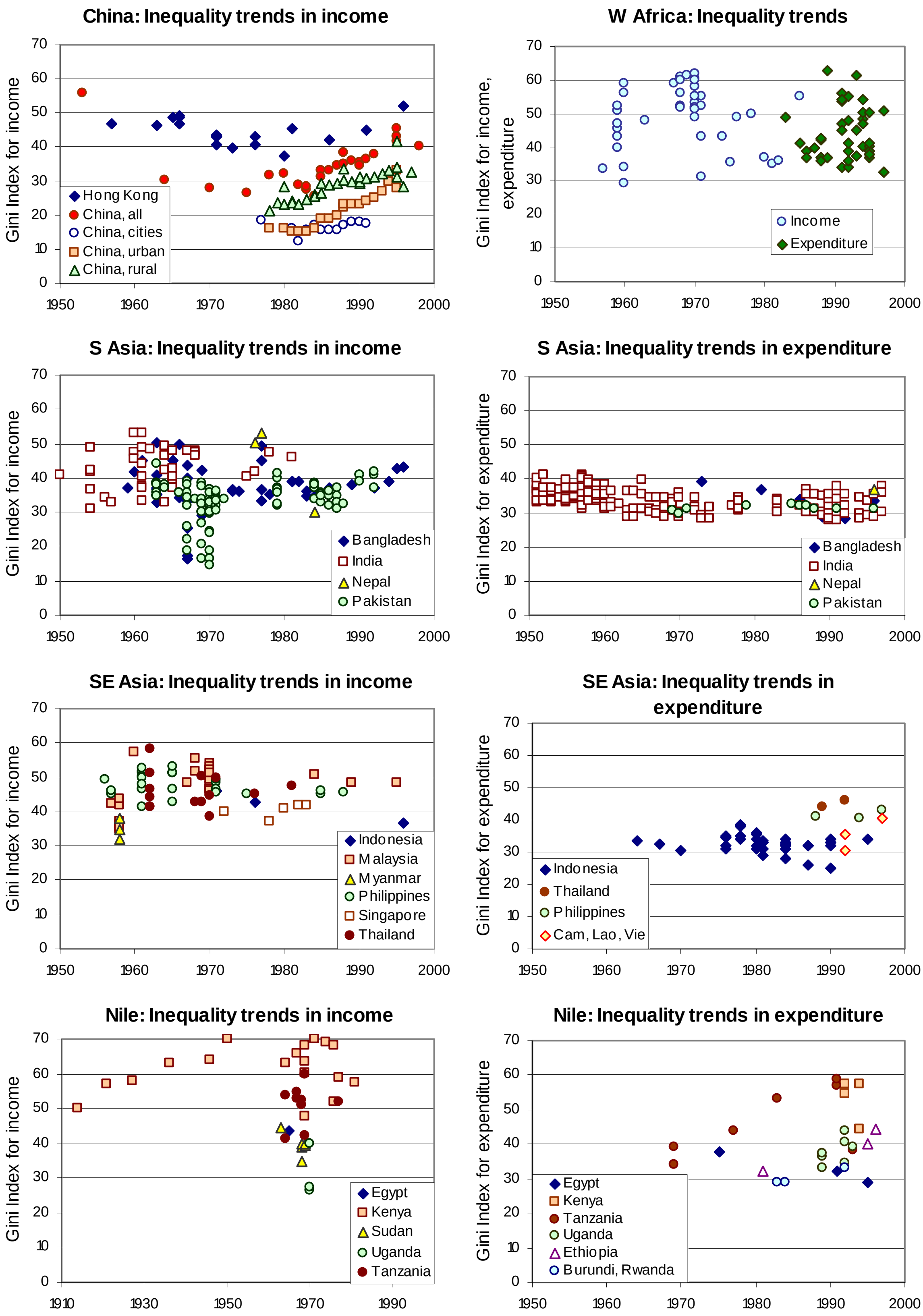
In the former USSR, Gini index values stayed between twenty-four and twenty-eight. After the collapse of the USSR, they typically jumped at least ten units, and even values up to sixty-two were recorded in the 1990s in some former states (Cornia et al. 2005).

The former communist economies of central and Eastern Europe, excluding USSR, showed a similar but not as dramatic pattern. The Gini index values jumped from the stagnant level of twenty to twenty-five up to ten percentage units.

Figure 7.3d

Trends in inequality are not very clear, except for China

Gini index values (various concepts) for income inequality and expenditure inequality (source: UNU/WIDER and UNDP 2000). Expenditure values for China are not shown due to very few data points.



China's transition has been a smoother and more controlled one (Figure 7.3d). The country forced the high inequality (Gini over fifty) of the 1950s in a good decade to around thirty. The situation was stable over two decades, until the Gini started to grow in mid-1980s. Ever since the inequalities have grown, and the Gini index value is now around fourty.

Clearly, China's economic progress has been remarkable since the mid-1980s, and the growth has not been distribution-neutral. In contrary, income differences have markedly grown in the country as a whole, as well as in rural and urban areas if considered separately. Accordingly, China's rich have benefited more from economic progress than the poor. Another question is whether such a growth would have been possible without widening of income gaps.

Sooner or later, China must start to redistribute its wealth more than done at present. Otherwise, the disparities may grow high enough to distort the economy and become to a source of regional instability. Some signs to that direction are already there.

However, one part of the story is the fact that China's inequality balance is very much governed by the dominance of the coastal megacities and wealthy provinces. The rural disparities are fairly low, and so are the disparities within urban areas.

S Asia's Gini index values have been far more stable. There is a slow but continuous decline in expenditure gaps over several decades. The income gap seems to be widening to certain extent since mid-1980s.

The other study regions have too few data in order to make systematic interpretations of the temporal evolution in income and expenditure distributions.

It seems that the income Gini index values tend to converge to the region of thirty-five to fourty in almost any part of the world. The exceptions are low-income countries including the poorest of the transitional economies, where the index values are often much higher.

As global trends, the inequalities within countries seem to be in growth in far more countries than in decline (Table 7.3b). In only 12% of the countries included in the WIID Database (1998 version), representing only 5% of the population in those countries, the inequality has been decreasing. Among study region countries, Cornia et al. (2005) mention only the Philippines and Malaysia, where the inequality has declined.

The pattern that was recognized in the case of China and S Asia in which inequalities declined but have grown since 1980s seems to be very typical. This pattern is usually called "the U-shaped pattern". 55% of people of the WIID Database countries live in such economies (Cornia et al. 2005).

Table 7.3b

Inequalities grow in 2/3 of world's countries

Results based on the 1998 version of the WIID Database. Trends in the Gini index values in seventy-three countries are summarized (source: Cornia et al. 2005).

Inequality	% of countries	% of people	% of GDP PPP
Rising	66	59	78
Continuously, stable	*26*	*4*	*5*
U-shaped	*40*	*55*	*73*
Falling	12	5	9
No trend	22	36	13

As a positive result of this analysis it is possible to conclude that given the stable and strong economic progress in China, S Asia and SE Asia, and the fairly modestly growing inequalities, these regions have a reasonable capacity to reduce their poverty. They are in this respect perhaps better-off than almost all other developing parts of the world.

Unfortunately, in the other end come the African study regions, which do not have now much if any capacity for poverty reduction.

Realistic range for poverty reduction

As mentioned in the overview of section seven, one of the seven international development targets agreed by the International Development Assistance Committee is that the proportion of people living in extreme poverty should be reduced by at least 50% by 2015.

Many agree that this goal is still feasible in the global level, but the overall feeling seems to be that some regions have practically an impossible mission ahead of them with this target. More specifically, the poverty incidence in the least developed countries does not seem to be deductible in notable amounts.

In contrary, emerging economies such as China and India seem to be able to cut their poverty rates in such a magnitude, that the global figure will sharply be reduced. Accordingly, the least developed countries are expected to fall seriously beyond the progress of the rest of the world. Most of the middle-income countries and emerging low-income countries are expected to have the potential to reduce their poverty markedly.

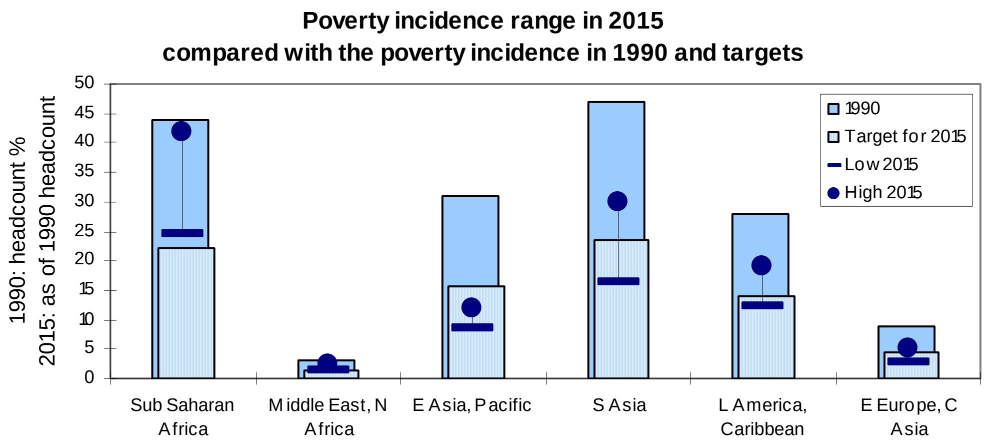
Hanmer and Naschold (2000) present interesting simulations on this issue (Figure 7.3e). They propose, that Sub Saharan Africa will have the greatest problems in reaching the poverty reduction target. In fact, this task seems to be unworkable with any realistic economic growth rates and redistributive policies. The annual economic growth should be around 6% and 7%. The forecasted growths tend to be below 2%, which makes the target unfeasible.

Latin America has a slight chance of meeting the goal. S Asia will have it easier, but the task will not be straightforward. E Asia and the Pacific had higher poverty incidence than Latin America and the Caribbean, but is expected to reduce poverty by well below one-half by 2015. The other macroregions have far lower poverty rates than these four.

As a gross balance, the number of people living in absolute poverty is expected to range between 400 and 800 million in 2015, and will concentrate more and more to the least developed countries, particularly in Sub Saharan Africa.

These calculations use the international poverty line as the criterion for an individual living in absolute poverty. Usually, the line is set to income of US$ 1 a day, which is of course a very simplistic yet extremely pragmatic approach (Chapter 5.5).

Figure 7.3e
Sub-Saharan Africa will not reach the target of halving poverty incidence between 1990 and 2015
Poverty incidence % in 1990. The international target for poverty reduction by 2015 is 50% of the headcount in 1990. The low and high scenarios for the poverty incidence in 2015 related to the headcount in 1990 are also shown (source: Hanmer and Naschold 2000).



Some important redistributive tools

Based on experience from India, Amis (1997) emphasizes that the overall process of social and economic development should be always the main concern in urban poverty alleviation. Local municipalities play a central role; they fail too often to provide conditions that facilitate economic growth (including law and order), providing health and education, and improving the local environment.

Now, all the above has been excessively from the macroeconomics dimension. Clearly, this is a biased view; both the micro and macro levels must work hand in hand in order to gain progress.

Satterthwaite (1997) classifies the approaches to urban poverty reduction in the following way:

- Increasing income and/or assets
- A job through employment creation
- Credit to small-scale or informal enterprise
- Education, literacy, and vocational training.
- Providing squatters with legal tenure
- Emergency credit
- Upholding human rights
- Access to justice within the juridical system
- The right to vote, to have representative government and to organize to make demands
- Improving housing and basic services
- Tenure of housing
- Improved water, sanitation, drainage, and garbage collection
- Basic health-care
- Day-care for children
- Housing finance

- Transport: cheap and efficient public transport

Last years have seen growing emphasis on the financing problems of informal microenterprises, which are a vital part of the semi-informal economic life. By financing and credit, they are allowed to grow and become parts of the formal economic structure. A famous example is the Grameen Bank that operates in Bangladesh. It targets the poor and provides small loans to individuals who are conventionally left outside of the banking practice. It has been built upon the local social structure. After the bank's own words (Grameen 2001): *"these millions of small people with their millions of small pursuits can add up to create the biggest development wonder"*.

More conventional and continuously crucial issues in poverty reduction policies, particularly in poor economies are infrastructure provision, education, and health care. Local government's role has received lately far more notice than before, due to the tendency to emphasize decentralization policies over centralistic ones.

A much used indicator for the investment of a society to the education of the poor is the ratio between government subsidies to primary education and to secondary or tertiary education. In developing countries on an average, the subsidies to secondary education are about three times as high as to primary education, and those to tertiary education some thirty times as high. This translates into the following figures. The richest quintile receives on average 28% of these subsidies, whereas the poorest one receives only 13% (Addison and Rahman 2003). Some sample data from African countries are shown in Table 7.3c.

Table 7.3c
Primary education benefits also the poor
Unit education subsidies by level in selected African countries (sources: Castro-Leal et al. 1999, Addison and Rahman 2003).

Country, year	Secondary per primary	Tertiary per primary
Côte d'Ivoire	1.8	5.4
Ghana	2.6	15.8
Guinea	2.5	54.5
Kenya	2.8	30.7
South Africa	1.8	5.0
Uganda	3.2	32.0

Structural adjustment programs have been one of the tools of IMF and World Bank to alleviate poverty. The greatest gain of these programs has obviously been that they buffer the poor from economic instabilities. The poor do not feel the economic recession as dramatically as in conditions without such programs. On the other hand, the poor do not benefit from economically good times either. Easterly (2001) regrets that the informal sector tends to be largely excluded from structural adjustment programs. He emphasizes that these programs only work properly within a good coordination with "home-grown programs" that stem from the national experience and are more able to target the informal sector as well. Alone, the programs have shown to be too superficial—only a few macroeconomic variables are adjusted without imposing sufficiently deep reforms to the economy as a whole.

The income gap approach means that the poor are directly targets of economic compensation in order to narrow the gap of different social strata. This could become economic to raise the poor over the poverty line by direct financial support, e.g. by providing provisions to mothers whose children go to school. Some argue that these subsidies and provisions should more closely be bound to subsidies for basic services, or services provided by local governments. These arguments stem from the need to control inflation and from the need to build capacity, particularly for the technical and administrational infrastructure that helps the poor to meet their basic needs.

A simple hypothetical calculation is easy to make. Assume that there are 1.44 billion people who live in absolute poverty (Fig. 5.5d; Nafziger 1997). If they all would be given US$ 1 dollar a day, adjusted with PPP, the poverty problem would be solved. This is an extremely naïve example and should be seen as a case of oversimplified calculations that are easy to make in front of a desk only. Let's continue anyhow. The sum needed for this would be around US$ 0.4 billion a day. In one year, the sum would add up to US$ 150 billion. The world total official development assistance was US$ 53 billion in 1997 and total net financial flows to developing countries was US$ 256 billion (World Bank 1999).

Whereas the approach is interesting, it would require tripling of the aid finance, cause notable inflation, and distort the economies by supporting activities that do not construct the societies. In contrary, as an incentive approach it could still work in many conditions.

Many empirical studies show that after a group of people has been lifted over the poverty line, they feel that their welfare decreased. One example is the study by Dercon (2006) from rural Ethiopia. This illustrates that whereas the poverty line approach is extremely practical and allows easy comparisons between the poverty incidence in different economies, it should not be taken too seriously in policy making. The poverty issue should be comprehended in far more profoundly.

7.4 Empowerment

Muhammed Mizanur Rahaman and Olli Varis

"Help yourself" is one of the most basic compliments of the English language. It is used in situations where somebody offers another person to approach her/himself something that has been set for instance on serve. In a societal context, the term empowerment is somewhat analogical. Instead of keeping the individuals passively waiting for the government or somebody else to serve them with amenities of whatever kind, they are enabled and encouraged to be active in the society in a constructive manner.

Overview

It was Amartya Sen—the Nobel Prize laureate in Economics in 1999—who has contributed most strongly to the inclusion of the concept of empowerment into the development vocabulary. His numerous works on poverty that yielded the Prize are largely based on the philosophy of helping and enabling the poor and deprived people to help themselves.

The lack of (especially poor) people to participate in decision-making leads to the situation where the local people are left with the negative consequences of the actions of "outsiders" of their livelihood, such as international and national parties. The people should be able to use their traditional skills for gaining control over their lives. On the other hand they should be provided with new capacities to do so in novel conditions if their living environment will be subjected to change.

Definitions

The root of the word empowerment is power. There are many meanings for this word in this setting. The four central ones are presented in Table 7.4a.

Accordingly, the word empowerment has several meanings and interpretations, depending on the context and the user. Most often, however, it is associated with the "power-within" term.

Some basic definitions include:

"The process by which people, organizations and communities gain mastery over their own lives" (Rappaport 1984).

"The process by which people, organizations or groups who are powerless or marginalized, become aware of the power dynamics at work in their life context, develop the skills and capacity for gaining some reasonable control over their lives, exercise this control without infringing upon the rights of others, and support the empowerment of others in a community" (McWhirter 1994).

"Development must be by people, not only for them. People must participate fully in the decisions and processes that shape their lives." "…but at the same time promotes a rather instrumentalist view of empowerment; investing in women's capabilities and empowering them to exercise their choices is not only valuable in itself but is also the surest way to contribute to economic growth" (UNDP 1995).

Table 7.4a
Power and empowerment
The four basic types of power in a society (after Oxaal and Baden 1997).

	People and power	Practical implications
Power over	An either relationship of domination or subordination.	Conflict and direct confrontation between powerful and powerless interest groups.
Power to	Decision-making authority and power to solve problems. Can be creative and enabling.	Capacity building, supporting individual decision making, leadership, etc.
Power with	Organizations for common purpose or common understanding to achieve common goals.	Social mobilization, building alliances and coalitions.
Power within	Self-esteem, self-awareness, and assertiveness. Recognition on how power operates and gain influence in it.	Increasing self-esteem, awareness or consciousness rising, and confidence building.

Related to empowerment, a recent concept of ingenuity is highly interesting. Homer-Dixon (1999, 2000) defines it as a context-specific skill to make living—which may not be valid in other conditions. If conditions are changed for any reason—be it dam construction, urbanization, war or whatsoever—the old skills may become partly or totally invalid. The people may no longer have the basic capacity to make a decent livelihood for themselves. Homer-Dixon calls this problem as ingenuity gap. This gap is very closely related to empowerment.

Due to its many-sided state, there are no well-established indicators for empowerment. With Julian Rappaport's classic words: *"Empowerment is like obscenity, you don't know how to define it but you know when you see it"*. Therefore, the subsequent regional overview is not as statistics-based, but instead, a more ad-hoc style. Before the regional overview, however, some issues on women's empowerment are presented due to the importance of the gender issue in this context.

Empowerment and gender

Recent UN conferences have advocated that women's empowerment is central to development. Some cornerstones include:

- The United Nations Conference on Environment and Development (UNCED) Agenda 21 mentions women's advancement and empowerment in decision –making, including women's participation in 'national and international ecosystem management and control of environmental degradation' as a key area for sustainable development (quoted in Oxaal and Baden 1997).

- The international Conference on Population and Development (ICPD) in Cairo, discussed the population issue as a technical demographic problem, but as a choice that women should be empowered to take within the context of their health and reproductive rights.

- The Copenhagen Declaration of the World Summit on Social Development (WSSD), called for the recognition that empowered people, particularly women, strengthening their own capacities is a main objective of development Furthermore the empowerment requires the full participation of people in the formulation, implementation and evaluation of decisions determining the functioning and well being of societies.

- The Report of the UN 4th World Conference on Women called its Platform for Action 'an agenda for women's empowerment' remaining that 'the principle of shared power and responsibility should be established between women and men at home, in the workplace and in the wider national and international communities'. During Beijing summit the international community expressly recognized that women and men experience poverty differently, and agreed that if these differences are not taken into account, the causes of poverty cannot be understood. The Platform for Action in Beijing emphasizes that the "empowerment of women is a critical factor in the eradications of poverty" and recommend that poverty eradication strategies address the multidimensional nature of poverty".

Amartya Sen (1999) describes women empowerment as a key to control population growth, saving environment, and poverty eradication in his book Development as Freedom. He mentions *"women empowerment, including female education, job opportunities and property rights, as well as other forms of social change, are key instruments for reducing fertility rates—the number of children and woman bears—and slowing population growth*".

He continues: *"reducing fertility is important not only because of its consequences for economic property, but also because of high fertility in diminishing the freedom of people – particularly young women – to live the kind of lives that they have reason to value. In fact, the lives that are most battered by the frequent bearing and rearing of children are those of young women who are reduced to being progeny-generating machines in many countries in the contemporary world".*

And furthermore: "*The solution of population growth can be expanding the freedom of the people whose interests are most directly by over frequent and child rearing, viz., young women. The Solution of the population problem calls for more freedom, not less.*"

Box 7.4a and Table 7.4b give further information on the issue of empowerment of women.

Box 7.4a
Empowerment through decision making
After Oxaal and Baden (1997).

The United Nations Development Programme (UNDP) has recently adopted the gender in the development goals, which includes a commitment to advocating and promoting the empowerment of women in political and economic decision-making at all levels from the household to national government and in local, national and international administrative structures. Currently, it is suggested that empowerment will be promoted through increasing women's decision making powers, the support of income generating activities and provision of skills and education to women.

Table 7.4b
Sources of women's disempowerment
After Carr et al. (1997).

	Women-intensive	Women-extensive
Social	Dependence on elite	Dependence on male kin
	Dowry	Divorce or desertion
	Poor housing	Patrilocal residence
	Poor infrastructure	Gender violence
	Class violence	Norm of seclusion
	Social isolation	Limited bargaining power/mobility
Political	Lack of consciousness	Male-biased policies
	Lack of representation	
	Lack of voting rights	
	Limited bargaining power	
	Anti-poor policies	
Economic	Limited asset base	Patrilineal inheritance
	Limited access to recourses	
	Limited employment	Male-Biased Recruitment
	High interest loan	Limited excess to loan
	Indebtedness	
	Limited bargaining power	
	Imperfect markets	Gender-stratified markets
	Unfair or high prices	
	Environmental degradation	
	Exploitation	Gender exploitation

Empowerment and health

The link between empowerment and health in general and specifically for women is receiving growing recognition. In Bangladesh 80% of pregnant women suffer from anemia—this rate is the highest in the world—and about 1/3 of newborn babies are underweight (Carr et al. 1997).

Research has highlighted the relationship between powerlessness and susceptibility to ill health, and the health-enhancing capability of empowerment, defined as control and destiny, at both individual and community levels (Oxaal and Baden 1997). These links are also gaining recognition in international development agencies. For example WHO links community participation to empowerment as a means of promoting healthier individuals and environment.

The WHO (1995) position paper for the 4th World Conference on Women states: *"The empowerment of women is a fundamental prerequisite for their health. This means promoting increased access for women to resources, education and employment and the protection and promotion of their human rights and fundamental freedoms so that they are enable to make choices free from coercion or discrimination."*

FAO (2002) emphasizes the gender equality and empowerment of women for achieving food security in 21st century: *"Given equal access to opportunities and resources, women like men have proven to be efficient, dynamic, Indispensable partners in development. Together, on the firm, and all level of the society, women and men constitute a formidable partnership to achieve food security in the 21st century."*

Regional overview

The traditions in the study regions differ greatly with respect to the concept of power. The two extremes are provided by the Asian giants India and China. Whereas the former still respects and leans at least partly to the "power-within" approach by Mohandas Gandhi (Box 7.4b), the latter one has recent history of a strict "power-over" society.

Box 7.4b
Mohandas Gandhi's talisman
Written in the gate of the mausoleum of Gandhi. An example of the "power-within" philosophy.

"Recall the face of the poorest and the most helpless whom you may have seen and ask yourself, if the step you contemplate is going to be of any use to him. Will he be able to gain anything by it? Will it restore himself to a control over his own life and destiny? In other words, will it lead to *sivaraj* or self-rule for the hungry and also spiritually starved millions of our countrymen? Then you will find your doubts and you melting away."

China

Strong command and control tradition is an issue that comes first in mind from China in respect of power. Not only the communistic era since 1949, but also the mighty emperors that have ruled the country since time immemorial.

There are not many less empowered societies—on an individual level—as China was during the cultural revolution a few decades ago.

Traditionally empowerment has been very restricted due to very high control in the society. Along with rapid economic growth and political relaxation the situation has changed, however, and keeps changing rapidly.

At present the empowerment scene is still restricted by the strictness of the society, yet within these bounds individuals are rapidly gaining more possibilities to direct their lives. On the other hand, these bounds keep the society safe. Besides growing economical possibilities, the improving educational level contributes to the picture.

Returning to the dinner table analogy presented in the beginning, China used to have very strict table rules and not too much to serve. No self-service was available. Now, the rules have relaxed a bit and the table has gradually become pretty full of dishes.

China has moved from a “power-over” society to the “power-to” direction.

S Asia

S Asia has an interesting mix of traditions in this respect. The caste system restricted very strongly the livelihood of the untouchables and lower castes. Islam became popular in the middle age among those people and offered them new possibilities. However, many new power structures came in place.

Mohandas Gandhi opposed this situation, along with his peaceful fight against the colonial power in the 1930s and 40s. When becoming into power in the newly established India in 1949, he banned the caste system and with his “power-within” ideology, which he personally conducted in his everyday life, changed the situation.

However, for many decades the economic and social possibilities for most of the people, particularly to those who formerly used to belong to the untouchables and lower castes became very limited in practice. The tribal people—who today count up to 700 million—have also suffered from serious problems in this respect.

The development in Pakistan and in Bangladesh has been somewhat different in terms of traditions and official politics. However, the very hierarchical societies with a huge population living in very poor circumstances with not much power over their livelihood have been similar.

Nepal was a very closed Kingdom until the early 1990s. Again, despite of the different religious and cultural background, many things have been similar to the rest of S Asia in terms of empowerment.

The S Asian situation has been changing though. A few decades ago many ideals were along the lines of “power-within”, the reality was a complex mix of power structures, and empowerment was not well developed. Recently, the economic and social liberation, which surprisingly has gone to some extent hand in hand with raising religious-traditional fundamentalism, has offered increasing possibilities particularly to the middle class.

There are many interesting issues related to the concept of empowerment and S Asia. First of all, Amartya Sen was originally from India. Second, the subcontinent has become famous of some well-established tools and approaches for systematic empowerment of powerless populations. Such approaches include Participatory Rural Appraisal (Box 7.4c), Rapid Rural appraisal and many more. Such approaches were formerly brought to daylight by NGOs and these days they are promoted even by the governments. Third, the S Asian microcredit systems have pioneered the scene and many other parts of the world are establishing banks such as the Grameen Bank of Bangladesh. Many other developing parts of the world are learning from S Asia in these and many other respects.

SE Asia

SE Asia is culturally and historically much more diverse region than the two discussed above. In the continental area, the Indian and Chinese influences confront and are partly mixed with local cultures. The island states have a great diversity in themselves. Colonial influence has been destructive in most countries, and the societies represent very different development levels.

The expression Asian way has become common as an expression of restricted human rights and limited democracy, but efficient economy. Particularly that expression seems to hold to Malaysia, Thailand, Singapore, and to certain extent to the other countries of the region.

The strict and non-transparent discipline resembles somewhat of the Chinese style, and clearly the very central role of the ethnic Chinese in the economy and society in many countries of the region is related to this fact. Moreover, the styles of many other cultural groups are not so different from the Chinese style.

Box 7.4c

Empowerment through Participatory Rural Appraisal (PRA)

Empowerment in the PRA context has four angels: differences within communities; methods and process; community-level organization, and conflict and negotiation. After Chambers (1997).

Empowerment is essentially a bottom-up process rather than something that can be formulated as a top-down strategy. Understanding empowerment in this way means that development agencies cannot claim to empower people. People must empower themselves. Development organization can play an enabling or facilitating role. They can ensure that their programs work to support participation, acquisition of skills, decision-making capacity, and control over resources.

PRA is one of the widely used methods used for development projects. PRA is a methodology for interacting with villagers, understanding them and learning from them. PRA uses group animation and exercise to facilitate information sharing, analysis, and action among stakeholders. The purpose of PRA is to enable development practitioner's government officials and local people to work together to plan context-appropriate programs. PRA can be empowering for lowers, and specially when gender-sensitive, it can be and has been empowering for women.

Differentiating groups and interests can empower the poorer in several ways. It can give them collective awareness and confidence to confront others and argue their case. Whether empowerment is good depends on who are empowered, and how their new power is used. If those who gain are outsiders who exploit, or a local elite, which dominates, the poor and disadvantaged may be worse off. Whether PRA is equitable and good depends then on whom it involves. The natural tendency is for this to be men rather than women, the better off rather than worse-off, and those of higher-status groups rather than those of lower status.

PRA tools, such as participatory mapping, can identify groups distinguished according to local values. Focusing group discussion can then be convened to identify the priorities and interests of different categories of people, including those who are disadvantaged. The contrast can be sharp. Drawing on application of PRA techniques in Sierra Leone, Ghana, Malawi and Bangladesh, it has been shown how significant can the differences be between ethnic group, age, gender and economic status, and combinations of these.

A person becomes more empowered when he or she is able to participate meaningfully in family and community process. People can learn through PRA. Through diagramming, mapping, investigating and observing, they can add to their knowledge. Through their analysis, they become yet more aware and reach new understanding. People can also gain in skills and confidence. They learn that they can do things they did not know they could. The second map is more detailed than the first, and the third map is more detailed than the second. PRA processes often trough up new leasers in communities, people with attitudes expressed in the free context of PRA activities.

Empowerment can be weak and short-lived unless it is not embodied in institutions. PRA is often regarded as a one –off activity. But for many practitioners it affects and is a part of stages in processes which empower community–based organizations. The need for new or transformed organizations at the group or community level has been increasingly recognized by NGOs and governments. These encompass for example savings and credit, income- earning activities, natural-resource management, maintaining group or community solidarity, preparing proposals and negotiating with outside agencies. They can maintain group or community solidarity and negotiating power in relation to threats. They can deal with other community-based organizations and mobilize countervailing power to meet and match the power of the hierarchies of NGOs and the state.

PRA approaches and methods can change the attitudes of dominant groups. Gender relations provide examples. When both women and men have separately made their maps, men have exclaimed that they did not know what women can do. Women have again and again made social maps with more detail, and as it has turned out, they tend to be more accurate in detail than those made by the men. More directly PRA approaches have been used to enable men to appreciate the hard life and conditions of women. Meena Bilgi of the Aga Khan Rural Support Program (India) found men in one village in Gujarat hostile to her work with advancing drudgery-sparing technology for women. She asked the men to diagram and discuss women's time use. They first doubted the information, which they had given. Then they became defensive, saying that men's work was harder. Finally they analyzed women's activities, listing the difficulties and problems, which they faced. In the end, the men´s attitudes changed towards new technologies to benefit the women.

PRA methods such as diagramming can also be brought into play to clarify and resolve conflicts. Agroecosystem diagramming was used in Philippines to make explicit the differences of interests between groups after the construction of a small dam at lake Buhi and to achieve consensus about priorities. Diagrams are promising as a means of defuse tension by making agreed fact visible and differences explicit, focusing public debate on a physical thing rather than on individual people. The identification, expression, and resolution of conflicts of interest are another frontier for participatory method.

What comes to empowerment in the region, the progress of many of the economies would indicate that the people are able to empower themselves to development. Myanmar is the strongest exception to this general impression. Lao PDR, Cambodia and Vietnam are becoming increasingly encouraging and open societies, although many obstacles for empowerment still remain from the sad decades of recent past.

The Philippines is suffering from a sort of passiveness which might come up to institutional weaknesses and a certain collective depression in the society. This is in close relation to empowerment. Indonesia has some similarities to the Philippines in this respect.

Nile Basin and W Africa

Whereas in the case of Asian study regions, the analysis above was made on the country level, in African regions this is not perhaps the best possible approach. African study countries are not based on cultural or ethnic boundaries, and their economic integration is very high.

The big cultural and ethnic divides in the African study regions tend to go in the east-west direction. One of them is the divide between Arab-Berber population and the Sudanese ethnic groups. The term “Sudanese groups” does not refer here only to the territory of the Sudan, but to the whole Sahelo-Sudanese zone, which forms the southern border to the Saharan desert. This divide cuts the continent between the fourteen and eighteen latitudes. Another is the divide between the Muslim and Christian dominance. This goes somewhat South of the ethnic divide.

The Arab-Berber people are culturally very hierarchical. A strict caste system and even slavery are not uncommon. Traditionally, Sudanese groups have been suppressed and even held as slaves (Toupet 1992). It must be mentioned though that the Sudanese have also held slaves themselves, and have their own caste systems, which however are not as definite as the ones by the Arab-Berbers.

The population in the African study zones can be divided across the livelihood methods as well. The three main groups are nomads, settled rural people (sedentary people), and urban dwellers. The Arab-Berbers are traditionally nomads, and in addition the Peul among the Sudanese are nomads as well. The other Sudanese are sedentary. In towns and particularly in cities the ethnic groups are mixed.

The contacts between sedentarists and nomads are traditionally very complicated, and are conflict-prone. Yet also symbiotic relations side-by-side are common (Toupet 1992). In recent decades, many nomads have partly settled down and practice farming and trade as well.

The traditional social order, as been said, is very hierarchic and is still highly important, particularly in rural areas but also in towns and even cities. This holds to nomads in particular.

This secular order or doctrine has governed the management of all aspects of livelihood including natural resources management. The resources have been a common patrimony for the ethnic group, of a social group or even of an empire. Such groupings have been very cohesive and the hierarchical power structures have formed the skeleton to their social order. This cohesion incorporates psychosocial, socio-political, and many other aspects (Obdiambo 2001).

Thereby, the empowerment of individuals has not been an issue. It is even a sort of a threat to the social order and the power structure. In this sense, the empowerment philosophy is in contrast with traditional social systems, which have been developed over centuries and millennia by different groupings of people to allow their cultural and physical survival (Box 7.4d).

In this context, however, it is necessary and just to mention that many modern societies offer as well very limited freedom and empowerment to their members. The strictness of the societal order may be invisible to the members of the society, yet stepping out can be punished very strictly, be the society a traditional or a modern one.

Urbanization has marked a possibility to many individuals to escape these traditional structures. In some sense, the spread of the monotheistic religions—Islam from the North with Arab-Berbers and Christianity from the South—has done the same, yet the change from the traditional situation has not been dramatic.

Changes due to modernization of the society may shake the balance of traditional groupings dramatically. For instance in harsh conditions of the Senegal River valley, the local, traditions-based ingenuity has been the basis for people’s survival over centuries in these conditions (Varis and Lahtela 2002). Its role is again in growth due to the rapid growth of the informal sector in the whole of W Africa (Snrech 1998).

One example is the construction of the Diama Dam on the delta of the Senegal River at the border of Mauritania and Senegal in late 1980s. The ethnic mix along the river is rich. Plenty of nomad and seminomad groups, both Arab-Berber Moors and Sudanese Peul occupied much of the valley, together with sed-

Box 7.4d

Women's and girls' effort for safe water

According to UNICEF, rural African women and girls spend as many as 40 billion hours each year hauling water. After Lifewater International (2002).

For millions of women around the world, fetching and carrying water is part of their daily work routine. Men rarely take part in the collection of water . It is generally seen as exclusively women's work. Women in rural Africa often walk five miles or more every day to fetch water, in other words a total journey of ten miles. In the dry season even twice that distance is not uncommon.

As well as traveling such long distances, the women have to wait in line for their turn to collect water. Waiting times can add five hours onto the journey time. Some traditional sources almost dry out for several months each year. It can take up to an hour for one woman to fill her bucket. To avoid such long waits many women get up in the middle of the night to get to the water source when there is no queue.

Traditional wells are often little more than waterholes dug out deeper and deeper as the dry season progresses. They can be very difficult to reach, with steep sides, and sometimes wells collapse, killing women and children. Paths are narrow and slippery and many accidents occur. Imagine the frustration of walking three miles towards home with a heavy water pot, falling and losing all the water so carefully collected, and probably breaking the pot into the bargain.

Water containers usually hold about twenty liters of water, which weigh 20 kg, the same as the baggage allowance on most airlines. Constant carrying of such heavy weights, commonly on the head, back or hip has severe health implications. Backache and joint pains are common, and in extreme cases curved spines and pelvic deformities can result, creating complications in childbirth. Pregnant women sometimes keep on carrying water until the day they give birth.

The tragedy is that, having spent so much time and effort in reaching a source of water, the water itself is often dirty, polluted and a health hazard. Unclean water causes illnesses such as diarrhea and dysentery, which are responsible worldwide for the deaths of thousands of children under the age of five every day. Children throughout the world suffer many serious problems as a result of unclean and scarce water. Their health and education are directly affected by the water their families need to drink, cook and wash with every day.

In many countries children, particularly girls, are responsible for the collection of water. Girls as young as ten years old may take the main responsibility for drawing and carrying the family's water. The size of water container may vary with the size of the child, but each liter of water carried weights one kg, and may need to be carried up to five or seven kilometers. Carrying such heavy weights is damaging in the long term for adult women: for girls there are even more serious implications given their physical immaturity. In particular, there can be damage to the head, neck and spine. In extreme cases deformity of the spine can lead to problems in pregnancy and childbirth.

Collecting water is not only physically stressful but extremely time consuming. One of the most serious effects is that girls are often not able to attend school. Children are most vulnerable to the diseases, which result from both lack of water and dirty water. In developing countries each child has an average of ten attacks of diarrhea before the age of five and one in ten children die of diarrhea and dehydration. Besides the sickness and death caused by associated diseases, women and children spend so much effort getting water that there is little time for education or home-based industries.

entary groups. No well-established land tenure system existed on a legal basis, but the groupings had their-customary rights to the resources. The introduction of rice farming as a consequence of the dam construction gave the land and river virtually to the urban and ex-pat people, leaving the customary rights powerless, and thereby disempowering most of the traditional dwellers of the valley.

Their power system had functioned—perhaps not well on an individual level—but on the group level, but the loss of livelihood was dramatic to the whole societies. Individuals and the whole social groups feel powerless, and it is not an easy task to find new roots after being uprooted from an old mental tradition. Homer-Dixon (2000) calls this phenomenon an ingenuity gap—the old ingenuous skills become suddenly invalid and learning how to deal with new situations takes time and effort. Many groups and individuals do not survive well such situations.

In a broader sense, the intervention of colonial powers and the colonialization has introduced large changes to the traditional social order, and caused loss of authority from the traditional holders of the power—at the top of hierarchies (Obdiambo 2001).

The power came from outside. People are missing the feeling of control on their issues. Kabou (1991) is convinced that the Africans are these days largely persuaded that their destiny is in the external hands, either the foreigners or the God. Therefore, Kabou sees that helping Africa to develop is about encouraging Africans to create the psychological conditions to bear and make changes.

This idea comes close to the empowerment approach. It is striking to see so much "undone work" and idle males as in many African townships. Traditional social order is gone but not much has yet come to replace it.

Another way that leads to emphasize the empowerment issue—in the case of individuals that are already out of the traditional social systems—comes from the poverty reduction direction. As was dramatically shown in the previous Chapter, the incidence of poverty in Africa is very high—over 40%—and the means to alleviate it by economical tools are far more limited than in other parts of the world. These economical tools include economic growth that could possibly trickle down to the poor, or redistribution of wealth.

Institutions are losing their grip of the societies, and consequently the informal sector flourishes (Chapters 8.1 and 8.2). Empowerment should therefore be much more an issue in the development discourse of Africa than it is now. For instance, in the collection of main outlines of African water resources, their management and related policies, and ongoing regional studies by Gash et al. (2001), the word empowerment is hardly mentioned. Most of the attempts to improve water resources management suffer from the ages-old dilemma of approaching the problems "externally".

Summary and conclusions

Many definitions for empowerment exist as was shown in the beginning of this Chapter, and the issue has still more aspects. The somewhat messy and obscure definitions would be worked out to be more systematic. Clearly, empowerment has typically a couple of dimensions (Figure 7.4). They are:

- *Finacial*: Access to credit and other instruments of finance. Microcredit programmes such as the Grameen Bank have became an important empowerment tool in Asian regions, and are developing also in Africa (e.g. Webster and Fidler 1996).

- *Economic*: In conditions where individuals are entering the modern society and have left out the traditional social order they are very powerless without money. Poverty is one important reason that causes disempowerment of people.

- *Institutional:* Missing property rights, unclear land tenure, weak and corrupt formal governance, etc., work against empowerment of people.

- *Political:* Many political systems are not happy about individual initiatives and work against the empowerment of people.

- *Cultural and social*: Traditional power structures constitute the skeleton of a big part of societies in the study regions, particularly in Africa. Whereas they have been developed over centuries to meet the very specific needs of the groupings of people in question and helped them survive culturally and physically, they often suppress certain groups of people—lower castes, women, etc. Ingenuity gap tends to follow though when these traditional social orders are broken and many suffer from this gap.

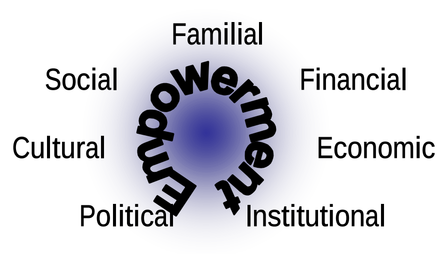
- *Familial*: Depending partly on the social order but by far not entirely, the equity in the family level and the empowerment in the same context is a key building block of empowered society.

The study regions differ considerably with respect to these five dimensions of empowerment. In China, economic and financial possibilities to influence on their lives improves rapidly, yet political and to some level institutional issues do not follow in pace.

SE Asia shares some of China's features, although the diversity of the region is considerable. In S Asia, the cultural and social aspects are far more important with respect to disempowerment than in China. The caste system is a vivid example of this. Economic and financial constraints are considerable, but much attempt exists to overcome these constraints.

In African regions, the cultural and social dimensions are obviously still more important than in Asia, and they are accompanied by harsh economic and financial conditions plus weak institutions.

Figure 7.4
Dimensions of empowerment



References to Section 7

Ackers, J., Migoli, J. & Nzomo, J. 2001. Identifying and addressing the causes of declining participation rates in Kenyan primary schools. *International Journal of Educational Development* 21(4): 361-374.

Addison, T. & Rahman, A. 2003. Why is so little spent on educating the poor? In: van der Hoeven, R. & Shorrocks, A. (Eds.): *Perspectives on Growth and Poverty.* United Nations University Press, Hong Kong.

Amis, P. 1997. Indian urban poverty: where are the levers of its effective alleviation? *IDS Bulletin* 28(2): 94-105.

Buchmann, C. & Hannum, E. 2001. Education and Stratification in Developing Countries: A Review of Theories and Research. *Annual Review of Sociology* 27: 77-102.

Carr, M., Chen, M. & Jhabvala, R. 1997. *Speaking Out: Women's Economic Empowerment in South Asia.* The University Press Limited, Dhaka.

Castro-Leal, F., Dayton, J., Demery, L. & Mehra, K. 1999. Public social spending in Africa: Do the poor benefit?. *The World Bank Research Observer* 14(1): 49-72.

Chambers, R. 1997. *Whose Reality Counts?: Putting the first last.* Intermediate Technology Publications, Essex.

Cornia, G.A., Addison, T. & Kiiski, S. 2005. Income Distribution Changes and Their Impact in the Post-Second World War period. In: Cornia, G.A. (Ed.): *Inequality, Growth, and Poverty in an Era of Liberalization and Globalization.* Oxford University Press, Oxford.

Craig, H. & Henevald, W. 1996. *Schools Count: World Bank Project Designs and the Quality of Primary Education in Sub-Saharan Africa.* World Bank Technical Paper 303. World Bank, Washington D.C.

de Haan, A. 1997. Urban poverty and its alleviation: Introduction. *IDS Bulletin* 28(2): 1-8.

Dagdeviren, H., van der Hoeven, R. & Weeks, J. 2005. Redistribution does Matter: Growth and Redistribution for Poverty Reduction. In: Shorrocks, A. & van der Hoeven, R. (Eds.): *Growth, Inequality, and Poverty: Prospects for Pro-poor Economic Development.* Oxford University Press, Oxford.

Dercon, S. 2006. Economic reform, growth and the poor: Evidence from rural Ethiopia. *Journal of Development Economics (in press).*

Drèze, J. & Kingdon, G. 1999. *School Participation in Rural India.* The Development Economics Discussion Paper Series, No. 18. The Suntory and Toyota International Centres for Economics and Related Disciplines, London.

Easterly, W. 2001. The effect of IMF and World Bank programs on poverty. *WIDER Development Conference on Growth and Poverty*, 25-26 May, 2001, Helsinki, United Nations University/World Institute for Development Economics Research (UNU/WIDER), Helsinki.

Economist 1998. 6.3 brides for seven brothers. *The Economist*, December 19th: 86-88.

FAO 2002. *Gender and Food Security.* Food and Agricultural Organization of the United Nations (FAO), Rome. www.fao.org/gender (8.5.2006).

Fuller, B. 1991. *Growing Up Modern: The Western State Builds Third World Schools.* Routledge, New York.

Fuller, B. & Rubinson, R. 1992. *The Political Construction of Education.* Praeger, New York.

Gash, J.H.G., Odada, E.O., Oyebande, L. & Schulze, R.E. (Eds.) 2001. *Les Ressources en Eau de l'Afrique.* Biospheric Aspects of the Hydrological Cycle (BAHC), Potsdam.

Grameen 2001. *GRAMEEN. Banking for the Poor*. Grameen Bank, Dhaka. www.grameen.org (8.5.2006).

Hanmer, L. & Naschold, F. 2000. Attaining the international development targets: will growth be enough? *Development Policy Review* 18(1):11-36.

Homer-Dixon, T.F. 1999. *Environment, Scarcity, and Violence*, Princeton University Press, Princeton.

Homer-Dixon, T.F. 2000. *The Ingenuity Gap*. Princeton University Press, Princeton.

Inkeles, A. & Sirowy, L. 1983. Convergent and divergent trends in national educational systems. *Social Forces* 62(2): 303-333.

Kabou, A. 1991. *Et si l'Afrique Refusait le Développement?* Éditions l'Harmattan, Paris.

Lifewater International 2002. Lifewater International, San Luis Obispo. www.lifewater.org (8.5.2006).

Lloyd, C.B., El Tawila, S., Clark, W.H. & Mensch, B.S. 2001. *Determinants of Educational Attainments Among Adolescents in Egypt: Does School Quality Make a Difference?* Population Council, New York.

Makubuya, E.K. 2002. Education and Development – Uganda Country Statement. *ECOSOC Roundtable on Education,* New York, 14 February, 2002.

McWhirter, E.H. 1994. *Counseling for empowerment*. American Counseling Association, Alexandria.

Meyer, J.W., Ramirez, F.O. & Soysal, Y.N. 1992. World expansion of mass education, 1870-1980. *Sociology of Education* 65(2): 128-149.

Miller-Grandvaux, Y. & Yoder, K. 2002. *A Literature Review of Community Schools in Africa.* Support for Analysis and Research in Africa (SARA), Washington D.C.

Munasinghe, M. (Ed.) 1993. *Environmental Economics and Natural Resource Management in Developing Countries*. The World Bank / Committee of International Development Institutions on the Environment (CIDIE), Washington D.C.

Nafziger, E.W. 1997. *The Economics of Developing Countries.* 3rd Ed. Prentice-Hall, Upper Saddle River.

Nannyonjo, J. 2001. The HIPC debt relief initiative, Uganda's social sector reforms and outcomes. *WIDER Development Conference on Debt Relief,* 17-18 August, 2001, United Nations University/World Institute for Development Economics Research (UNU/WIDER), Helsinki.

Obdiambo, T.R. 2001. La formation en Afrique d'une nouvelle génération de gestionnaires des ressoources en eau. In: Gash, J.H.G., Odada, E.O., Oyebande, L. & Schulze, R.E. (Eds.) *Les Ressources en Eau de l'Afrique.* Biospheric Aspects of the Hydrological Cycle (BAHC), Potsdam.

Oxaal, Z. & Baden, S. 1997. *Gender and Empowerment: Definitions, Approaches and Implications for Policy*. Report 40. BRIDGE Institute for Development Studies, Brighton.

Rappaport, J. 1984. Seeking justice in the real world: A further explication of value contexts. *Journal of Community Psychology* 12(3): 208-216.

Satterthwaite, D. 1997. Urban poverty: reconsidering its scale and nature*. IDS Bulletin* 24(2): 9-24.

Sen, A. 1999. *Development as Freedom.* Oxford University Press, Oxford.

Snrech, S. 1998. West Africa undergoing long-term change. In: Cour J.-M. & Snrech S. (Eds.): *Preparing for the Future—A Vision of West Africa in the Year 2020.* Club du Sahel, Organisation for Economic Co-operation and Development (OECD), Paris.

Todaro, M. 1997. *Economic Development*. 6th Ed. Longman, London and New York.

Toupet, C. 1992. *Le Sahel.* Éditions Nathan, Luçon.

UN 2001a. *National Population Policies.* United Nations Bureau of Economic and Social Affairs, New York.

UN 2001b. *World Population Prospects: the 2000 Revision.* United Nations, New York.

UNDP 1992-1996. *Human Development Report.* (released annually). Oxford University Press, New York.

UNESCO 1997. *A Guide to Sustainable Book Provision.* United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris.

UNESCO 2000. *Education for All - Year 2000 Assessment: Statistical Document.* UNESCO Institute for Statistics, Paris.

UNICEF 2000. *Defining Quality in Education*. The United Nations Children´s Fund (UNICEF), New York.

UNICEF 2002. *Official Summary of the State of the World's Children.* UNICEF, New York.

UNU/WIDER & UNDP 2000. *WIID: World Income Inequality Database*. Version 1.0. United Nations University (UNU)/World Institute for Development Economics Research (WIDER), Helsinki / United Nations Development Programme (UNDP). www.wider.unu.edu/wiid/wiid.htm (8.5.2006).

Varis, O. 1998. *Water and Third World cities: the expanding puzzle*. Research in Progress RIP16, UNU/WIDER, Helsinki.

Varis, O. & Lahtela, V. 2002. Integrated water resources management along the Senegal River – Introducing an analytical framework. *International Journal for Water Resources Development* 18(4): 501-521.

Watkins, K. 2000. *The Oxfam Education Report.* Oxfam GB and Oxfam International, Oxford.

Webster, L. & Fidler, P. (Eds.) 1996. *The Informal Sector and Microfinance Institutions in West Africa*. The World Bank, Washington D.C.

WHO (World Health Organization) 1995. *Position Paper.* The 4th UN World Conference on Women, Beijing.

Williams, J.H. 2001. On School Quality and Attainment. In: Crisp, J., Talbot, C. & Cipollone, D.B.

(Eds.) *Learning for a Future: Refugee Education in Developing Countries.* United Nations High Commissioner for Refugees (UNHCR), Geneva.

World Bank 1992. *World Development Report 1992: Development and Environment*. Oxford University Press, New York.

World Bank 1997. *World Development Indicators 1997 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 1999. *World Development Indicators 1999 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2001. *World Development Indicators 2001 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

8 POLICY TOOLS: INSTITUTIONS

Institutions provide the rules for the society. With the words of Douglass C. North, Nobel Prize Laureate in Economics in 1993, institutions constitute the glue that keeps societies from falling apart.

State provides institutions such as laws, regulations and government setup in order to govern the society. These institutions are called the formal ones, and depending on the state, they have a different level of control over the society.

The other group of institutions is the informal ones such as habits, manners, cultures, customary rights to land, water and other natural resources, commitment, trust, indigenous knowledge and so forth. These institutions are often obscure to outsiders, and therefore typically underemphasized in development discourse and policies. However, their role is crucial indeed in every society, and particularly in those societies where the government controls are fairly limited. In many countries in Sub-Saharan Africa, an estimated 2/3 of the labor force are in activities that are called the informal sector.

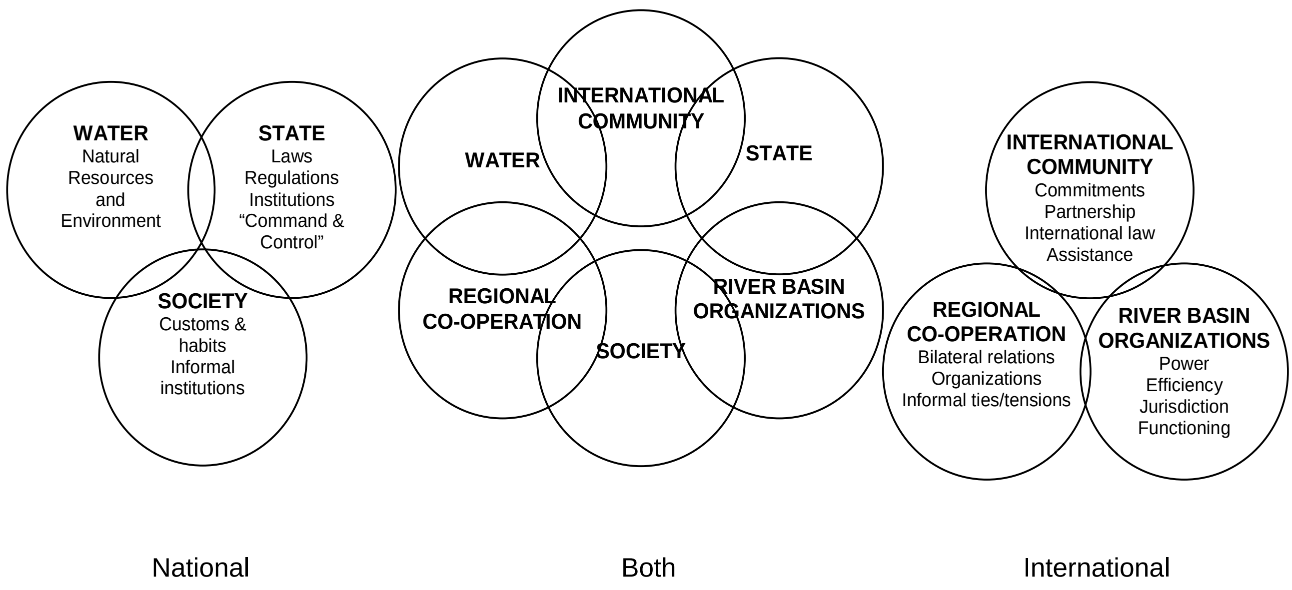
The institutional issues cross national borders. This is clear when talking about international organizations, international laws, and so forth. Equally crucial is to realize that many if not most informal institutions do not respect borders. National borders and traditional states are challenged on one hand by decentralization and on the other hand by globalization.

A society is a complex game, and thus the rules are complex as well, as was outlined above. Too simplistic views are very common. Some typical pitfalls of thinking include

- The difference between the state and the society are not recognized.
- The risk of erosion of the formal power is not recognized when promoting globalization and decentralization.
- Globalization is often thought to restrict itself to the formal part of the society which is not true since the informal activities—both constructive and destructive ones—globalize at the same time.

Figure 8 provides a schematic for some important components of institutional setup within the domain of this book.

Figure 8
Water-related institutions: most important components



8.1 Development of formal institutions

Olli Varis

Institutions provide the rules for the society. Their various functions range from legislative, juridical and administrative to many informal aspects such as culture, religion and ethnicity. Institutional set-up stays high in prevalent development theories. It should be flexible, but provide social stability, and allow the country to solve the problems it is facing. This chapter concentrates on the development of formal institutions and governance.

Classification of institutions

Douglass C. North (1990), one of the leading figures in new institutional economics (cf. Chapter 3.2), divides institutions in the following five classes:

- *Legislative and executive* institutions provide the formal rules for selecting the decision-makers and for decision-making, including making, revising, and implementing laws and regulations.
- *Juridical* institutions are responsible of selecting and motivating judges, implementing laws and other formal rules, and other juridical tasks.
- *Administrative* institutions govern the conduct of bureaucratic activities including relations such as dealings with the public, contracting with the private sector, and responsibility allocation within the bureaucracy.
- *Informal* institutions cover custom, cultural values, religions, and broadly accepted norms of behavior that constrain the behavior of individuals and groups of people (cf. Chapter 8.2).
- *The structure and character of social interests:* Group identities and their interrelations defined by ideology, culture, kinship, ethnicity, etc.

Table 8.1a divides institutions to formal and informal ones. Any of them can be developed carefully to support the development of a society, or they can be handicapped or even destroyed by unbalanced or careless policies. The most important formal institutions to this analysis are discussed below, whereas informal institutions are addressed in Chapter 8.2.

Table 8.1a
Examples of formal and informal institutions
The various roles of informal institutions are often overlooked in development planning. Formal institutions will be discussed in this Chapter, and the informal ones in Chapter 8.2.

Formal	Informal
Government setup Non-governmental organizations (NGOs) User organizations Donor agencies Legislation Professional/technical "licensed" knowledge	"Good" habits and manners Traditions, culture, religions Indigeneous knowledge Attitudes, values (voluntarity, goodwill, responsibility, commitment, trust, solidarity, compassion, respect of life, freedom…)

Political system

Most of the study region countries have a colonial past. The British and French colonies were most numerous in these regions. Table 8.1b lists the situation in the year 1939.

The colonial past has printed it traces into the institutional structure of the countries. The former Portuguese and Belgian colonies have suffered severe crises and civil wars. Besides those in the study regions, countries such as People's Republic of Congo (Belgian), as well as Angola, Mozambique, and East Timor (Portuguese) have had a very confusing and bloody history after their independence.

The French style has often been less democratic than the British one. Income disparities have been enormous (Figure 5.5b). One-party systems have dominated, with an exception of Senegal. Some former French colonies have taken steps towards democracy in the 1990s, including Benin, Côte d'Ivoire, Burkina Faso, and Mali.

In former British colonies, democracy has been common. However, countries such as Pakistan, Myanmar, Kenya, Tanzania and Nigeria are exceptions.

China has had a communist system since 1949, although in practice, the economic system has become

Table 8.1b
The colonial past of the study countries

Situation: 1939	Countries
Independent countries (6)	China, Nepal, Thailand, Egypt, Ethiopia, Liberia.
British colonies (15)	Hong Kong, Bangladesh, India, Pakistan, Malaysia, Myanmar, Singapore, Kenya, the Sudan, Tanzania, Uganda, the Gambia, Ghana, Nigeria, Sierra Leone.
French colonies (15)	Cambodia, Lao PDR, Vietnam, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Guinea, Mali, Mauritania, Niger, Senegal, Togo
Belgian colonies (2)	Burundi, Rwanda
Dutch colony (1)	Indonesia
Portuguese colony (1)	Guinea-Bissau
US colony (1)	The Philippines

increasingly liberal and open. Also Egypt and Ethiopia have a socialistic system, and the present trend is liberal. The Kingdom of Thailand has had stable conditions, although the army has intervened the politics from time to time. Liberia has not been able to stabilize itself. The country seems to suffer from endless riots. The issue of political stability is analyzed in detail in the Chapter 5.1.

In many countries, religion has an official status in the country. This aspect is, however, discussed in detail in Chapter 8.2, within the context of informal institutions.

The integrated management paradigm

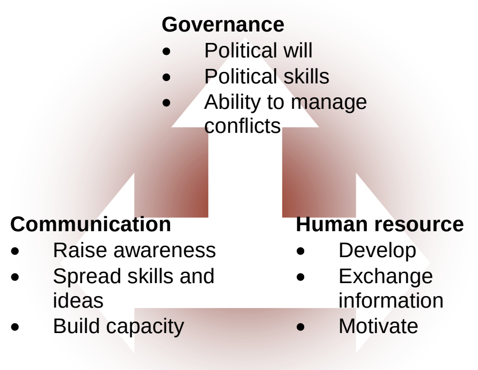
"*Water resources should be managed in an integrated and holistic manner*" claims every agenda. Whether these are just empty words or not, depends greatly on the institutional setup of the region, river basin, or country in question and on the prevailing mental environment (Figure 8.1a).

The integration should be fluent across the following directions:

- *Geography*: from grassroot level to national scale, to regional and river basin scales (Box 8.1a), and to international frames. Some governments are overly centralized, some do not co-operate with the international community, some do not co-operate with their neighbors.

- *Time scale* of planning and administration. The long-term contingency plans, strategic plans, master plans, and other national policy frameworks should be compatible with the regional and international settings, and actively contribute to their improvement. They should also direct local and grassroot activities in a beneficial way, sensing at the same time what is going on out there, and involving local people, various stakeholders of water management, and NGOs into the development of good policies. There should be a two-way avenue from research to advice, to plans, and to actions (Figure 8.1b).

Figure 8.1a
Opening of the society
Open communication and human resources development has changed and will change most countries of the world dramatically since the late 1980s.

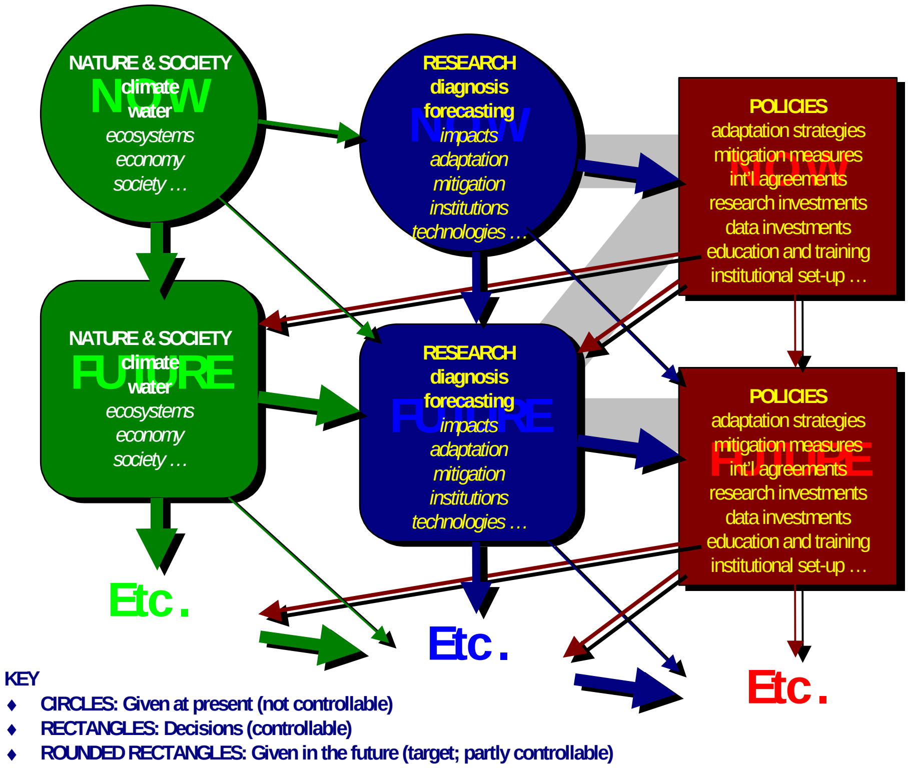


- *Disciplines*: the academic world—where a bulk of water managers learn the basics of their profession—witnesses today strong tendencies of fragmentation and specialization.

The latter one deserves more scrutiny, since this aspect is too often understated or even neglected among academic people. It is no longer enough that one is a specialist in hydrology, nor in river hydrology or in flood forecasting, but better so, for instance, in conceptual 2D models used for flood forecasting in agriculturally dominated watersheds in the boreal zone with a seasonal frost.

This is a very natural inclination, being as well necessary in many ways one can easily argue. Yet, the tendency faced by those involved in policy-making, planning and management of natural resources, social issues, the environment, and so on, is the opposite. Given the real-world problem-solving and policy-making situations, interdisciplinary learning and comprehension is substantial—in a sharply augmenting manner—for reaching overall views and visions over the highly fragmented, mosaic-like scientific knowledge, and for involving the views of various stakeholders in a constructive and balanced way. This problem should be taken seriously, both at universities and among practitioners.

Figure 8.1b
Sharing the knowns for better action



Institutionalization in China

The Chinese institutionalization of water resources has a nearly continental scale, and the problems it has to tackle with are enormous. Therefore, integration should be built in this system. The country's traditions and concurrent political system have centered much of the power into the capital, Beijing, and to the Ministry of Water Resources.

China is undergoing a rapid and profound transition to a market-oriented economy. The traditional, rigidly centralized political system is moving towards a more decentralized system. The lack of unified water administration and management has been acknowledged. The gap between planning and decision making is remarkable. Finally, the inadequacy of financial resources is an important constraint (ADB 2000). These constitute the starting points for the consideration of the country's institutional possibilities to face its water resources challenges.

The lack of unified water administration and management poses a serious problem in facing the contemporary water challenges. The institutional arrangement is overly complex, and prone to rivalries and inefficiencies. The country is moving from a centralized to a more decentralized system, but water institutions have difficulties to keep in tact with these reforms. The increased independence of provincial action—keeping in mind the escalating gaps between different regions, the ambition to strengthen the thus far weak river basin authorities of the six major rivers, and the strong tradition of centralized system—are accentuating difficulties in policy coordination and action (ADB 2000).

Planning has enjoyed a high priority in Chinese water policies. Sophisticated plans exist, yet a hiatus remains between planning and decision-making. This is partly due to financial shortcomings, but institutional problems addressed above are also responsible.

Perhaps one should discuss really seriously the roles of the provincial authorities: is China simply too large to be managed as centrally as done now? Unification and standardization of practices on an almost continental level is in many ways very good and promotes efficiency. It also helps in managing gaps that different regions may have in their systems. However it tends to freeze the development by making any local initiatives and changes raising from evident pressures difficult.

China is streamlining its policy making to be more compatible with the international style by joining the WTO in 2001 and being increasingly involved in the globalization and integration processes (Chapter 8.4).

Box 8.1a

River basin management and jurisdiction management

After Shen and Varis (2000).

All seem to agree on one matter in water resources management: water should be managed based on river basins, not administrative boundaries, whatever in the nations or among the nations; and water rights should be prioritized over the administrative rights, making water rights higher than the national sovereignty in the international river basins.

How to best coordinate activities based on hydrological boundaries with those based on administrative boundaries is a perennial issue in water resources management. A river or other water body crosses jurisdictional boundaries, and inter-actions within the hydrological cycle are significant, some form of basin agreement, coordinating mechanism or management entity is clearly required. This has been long recognized worldwide: It requires that we shift the analytic framework from the narrow views of sector users or the artificial boundaries of administrative and political unit to the natural boundaries of catchments, basins, and aquifers.

What is the reality in the river basin management? If the integrated water resources management principle is adopted, then basin-level systematic management is clearly a need. Yet, still too many of the river basin commissions (whatever international or intranational) are too weak, without specific governing board or corporate status. The commissions find it difficult to enforce provisions of basin plans on other sectors and riparian governments, and the functions that they perform overlap with activities undertaken at local level. River basin commissions in principle help resolve conflicts between jurisdictions and sectors, and ensure that multiple uses are served according to established priorities in the river basins. But these functions are hampered by an absence of formal agreements on inter-boundary water allocation, pollution limits, and other matters. Even more, administration of land, groundwater and water quality is typically handled by agencies at jurisdiction levels.

These problems arise from the lack of clarification needed on how a geography-based agency relates to the mandate of the sectoral agencies and/or the administrative and/or political units which do not generally correspond to the basin boundaries. But the problems between water management among the basin and administrative boundaries will always exist because water is only one of the natural resources in the economy and society. What if water rights would be higher than national sovereignty, would conflict potential increase? Why not to build a good cooperation and regulation mechanism in the international river basins in the first place? We need deep thinking.

Institutionalization in S Asia

The S Asian subcontinent suffers from the deep split between the two big powers of the region: India and Pakistan. What comes to water management, a further problem is the poor integration of China, particularly Tibet, in the regional policy-making concerning the big Himalayan rivers Indus and Brahmaputra. Problems have also occurred in the Nepal-India relationship due to Nepal's hydropower plants, as well as the India-Bangladesh axis, caused by India's high water use of the Ganges water, particularly due to the dry season. In that period, Bangladesh receives 1/3 less water than in natural conditions, and the water uses suffer from water shortage, saltwater intrusion from the Bay of Bengal, and other similar consequences.

India has a federal system, which is less centralized than the Chinese one. Whether it is more efficient and integrated, is difficult to judge. A certainly different tradition is the high respect and developed practice of local participation of citizens in policy making and discussion. This sometimes shows as large demonstrations of NGOs and other bodies, which reach high political importance, such as in the case of the vivid changing of opinions about the construction of the Narmada river (see e.g. Blasco 2000).

The movement against the construction of the Narmada valley is a massive activity. Two ladies are standing at the front of that movement. They are Arundhati Roy and Medha Paktar, who both have gained a notable international fame, Roy of her books (e.g. Roy 1997, 2000), and Paktar of her involvement of her international contributions, such as the work of the World Commission on Dams (WCD 2000).

Nepal continues to a direction which is difficult to predict. The local expertise in water management improves constantly, and the direction is towards conditions that would allow a transparent and integrated system in a much more evolved way as only a decade or two ago. Pakistan is a question mark. Its federal system resembles much of the Indian one. The violently changing military governments and the growing role of religious intolerance hamper, though, integrated water management.

The region’s common problems are (SASTAC 2000):

- *Policy:* National water policies exist in some countries, and are under preparation in others. They are not yet effective in the countries.
- *Legislation:* Suffers from overlaps and inconsistencies. Framework needs much reform.
- *Governments:* Too heavily involved in managing and controlling resources up to the micro level. This has yielded huge inefficiency problems

(Dixit 2000). Decentralization and enlarging role of private sector are expected to follow.

- *Institutional fragmentation:* The administration is overly fragmented, and broader water resources management functions have been somewhat neglected.

- *Institutional capacity:* These shortcomings are very serious in S Asia.

- *Right to information:* The tradition of keeping government information partly secret (Officials Secrets Act) hinders the development of policies towards transparency and accountability.

- *Enforcement and implementation:* Many existing laws are not enforced for various reasons. Public awareness sometimes helps, yet severe problems exist.

- *Water infrastructure:* maintenance is dominantly inadequate, and systems deteriorate. Populistic politics do not take enough long-term concern.

- *Gender sensitivity:* women's participation is far too low in the sector activities and decision-making.

- *Human resources development:* still a constraint.

Institutionalization in SE Asia

SE Asia is split into smaller states than the other Asian regions. Many countries have a bloody and problematic past, yet most of them have stabilized and had a very favorable economic development in recent times. In the continental SE Asia, the lack of international co-operation is a constant problem, despite of the attempts to develop the Mekong River Commission over decades.

Since 1957 there has been the Mekong River Commission supported by the United Nations and other international organizations. It has attempted to solve the regional water controversies with varying success. Its functioning has been made especially difficult by China's absence, and several national and international conflicts and wars in Vietnam, Cambodia and Laos (Jacobs 1995). The other large international rivers, the Red River and the Salween, are even less institutionalized in the basin level.

The island states have different problems in institutionalization. Their water resources are split—along with their territory—into a high number of small watersheds on different islands. The regional water authorities need not worry much about big rivers or aquifers that cross provincial or national borders. However, the geographical, and to a certain extent, ethnic and religious heterogeneity cause trouble. The cumbersome route of information from the local people to the central government is a big problem.

Institutionalization in African regions

World Bank (Sharma et al. 1996) performed a comprehensive analysis on the challenges and opportunities for sustainable water development in Sub-Saharan Africa. Although such an analysis gets very soon obsolete, this very study—due to its uniqueness—provides important, comparative information of the development phase of water-related institutions in the African study countries. Among other issues, the institutional capacity and governance environment were analyzed by country, using four performance indicators (Figure 8.1c):

- *Governance environment:* Only one country, Burkina Faso, scores High in this respect. The Sahel stripe from Guinea-Bissau and Senegal to Chad, as well as Côte d'Ivoire, Ghana, and Benin from W Africa fall in the Medium category. Among the Nile countries, Ethiopia, Uganda and Tanzania ranked Medium. All the other countries are in the Low class (compare also Figure 8.1f which gives somewhat different results).

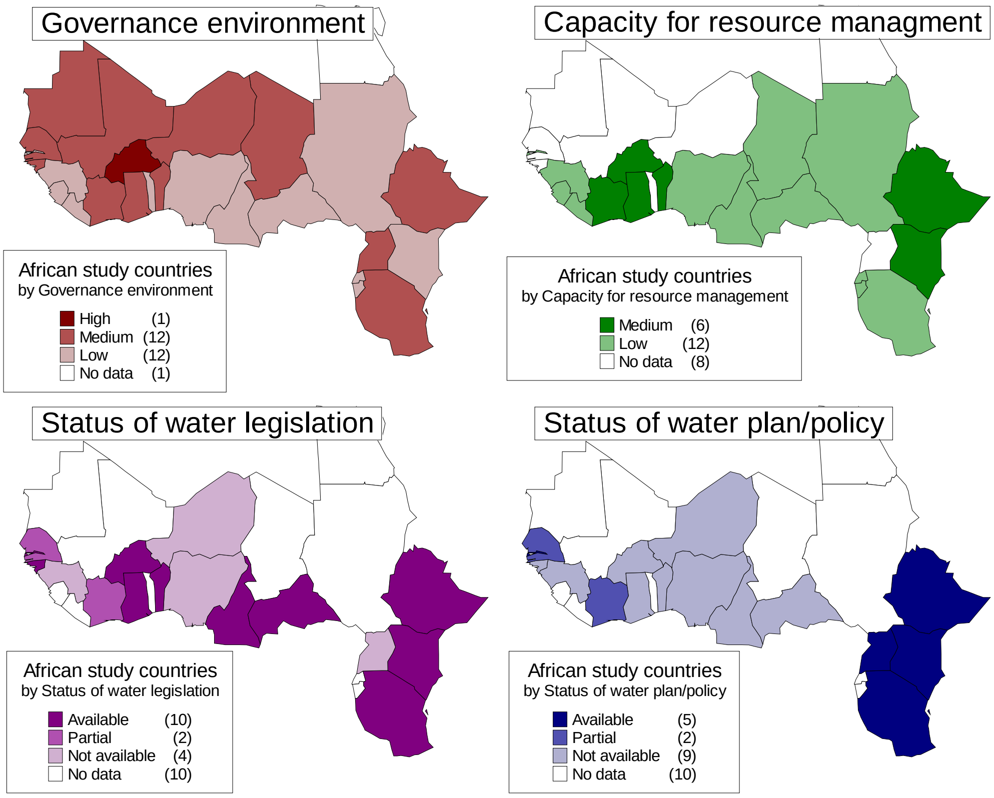
- *Capacity for resource management:* None of the study countries ranked High. Kenya and Ethiopia from E Africa, and Côte d'Ivoire, Ghana, Togo, and Burkina Faso from W Africa were classified Medium. The other countries were in either Low category or no data was available.

- *Status of water legislation:* In E Africa, Ethiopia, Kenya and Tanzania have the legislation. Among the W African countries, the law exists or is partially available in Senegal, the Gambia, Guinea-Bissau, Côte d'Ivoire, Burkina Faso, Ghana, Benin, Cameroon, and Central African Republic.

- *Status of water plan and water policy:* E Africa is ahead of W Africa. Water plan/ policy exists in Ethiopia, Kenya, Uganda and Tanzania, and to a part in Senegal and Côte d'Ivoire.

There are certain countries that perform better than the rest. They are Ethiopia, Kenya and Tanzania from E Africa, and Burkina Faso, Côte d'Ivoire, Senegal, Ghana and Benin from W Africa. Unfortunately, plenty of data are missing. After all, the situation in the upper part of the Nile basin seems to be somewhat better than elsewhere. Also the Volta, Gambia, and Senegal River basins, plus Côte d'Ivoire and Benin

Figure 8.1c
Institutional indicators of African study regions
After Sharma et al. (1996).



seem to be better institutionalized than the rest of W Africa. Since the study was targeted to Sub-Saharan Africa, Egypt was excluded from the analysis.

After the Global Water Partnership (2000a), the constraints for overcoming institutional shortcomings of W Africa are the following:

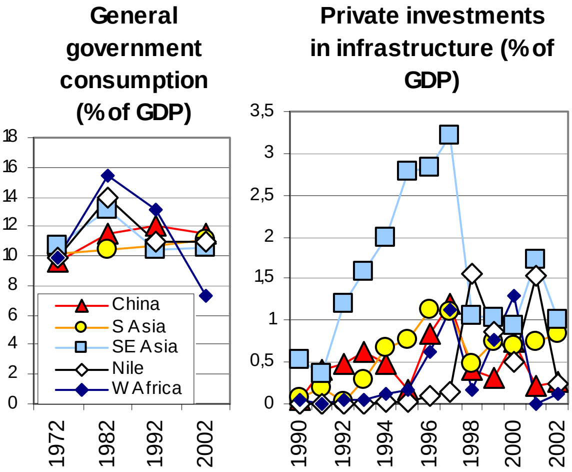
- *Internal resistance*: executives and institutions are sensitive to their positions, authority, and influence. Most water institutions remain inefficient, under-funded, and oversized.
- *The lack of political will*: reforms face inaction and delays.
- *Political instability*: frequent changes occur in government and low commitment of each new government to the policies of the previous rulers exists.
- *Dependence of development partners*: The aid dependency is high, and domestic capacity stays insufficient. Examples include Ghana, Nigeria, Burkina Faso, and Côte d'Ivoire.

In the Global Water Partnership's (2000b) water vision for the Nile Basin, a long list of over one hundred crucial aspects to water resources development was produced. The most important constraints, with respect to the issues analyzed in this context are the following:

- Political instability
- Mistrust and other shortcomings to mutual co-operation among the riparian countries
- Lack of transparency in dealing with issues of common interest
- Lack of technical, financial, and economic capacity
- Lack of visions and planning in long-term
- Inappropriate legal and institutional framework for water management
- Various disparities within the region

The urgency of the problems should press the countries to overcome them. Exchange of knowledge and experts, open data sharing protocols, mutual and external helping, elaborating the existing initiatives, adoption of modern technology, and closer economic integration were among the most stressed issues.

Figure 8.1d
Government and private investments
Data: World Bank (2004).



The Nile Basin Initiative is the most recent attempt to work towards better integration of water issues within the region. It builds on the late TECCONILE's work, with the aim: *"To achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources"* (NBI 2006).

The Initiative includes a series of action programmes with extensive goals. Whereas such initiatives are extremely welcome, their success depends utterly on the governments' political will to reach for common goals, and their empowerment to implement policies.

In both African regions, the lack of international co-operation seems to be a serious obstacle for rational water resources management (Global Water Partnership 2000a, b).

The efficient state paradigm

A few decades ago, a rich variety of opinions prevailed on the proper size of the public sector. For instance, Egypt used to have over 20% of all government consumption within the sector in 1970s. Many countries had less than half of that volume those days.

Since the 1980s, most countries in the study regions, as well as elsewhere, have converged to the envelope of 7 to 13% of GNP consumed at the public sector.

The tendency is towards still decreasing public sectors (Figure 8.1d). This can be seen in the growing volumes of privatized public activities (Box 8.1b).

The reason why a small government is assumed to be better than a big one is efficiency. Along with the small-government paradigm of Neoclassical economics and liberalism, the leading theme of World Bank's (1997) World Development Report is the efficient and small government.

Box 8.1b
Private and public, the goal is to make things work
After Shen and Varis (2000)

Many problems have occurred in the water sector managed by the public or governments. Since things are not evolving as desired, a logical response has been to change the rules; increase the private sector involvement in the business. Moreover, due to the lack of financial resources invested in the water sector, private sector involvement or even privatization is assumed to attract the needed capital.

It is too simplified to say that private sector involvement in water sector is a universal success in solving the water resources crisis. The massive privatization is no more than ten years old. Water sector infrastructure construction needs a large amount of fixed investment and with long return period, much longer than a decade.

There are also success stories of water resources management by public or government organizations, such as Finland and many other European countries, with decades of experience of making things work well. Most countries that have severe problems in water sector are developing countries, which have complex problems within their economy and society. The water sector privation needs more caution. In some countries, privation of the public sector would counteract institutional development, and for instance cause corruption and result in lower efficiency.

The water sector is not only water supply or wastewater treatment, it is a sector which combines flood control, water supply, drought alleviation, aquatic ecosystems conservation, etc. For most of its functions, the regulation from the government side must be there and be efficient. A bulk of the privatization experience is from water supply utilities.

Let us revisit S Asia (SASTAC 2000). The list of nineteen vision elements includes also the following point: *"Water cannot be left entirely to market forces. Need for clear demarcation and balance between roles of public and private sectors."* The underlying aim for the private sector involvement in the water sector is to earn money. But water is a tradable good only partly. It is also a basic human need for both the poor and the wealthy. Private sector involvement can help the situation in many cases, but it is not the only way to put things work better. The key issues are in sharing of responsibility and the provision of transparent accountability in a way that produces a good and efficient service.

A negative correlation between the government's employment share of the total population and the average central government wages as a multiple of GDP per capita is presented as an argument. This relation is visibly true in many countries, but things never are that simple. Besides, the scatter in the data is enormous.

The report itself alerts about the widely distributed negative side-effects and consequences of cutting public spending: "*The clamor for greater government effectiveness has reached crisis proportions in many developing countries where the state has failed to deliver even such fundamental public goods as property rights, roads, and basic health and education. There a vicious circle has taken hold: people and businesses respond to deteriorating public services by avoiding taxation, which leads to further deterioration in services*". Some states have crumbled entirely, for instance Liberia, Somalia and Afghanistan. Many others are in a very bad shape.

Evidently, it is an oversimplification to say, that the smaller government, the better, although it is easy to get such a feeling when following contemporary discussion on institutional affairs. Chapter 5.1 scrutinizes in more detail the issue of collapsed states, which is an increasing problem in developing and transitional economies throughout the world.

No doubt that a government should be efficient, but to define precisely what this would mean is very difficult. The government should have the development of the country in its own hands anyway.

Good governance vs. corruption

Perhaps the most cited source on governance and government institutions comes from the Transparency International. This organization has developed an index system for corruption, and analyzes annually an increasing number of countries and produces an important list of index values, which allows at least some degree of comparison of the governance system in various countries. Developing countries have not been well represented in these analyses, yet each year the coverage becomes somewhat better.
The most relevant index in this context is Corruption Perception Index (CPI). It is described in the following way: "*The CPI Score relates to perceptions of the degree of corruption as seen by business people, risk analysts and the general public, and ranges between 10 (highly clean) and 0 (highly corrupt)*". It has been defined by combining corruption information from numerous sources. The principal sources include ten respected institutions, for instance the Wall Street Journal, Gallup International, the World Bank and the University of Basel, the World Economic Forum, and so forth. For further details, see Lambsdorff (1999).

Twenty-two study countries were included in the 2002 study (Figure 8.1e). The results show that—perhaps coincidentally—the corruption augments almost systematically towards the south, both in Asia and in Africa. However, a sad observation is that almost all of the study region countries are very severely corrupt. The only exceptions are Singapore and Hong Kong.

Less coincidentally though, the CPI relates very clearly to GNP per capita, even much better than GNP growth (Figure 8.1e).

There are a number of other indexing systems for the performance of the formal institutions. Two of them are summarized below due to their reasonably good coverage of the study regions.

As a joint effort, the World Bank and the University of Basel have developed an approach to quantify the governance environment from the point of view of private actors and businesses (World Bank 1999). Aspects shown in Figure 8.1f are measured using surveys. Altogether twenty-three questions are included.

The results with respect to the nineteen study region countries indicate, that the five aspects analyzed are fairly closely related. With respect to geographic differences, the African regions do not differ systematically from one another. A slight surprise is that Thailand does not score much better performance index values than India, Ghana, Uganda, Senegal and Mali, although it is economically superior to those countries.

Greedy leaders

Even though low and middle-income countries suffer from severe lack of economic capital and resources, their leaders sometimes use their opportunity to "steal" huge sums of money from the national accounts. Some examples include:

- As Pakistan's former prime minister Nawaz Sharif lost his position in 1999, the common belief was that the Pakistani rulers and bureaucrats had US$ 40 billion in foreign accounts. This, again, is over 10 times the annual foreign aid to S Asia, 130% of Pakistan's external debt, and 66% of the country's annual GNP.

Figure 8.1e

Degree of corruption grows towards south, and correlates well with GNP per capita

The 2002 Corruption Perceptions Index (CPI). Source: Transparency International (2002).

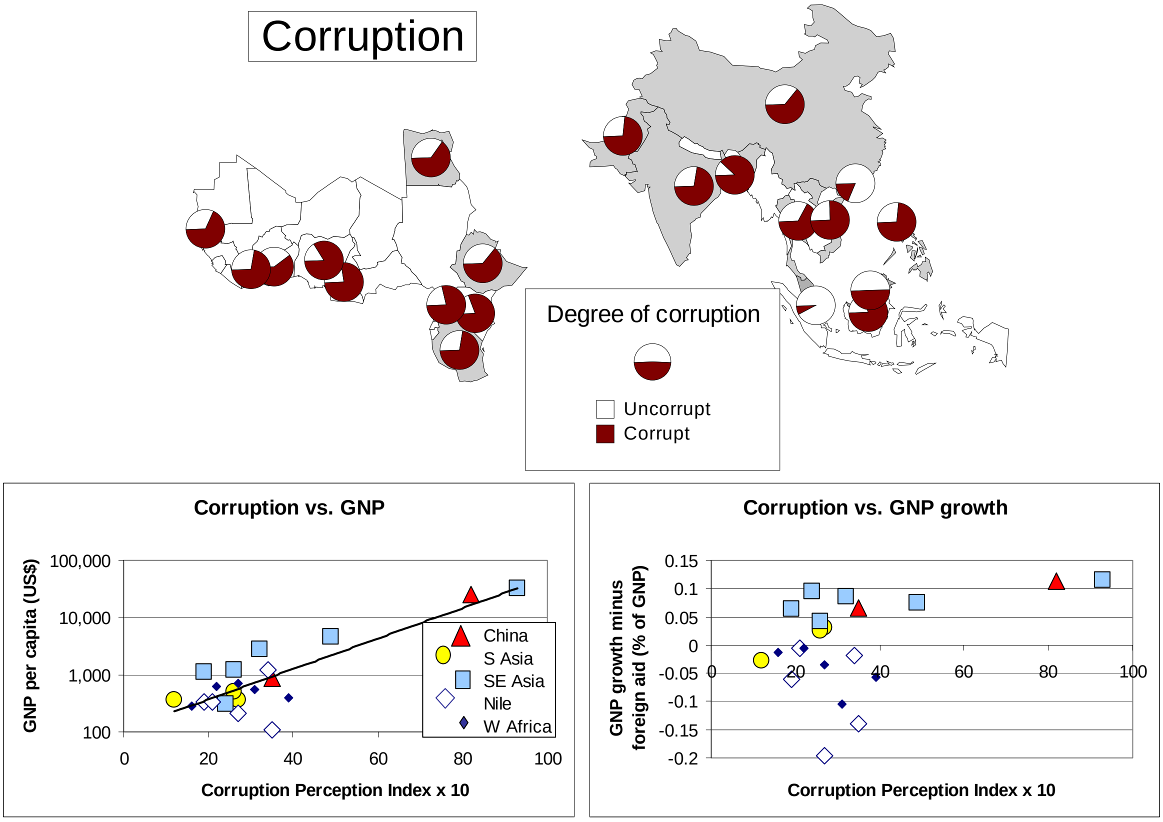
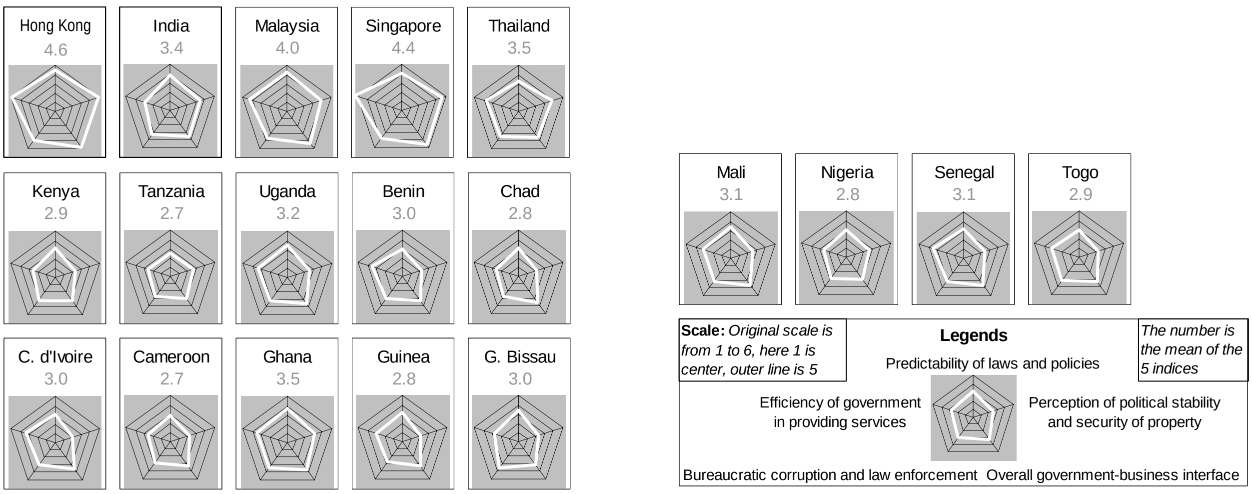


Figure 8.1f

Performance of governance

Source: World Bank (1999).



- Former first lady of the Philippines, Lady Imelda Marcos, has been accused to help his late husband to steal US$ 5 billion during his twenty years of rule. This sum accounts for 11% of the country´s external debt, and 6% of GNP.

- Zaire's late president Mobutu Sese Seko has been estimated to have had a property of US$ 8 billion as he fled the country and passed away soon after that in 1997. This was 15% of the country's GNP, and 66% of all external debt.

- Indonesia's former president Suharto—with his family in a broad sense—had a wealth of US$ 40 billion in 1999. Much of this is in foreign accounts. This sum is more than ten times the annual foreign aid to whole SE Asia, 30% of Indonesia's external debt, and 18% of its annual GNP.

- Nigeria's late president Sani Abacha has, according to Usher (2000) "…*robbed the Nigerian treasury of as much as $ 4 billion since taking power in 1993*". He passed away in 1998 at the age of 54. This sum was about 2.4% of the country's GNP at that period.

Such misuses of limited wealth of poor economies are common, yet it would be unjust to give an impression that all the governments within the study regions were stealing their citizen's money with the volume of the four example cases above.

Anyhow, huge problems exist. Finances such as these should be accounted as domestic savings, and invested to the benefit of the nation's economy, not end up in European, North American, or Japanese banks.

8.2 Development of informal institutions

Olli Varis

Are national governments loosing their power these days? Is the ensuing erosion of formal power a challenge to the water sector? Is the world returning to a more primitive economic system, in which governments have a smaller role, but the government-independent—partly semi-legal, illegal or religious—activities mushroom? Is the state's role further set in question by the growing role of multinational enterprises in developing countries?

Overview

These difficult questions cannot definitely be answered exclusively here. Instead, they are used as a starting point in a review of the characteristics of the informal sector within the study regions. Besides, the various challenges to the water sector due to this development are scrutinized, and some possible solutions to the issue are discussed. Solutions related to informal institutions are particularly addressed.

Typically, the informal institutions have very many-sided roles in societies, and understanding them can be a highly complicated and difficult process for an outsider. For instance, in S Asia, the mixed, highly important roles of the cast system, ethnic hierarchies and religious issues may easily appear as a sort of fatalism that hinders development. Yet, ignoring these issues tends to make formal institutions profoundly invalid (cf. Bista 1991). Corresponding, very diverse and strong cultural features are present in other old cultures (for Africa, see Kabou 1991).

Governments of many developing countries are gradually losing their already weak control over the economy (Figure 4.4o). The formal economy may develop and grow, but a growing share of economic activities and population are beyond its reach.

The informal sector pays virtually no taxes, is partly outside the legal system, receives only marginal services from the government, etc. Officially, in most countries, its volume is strongly understated, even neglected; although a grand share of citizens—the poor in particular—are fully dependent on that sector.

Transitions and weak governments

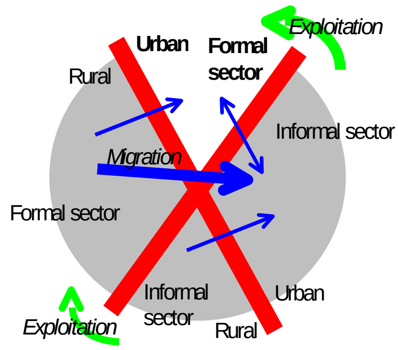
When a society faces a situation of rapid transition, the various roles of the informal institutions are essential to its stability. This has often been understated (North 1997). Such transitions include the collapse of centrally planned systems in the early 1990s, the collapse of the colonial power thirty years earlier, or say, the concurrent, exceptionally rapid urbanization process in Africa and parts of Asia (Figure 8.2a).

The transitions have caused huge gaps between governments and people. The power of the governments, and accordingly, the formal states, have eroded, partly because the informal institutions have not been properly respected and taken into account. More generally, formal institutions which do not lean on informal ones have shown to be weak.

Figure 8.2a

Ungoverned urbanization feeds the informal sector

One key factor of the urban informal sector expansion is rural-urban migration. In the Gambia, the informal sector employs 30% of the rural labor force, while in urban areas, 60% are informally engaged (Esim 1996). The Gambia's urban population grows 6.8% per year. Most of this feeds the informal sector (cf. Figure 3.2e).



The various roles of informal institutions are increasingly appreciated in development programs. Policies based on promotion of public awareness, grassroot activities, participatory approach, and so on—which are commonplace in present agendas—are often targeted at least partly to the informal sector.

The informal sector, leaning largely on informal institutions, grows rapidly in developing and transitional countries, and already incorporates a majority of urban dwellers in the world.

The informal sector

The split of the economy to the formal and informal sectors became evident in most African and Asian countries already before their independence (Drakakis-Smith 1987). A huge population with no adequate housing, health care or education lived very poorly, creating their own economic system that consisted of various illegal and semi-illegal activities. This informal, *petty-commodity* sector has grown to cover, in many cases, the majority of the population.

Today almost all governments are in favor of urban, industrial development. This *urban bias* boosts the urbanization process. The hope has been, that the growing industry and urban service sector would be able to absorb the excess labor force, but this has not happened, but to a small fraction of people. Even in the most successful countries in this respect, such as Brazil and Thailand, only one fifth of the population are engaged by industry. The informal sector must absorb 20-70% of urban labor force (Todaro 1997).

The informal sector is often of *high economic importance* to the country. It runs with low administrational costs, it is rather self-contained, it recycles many materials, and it is in many respects very productive and innovative (i.e. economics).

Authorities are often apathetic towards this sector (i.e. politics), as it provides potential, inexpensive labor and product supply to the formal sector, as well as other assets. Attempts to control this sector are not always as strong as they could be.

The *rural* informal sector is usually less significant social problem as the urban one, although in many cases it is the major economic force. This is because many of the *traditional, informal institutions* function well, and social fabrics are there.

With the present rapid urbanization, these fabrics get partly or totally destroyed, and the urban, informal sector runs into trouble. This is the case in particular when the urbanization process is dominated by uncontrolled migration of rural excess people to excess people of urban areas.

Many strategically important cities have attracted significant amounts of foreign investments and industries since 1970. Such cities include São Paulo, Rio de Janeiro, Mexico City, Soul, Taipei, Bangkok, Kuala Lumpur and many others. Infrastructure may develop rapidly, but not necessarily in a balanced way. Protection of the environment, e.g., waste water treatment and air pollution control, does usually not have a high priority, and the developments in the informal sector have been marginal, despite of its rapid growth. Freshwater problems as well as other infrastructure shortcomings and environmental problems are very pronounced in the informal sector.

In Africa, the links between formal and informal sectors tend to be weak (Fidler and Webster 1996). Therefore, most African countries *lack a genuinely integrated economy*. They have very distinctively two parallel economies—the formal and informal one.

In Chad, the informal sector contributes an estimated 66% of GNI, and in Guinea, about 62%. In Mali and Senegal, the informal sector accounts for the majority of all employment. The official figure of the volume of Niger's informal sector is 20% of the economy, but estimates as high as 66% have been proposed (World Bank 1989). After Coville (1996), informal areas occupy 24% of the area of greater Cairo, and house 46% of its people. The informal sector grows much faster than the formal sector almost in all Africa.

The role of women is vital in the informal sector, yet the equity problems tend to be more pronounced than in the formal sector. In Sierra Leone, 50% of all informal sector employees are women. This share is 66% in Burkina Faso and 80% in Cape Verde.

Chad's case is revealing. Sananikone (1996c) links the informal sector's rapid growth to the adverse economic and political climate that has prevailed in Chad over decades. The civil war that lasted several years from the late 1970s destroyed the regional economies and uprooted a big share of the population. On top of this, severe droughts in 1984 and 1990 reduced dramatically the production of fish, livestock and cotton, damaging the economy further. The catastrophic sinking of the water table of Lake Chad has been boosting Chad's ongoing political, natural, and economic instability. Urbanization has been rapid, and the formal urban economy has already been almost non-existing since the late 1970s. Capacity building for infrastructure, human resources, etc. has been disabled due to the above reasons. The informal sector contributes at present about two thirds of the GNI of Chad, and employs over three quarters of labor force.

With Sananikone's (1996b) words on Cape Verde, "…*the informal sector has mushroomed since the late 1980s, largely in response to the limited opportunities in the formal sector*". There, as in many economies, the informal sector has a clear competitive advantage due to its low financial and other contribution to externalities through taxation and regulations. This includes contributions to environmental protection and management, plus infrastructure development.

In Burkina Faso, the key constraint restricting the ‘formalization’ of the informal sector units is the high entry cost to the formal sector. It consists of cumbersome bureaucratic procedures, the lack of clear-cut regulatory norms, and high taxation (Sananikone 1996a).

Hidden water economy

Missing property rights lead to *extreme informal transaction costs* for water. In the outset, the rights are not based on clear, formal property rights. Instead, they are customary, embedded on local practices and traditions (Bruns 1997).

Every individual needs a certain supply of water each day. Therefore, water is a lucrative good for making business, particularly in urban squatter settlements, where traditions and old customary rights to water have faded away. The term “hidden water economy” is often used in this context.

In Karachi, Pakistan, the poor must pay up to forty times the ‘official’ price for water for the water vendors. The middle and upper sections of the population (the formal sector dwellers) receive the water piped in their houses at an official fare (Baloch 1999). Cairncross (1990) estimates, that between 20 and 30% of all Third World urban people are dependent on water vendors. The prices may mount up to one hundred times the official water price (Bhatia and Falkenmark 1992).

People’s response can be disastrous. In Karachi, given the situation in which the formal sector water supply reaches only a part of the inhabitants, and vendors sell water (with no quality control) at highly inflated prices, private wells are common. Water drawn from such wells originates from diverse urban sources, partly from leaking sewerage pipes, etc. Health risks are evident (Rahman et al. 1997). Also illegal uptake of water from leaking municipal water pipelines, even by damaging the pipes, is common.

1/3 to 1/2 of African irrigation is informal

Informal water use is also a big issue in rural areas. FAO (1996) estimates that informal irrigation covers between 35% and 50% of the total irrigated land in Africa. This is primarily an illegal activity, which tends to develop around formal irrigation schemes.

Despite of being merely illegal, it has an extremely vital and important function in increasing food security and providing nutrition locally to the rural poor, particularly during droughts.

Informal irrigation water markets expand rapidly in India, Pakistan, Indonesia and Jordan (Dick 1997). Water rights for such operations are not clearly established by law. Rural people seek for improvement in their living conditions by socially acceptable means, which are beyond the formal society’s rules.

Informal sector uses informal institutions

Is the informal sector *a constraint* to development, *or a resource* that allows opportunities that the formal sector cannot provide? It is both of them.

When managing the informal sector, its negative and illegal roles should be minimized and the positive and legal ones maximized. This is a delicate task with no simple solutions, since typically the high number of related, deeply interconnected issues—both positive and negative ones—are far from fully controllable. In both of them, informal institutions are in a key role.

Whereas the current tendency with formal water institutions is to target for *cost recovery*—the costs of services are covered by user fees—the same logic is difficult to put in work in the informal sector. The extreme transaction costs of water vendors never circulate back and translate to a better service, but marginally. The service is maintained at the minimum level, and the profits go elsewhere. In irrigation management, the informal markets, however, have in several cases yielded improved water use efficiency and distribution system improvements, and can therefore be seen as a necessary evolution of the rigid formal system (FAO 1996, Dick 1997).

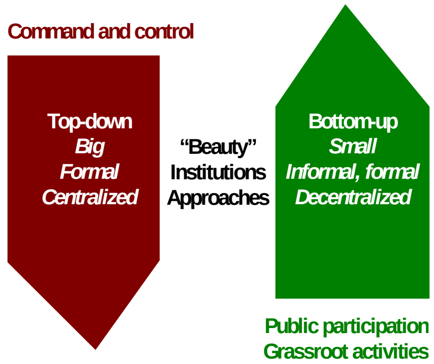
Typically, informal institutions have manifold roles in societies, and understanding them can be a highly complicated and difficult process, particularly for an outsider. This is a clear-cut challenge to all aid organizations. Water, for instance, has many mythical and sacral functions. Moreover, habits are extremely important in dealing with such a basic good as water.

China has at present a complex mix of informal features, originating from its rich traditions plus from the last fifty years. Ignoring these issues tends to make formal institutions profoundly invalid.

In the strata of social units in a society, two opposite directions of information flow can be distinguished: from government to individuals (*top-down*), and from individuals to the government (*bottom-up*). The top-down approach is characterized by such terms as central planning, command and control, big government, regulations, etc. Terms such as public participation, grassroot initiatives, non-governmental organizations (NGOs), public awareness, participatory approach, etc., are frequently associated to the bottom-up approach (Figure 8.2b; see Chapter 3.1).

Accordingly, two extreme ways exist in dealing with the informal sector: first, to *break the dual system* entirely, and second, to *mobilize the informal sector* to operate on the benefit of the whole society, and make it support the formal sector. Both of these approaches can be powerful, but in different circumstances.

Figure 8.2b
Top-down vs. bottom-up approaches
Selected characteristics



Breaking the dual system

Some countries have been able (and willing) to break the dual system and get the *informal sector under control*. This has happened by launching massive social programs, by constructing low-cost housing for the poor, by introducing birth and immigration control, and by demolishing the slum districts.

An example of such a country is Singapore, which has stabilized its economy and has been able to attract investments. A strict environmental policy including water and sanitation has been implemented. More than two thirds now live in 'new towns' which are a result of low cost housing programs.

It is to be seen whether such development will become a trend in the Third World. It requires huge amounts of political power and capital. Therefore, it is likely to reach only wealthy, rapidly industrializing countries. There are potential cases (particularly in Asia) that could take this route, yet in less wealthy countries with weaker institutional arrangements, it appears difficult if not impossible to achieve.

Mobilizing the informal sector to common benefit

The problem with most countries is the lack of economic, social, and human capacity to enforce and implement such radical policies. Therefore, most countries have to live with the informal sector, and attempt to mobilize its activities to yield benefits to the whole society.

Varis and Somlyódy (1997) analyzed the affordability of urban water infrastructure for low and middle-income countries. Using the cost envelope of US$ 150 to 300 per capita for western-type top-down solutions for water and sanitation (cf. Serageldin 1994), the situation appears hopeless for most of the mankind. Box 4.4 shows that the share of the GNI required for water infrastructure exceeds the typical 0.4% by orders of magnitude, except in high-income countries.

If the GNI per capita data for the formal sectors were available separately, evidently the situation would not look as dramatic. The informal sector, however, is the key problem in such calculations and consequent policy choices.

On the positive side, the informal sector provides a channel for a huge number of people to *help themselves*, to organize their economy so, that they can *survive*. It can be seen as a response to a too rigid and incapable formal system.

Fidler and Webster (1996) present a positive path for such survivalists. Many of them evolve gradually to self-employed persons, create microenterprises, and enter the formal sector with small-scale firms.

Informal sector development should provide opportunities for self-employment and entrepreneurship. Yet, the informal sector should not be grown out of hands; it should be allowed to fulfill its positive functions if the formal sector cannot take care of them.

Given the intrinsic property of people's self-help in often a desperate situation, in conditions beyond the capability of the government and formal institutions, they provide a natural ground for *the adoption of participatory approaches and grassroot level activities*. They, in turn, require public awareness and a feeling of ownership to the development process.

This does not necessarily mean formal property rights to water, land and housing, since it tends to be impossible in the majority of the cases. Instead, trust and a commitment to take the development of the local conditions into own hands is called for, in a way which is in harmony with the moral and other positive, informal institutions.

Shift from top-down to bottom-up policies

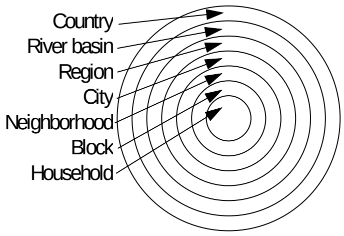
Recent years have seen a shift towards the *emphasis of the bottom-up approach* in many national and international agendas. Many suggest that decisions on water should be made at the lowest appropriate level in the society. NGOs have increasingly been recognized as justified partners in decision making, even in UN Summits.

The participatory approach, based on public awareness, which boosts the transfer of decision making to the lowest appropriate level appears to be high in many agendas, in comparison to the sectorial, central planning model that has dominated in the past few decades.

This is a great challenge to institutional building, especially in many Third World countries; informal institutions such as NGOs, neighborhood associations, small and microenterprises, even households should make commitments and be incorporated in the decision-making processes.

It is a particular challenge to develop solutions that allow the integration of the top-down (governmental) and bottom-up (localized markets along with public awareness) implementation and control of water decisions (Figure 8.2c).

Figure 8.2c
Social units
Levels of decision making in the water sector (According to Serageldin 1994)



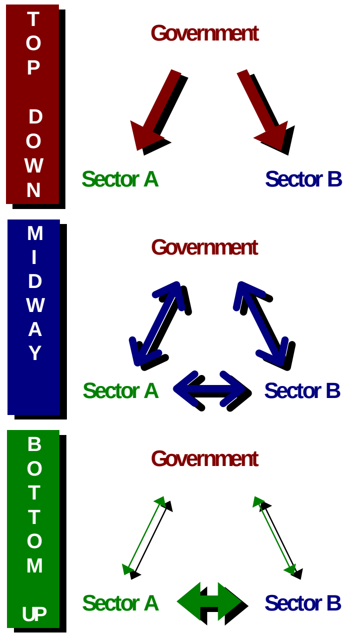
The mainstream discussion, however, tends to forget the *horizontal* direction of the society: there should be enough “social glue” to keep the society together (cf. North 1990 and Chapter 5.1). Accordingly, the social units within a certain level should also be working together and fit to one another. An example—the trinity of the government and two sectors, A and B—is presented in Figure 8.2d.

Authoritarian governments are in favor of the top-down approach with a weak horizontal integrity. Weak governments loose their touch over the society. The optimum would lie midway, where all the parties interact in a balanced way. Yet, the reality seems in many cases to consist of a strange melange of authoritarian reign what comes to the formal façade, and severe incapability of the government to handle the informal issues beyond this façade.

Privatization and the informal sector

Infrastructure provision—as well as most other facets of the water sector—have traditionally been attributed as a responsibility of the state. Although the role of the private sector has been in growth, public investments have an indisputable dominance in most countries of the world.

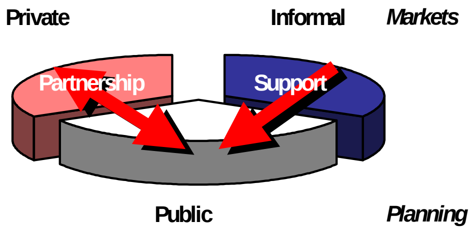
Figure 8.2d
Vertical and horizontal links within a society



Privatization and de-regularization of the state-controlled activities—including water services—are approaches to bring down the top-down dominance. It tends to be, however, not the formal sector’s question alone. In the same process, the integration of the informal sector activities could possibly be managed easier than in the situation of formal sector.

Perhaps the integration should be attempted anyway. The privatization of basic services in a situation in which the government lacks a robust control over most of the society may lead to sliding of the new private sector closer to the informal sector than desired, making the government still weaker.

Figure 8.2e
Positive interconnections between public, private, and informal sectors
The public and private sectors should be able to work in partnership, and the informal sector should support the public sector.



The formal urban sector tends to account for most of the fiscal contribution to the development of a country's infrastructure. The informal economy runs on a much shorter time perspective. The privatized sector should not loose the longer horizon (Figure 8.2e).

Indigenous and traditional practices

The renaissance of various *indigenous and traditional* water management practices and techniques is a sign of the growing recognition of informal institutions.

An example is the FAO sponsored Asian Water Management Network, which is a forum for information exchange in Asian countries concerning traditional water knowledge (e.g. Sharma 1997). The network enhances and supports people's participation in watershed management in thirteen countries. The—primarily rural—informal sector is therewith strengthened, and brought closer to the formal institutions to provide a win-win situation for both parties.

Religions

Even if religions are government-related institutions in some countries, they are described briefly in this context, since in most conditions, they influence to the human behavior in a personal, moral level, and thus can be classified as informal institutions, related to indigenous and traditional practices.

The dominant religions in the study regions can be crudely classified into the following two groups.

- *The indigenous and traditional philosophies and religions*. In Africa, the variety is rich, and it relates strongly to the ethnic origin of the population. In both study regions around 16% of the population attain these religions (Figure 8.2f). The major Asian religions or philosophies include Hinduism, Jainaism, Sikhism, Buddhism, Taoism, and Confucianism. They have very varying shares in the study countries. The E Asian

Figure 8.2f
The distribution of major religions in the study regions
In the Asian map, B, T, C stands for Buddhism, Taoism, and Confucianism. The Unclassified group is dominated by ethnic Chinese. Data from various sources.

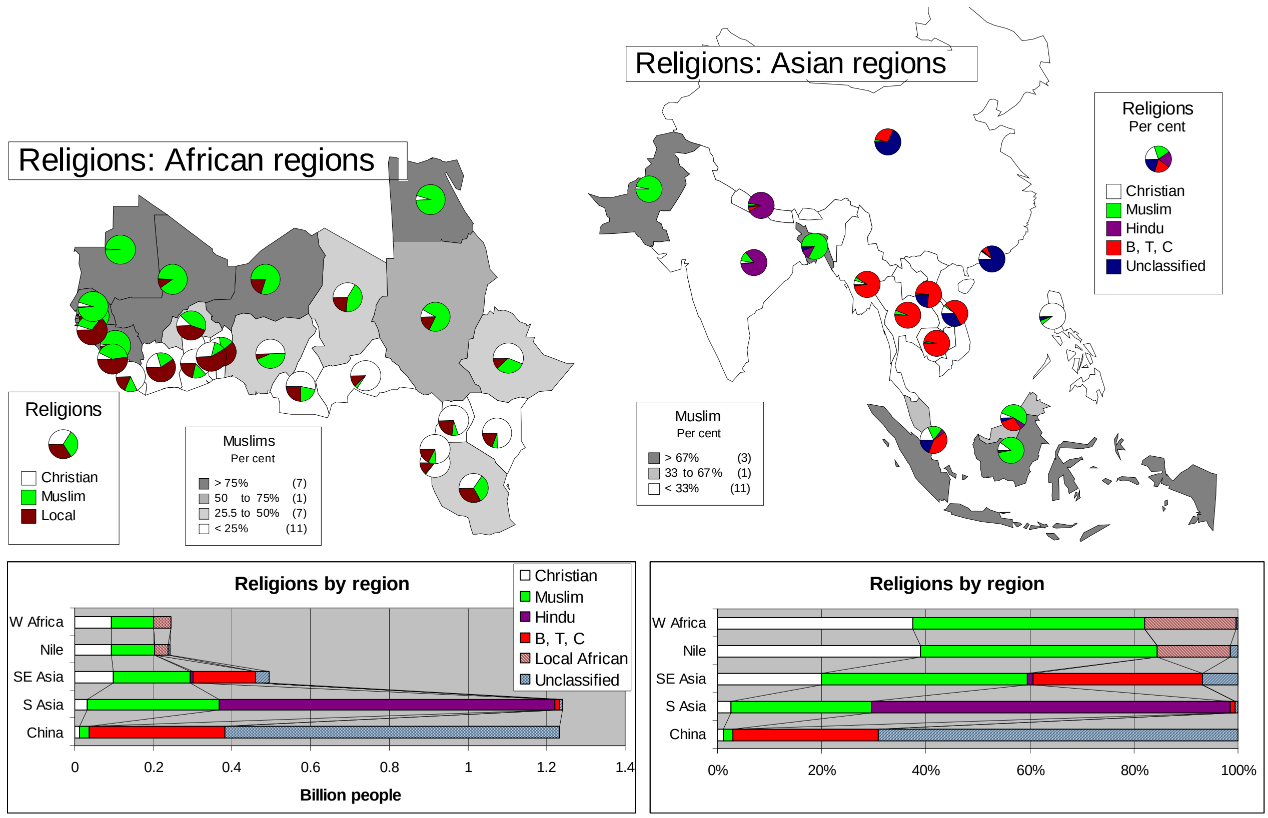
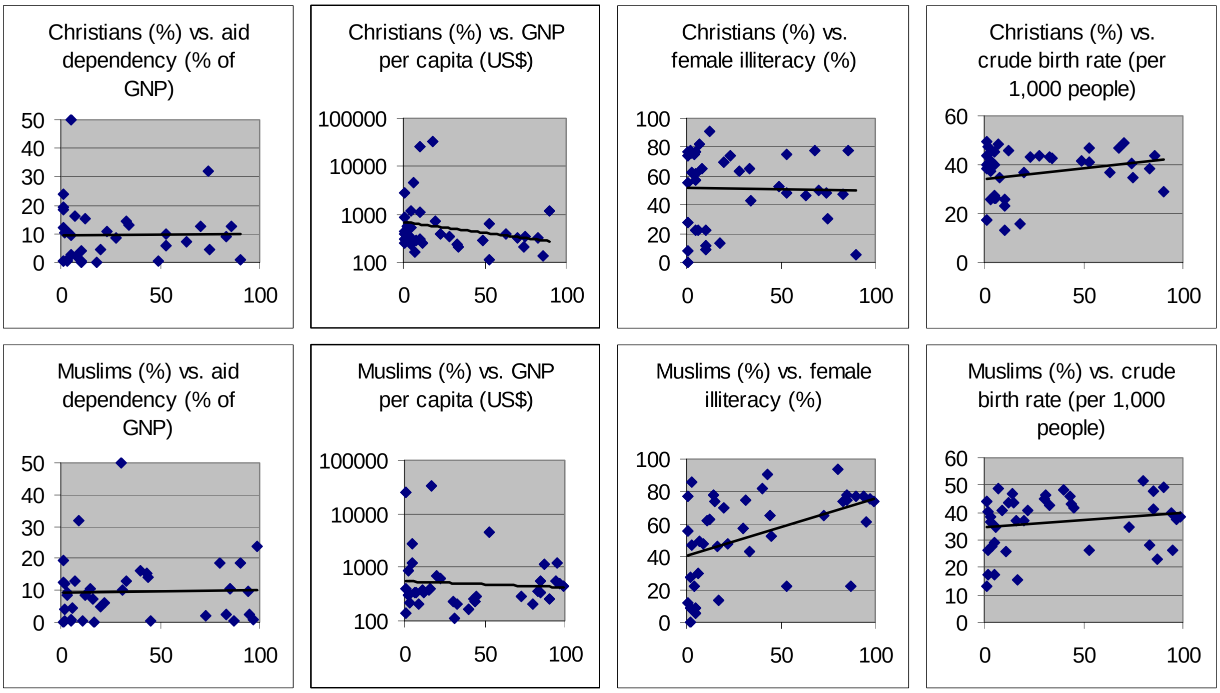


Figure 8.2g

The imported religions Christianity and Islam correlate weakly with social and economic indicators

The proportion of Muslims correlates less negatively with GNP per capita than the proportion of Christians of total population of a country. In contrary, female illiteracy correlates positively with the share of Muslims. Religion data from various sources, other data from World Bank (1999).



culture allows the mix of traditional religions or philosophies such as Taoism, Buddhism and Confucianism. Therefore and partly due to political reasons, statistics are very unreliable in the following countries: China, Hong Kong, Vietnam, Lao PDR, Malaysia, and Singapore.

- *The Middle East/European religions Islam and Christianity* (Figures 8.2f and g). They have been and are actively missioned or even pushed to the study regions, being partly traces of former colonial rules. These religions dominate in the African regions, with nearly equal shares. Yet, Islam dominates in N Africa and the Sahel zone, whereas Christianity takes over roughly South of the 12th latitude. In Asia, the Philippines is the most important Christianity-dominated country, whereas Pakistan, Bangladesh, Malaysia, and Indonesia are dominated by Islam.

Religions are a matter of deep emotion. The roles of religions in the development of societies awakens very straightforward perceptions in next to everybody's mind. However, the things are seldom as simple as such arguments propose, as can be seen from Figure 8.2g.

It is not easy to make comparisons of the importance of the religion in different cultures and geographic regions. However, some analyses exist. For instance, Carballo (2000) surveyed the religious behavior of individuals in six macroregions of the world. Among our study regions, W Africa and SE Asia were included. These two regions were very different from one another. For the question "*Apart from weddings, funerals and christenings, about how often do you attend religious services these days?*", 82% of W Africans responded at least once a week, while 27% of SE Asians responded in the same way. 97% of W Africans and 47% of SE Asians give God a high importance in their lives.

Concluding remarks

Can formal institutions alone do the job of providing a constructive skeleton for the society? Loyalty to formal, and partly also to informal institutions is decreasing—or at least severely challenged—in many parts of the world. There is not much reason for optimism. The roles of informal institutions are the more crucial the less loyal citizens or citizen groups are to formal institutions and the government.

The conclusions can hence be condensed as follows:

- Informal sector is growing in most nations
- Informal institutions grow in importance, since formal ones do not reach the informal sector sufficiently

- Informal institutions should be more respected and integrated into water development agendas
- This is challenging since they are deeply interwoven into the traditions and culture.
- The positive aspects of informal institutions should be supported, and their negative sides such as corruption, bribery, local mafias, etc., should be set under control.

In addition, two quotations of famous thinkers are a good reference in this context. Solzhenitsyn says: "*You only have power over people as long as you don't take everything away from them. But when you have robbed a man of everything, he is no longer under power*". And Goethe goes: "*Welche Regierung die beste sei? Diejenige, die uns lehrt, uns selbst zu regieren*". (Which government would be the best one? The one that teaches us to govern ourselves).

8.3 International commitments and regional co-operation

Tommi Kajander

Environmental problems respect no geographical boundaries. Climate change, marine, riverine and air pollution, ozone depletion or desertification never show a passport—the problems have reached the global scale. One answer to the global environmental degradation is in international environmental agreements and co-operation. International co-operation and institutions are the key in managing transboundary water resources as well.

Overview

This chapter focuses on international co-operation. The theme is approached from two different point of view and scales. First international co-operation is discussed at the regional level in terms of treaties and institutions concerning international watersheds in the study regions. Secondly the concept of international environmental agreements is reviewed. The most important multilateral conventions are summarized. The compliance with the agreements is discussed as well.

Transboundary basins and co-operation

Transboundary watersheds—river basins located in the territory of two or more countries—are counted in hundreds. Estimates of international watercourses in the world vary from 214 (UN 1978) to 280 (Green Cross 2000). Wolf (1999) estimates that there are 261 transboundary watersheds covering 45.3% of the earth's land surface. Population living in these basins is equivalent to 35-40% of the global population.

As a vital resource for human survival and economic development, water should be managed and utilized in an equitable way among the riparian countries. The increasing competition in water use between different sectors and the increasing water pollution and shortage problems require integrated water resources management in a basinwide scale. This approach arrogates regional co-operation and institutional and legal capacity.

There is no international law concerning transboundary water resources. The United Nations Convention on the Law of the Non-navigational Uses of International Watercourses (1997)—which would be the first of its kind—will hardly enter into force as just eight states have ratified it by the time of writing. To enter into force the convention needs the ratification of thirty-five states.

Co-operation between governments in the study regions however exists. Many treaties over international rivers have been signed and several organizations, involved in water resources management of transboundary rivers, have been established. Below, the most important institutions and treaties concerning the management of the international water courses in the study regions are introduced.

The Nile Basin

Treaties concerning the sharing of the Nile water dates back to 1891. The agreements have without exception been bilateral; the most important being the Nile Waters Agreement of 1959 between Sudan and Egypt. The treaty allocated 18.5 km^3 of Nile water to Sudan and 55.5 km^3 to Egypt. In total this is equivalent to the net water availability of the whole Nile River. The upper riparians of the Nile Basin were excluded from the treaties.

Basinwide co-operation in the Nile Basin has just recently begun. Nile Basin Initiative, launched in 1999 has been developed to achieve sustainable socio-economic development by utilizing and benefiting from the Nile waters equitably. The initiative comprises two programs: the Shared Vision Program and the Subsidiary Action Programs. The first aims to create an enabling environment for investments and action within a basinwide framework. The latter implements actual development projects, concerning two or more countries, at sub-basin level (NBI 2006).

According to Tafesse (2001) an effective basinwide organization can be implemented only if the 1959 Nile Water Treaty is revised and re-negotiated. In practice this means that the rights of the upper riparians have to be accommodated in the agreement.

West Africa

In West Africa there are four substantial international watercourses, which are Niger, Senegal and Volta River, and the Lake Chad Basin. In each of these basins, except the Volta, regional co-operation concerning water resources management exists.

Institutional co-operation in the Niger River basin originated in 1964 when the River Niger Commission was established. Its activities were however considered insufficient and the commission was replaced with the Niger Basin Authority (NBA) in 1980. The authority comprises of the nine riparians including Benin, Burkina Faso, Cameroon, Chad, Guinea, Côte d'Ivoire, Mali, Niger, and Nigeria (NBA 2006).

NBA's objectives are to harmonize and coordinate national policies for the development of the basin's resources and to execute an Integrated Development Plan of the Basin. In addition NBA's aim is to design, realize, exploit, and maintain common works and projects in the Niger river basin. The actual functionality of the authority remains questionable. Kliot et al. (2001) note that as an institution, NBA is not successful due to the opposing interests of too many riparians and the failure in mobilization of foreign aid.

The Senegal river basin is managed by the Senegal River Development Organization (OMVS), established in 1972 along with the agreement on sharing the Senegal River between Mali, Mauritania, and Senegal. The functions of the organization are promotion of navigation, irrigation and hydropower. OMVS is constructing and operating joint projects as well; the greatest achievements being the Manantali and Diama dams.

OMVS is stated as an effective organization, which has mobilized US$700 million from donors for the implementation of various projects (Kliot et al. 2001). However the management of Senegal River is also criticized. Niasse (2001) reports about the inequities in the sharing of costs and benefits at sub-national and community levels and states that coherence between the different water management units is lacking. OMVS has also been criticized of having a too one-sided macroeconomic view as it promotes hydropower, irrigated large-scale agriculture and navigation, and tends to forget the needs of the poverty-laden inhabitants of the river valley (Varis and Lahtela 2002, Lahtela 2003).

Co-operative basinwide activities concerning Lake Chad started in 1964 when the convention and statute relating to the development of the Chad Basin was signed. Consequently the Lake Chad Basin Commission (LCBC) was established by the riparians including Cameroon, Chad, Niger, and Nigeria. Central African Republic joined the commission in 1994.

LCBC promotes regional co-operation by i.a. preparing general regulations and drawing up common rules regarding navigation and transport in the context of the convention and statute. The commission is also involved in the development of the basin at practical level. It plans, mobilizes and monitors national projects and co-ordinates regional programs and joint research programs. According to Oguntola (2001) LCBC has also a considerable role in resolving conflicts within the basin. The commission has provided a forum for dialogue and enabled close contact and high level of co-operation between the member countries (Jauro 2000).

S Asia

The most important transboundary water resources in S Asia are Indus, Ganges, and Brahmaputra Rivers. As an extremely densely populated subcontinent, S Asia faces considerable challenges in water resources management. Co-operation between Bangladesh, India, Pakistan, and Nepal is crucial to achieve sustainable and equitable use of water resources. The negotiations have however been cumbrous due to political reasons. The co-operation in S Asia is more or less dominated by India.

The management of international watercourses in S Asia is prevailed by bilateral treaties. Indus water is divided between India and Pakistan by the Indus Water Treaty signed in 1960. The treaty resolved the conflicts over water and has prevented the both riparians from big claims.

The sharing of the waters of Ganges between India and Bangladesh has been troublesome and disputed since 1951. The issue reached considerable measures among with the completion of Farakka Barrage in India in 1975. The dam diverts water from Ganges to Hooghly River and thus reduces considerably the lowflow of Ganges in Bangladesh (Tanzeema and Faisal 2001).

Two treaties have been signed (in 1977 and 1996) on the sharing of Ganges water at Farakka. Although the agreements are much criticized they are better than having none. According to Kliot et al. (2001) the treaty of 1996 worked well during the dry season of 1998 and 1999. However the problems in Bangladesh will not be solved by treaties as the main problem is the water shortage in the dry season.

There are two international commissions, which are involved in governing water resources in S Asia. The Permanent Indus Commission was formed under the Indus Water Treaty in 1960. The Indo-Bangladesh Joint River Commission was established in 1972 to ensure the most effective joint measures in maximizing the benefits from common river systems between India and Bangladesh. The achievements of the both commissions have remained slight (Ilomäki 2000).

SE Asia

SE Asia is abundant with transboundary water resources. The biggest international rivers in SE Asia in terms of the basin area and annual average discharge are Mekong, Irrawaddy, Salween, and Red River. All of these rivers originate from China. However China is not involved in the regional co-operation considering the water resource management and development of the river basins.

Mekong River Commission (MRC), established in 1995 to replace the past Mekong River Committee, is one of the most active international institutions implementing co-operation in river basin development in the study regions. The member countries of MRC include the riparians of the Lower Mekong basin; Cambodia, Lao PDR, Thailand, and Vietnam. The upper riparians China and Myanmar are not members of the Commission.

The members of MRC have agreed to co-operate in all fields of sustainable development, utilization, management and conservation of the water and related resources of the Mekong River Basin. The activities focus to i.a. navigation, flood control, fisheries, agriculture, hydropower, and environmental protection. According to MRC (2006) the core activities of the Commission consist of the Basin Development Plan, Water Utilisation Programme and the Environment Programme (Box 8.3).

The commission is compounded of the council, the joint committee and the MRC Secretariat. The council makes the decisions at ministerial level while the joint committee is responsible of their implementation. The secretariat provides technical and administrative services to the council and the joint committee.

China

Although China is the uppermost riparian of all the major transboundary watercourses in S and SE Asia, its contribution to the basinwide co-operation of the rivers has been very weak. For example in the case of Mekong River it has not joined the MRC. However China develops extensively the Upper Mekong River Basin by inter alia building dams.

Box 8.3

Mekong River Commission's approach towards integrated water resources management

Basin Development Plan and Water Utilization Programme (after Varis and Keskinen 2003).

Given the very troublesome but politically relaxing situation in Cambodia, Lao PDR, and to some extent still in Vietnam, the ambient has obviously become suitable for long-term planning on a regional basis in the Mekong Basin. The strongest international organization in the region has over the years been the Mekong River Commission (MRC). Among the riparian countries Cambodia, Vietnam, Lao PDR and Thailand are its members, but China and Myanmar (Burma) are not.

The MRC is currently working on a comprehensive master plan for the lower Mekong River Basin (basin's parts that are within the four member countries). This Basin Development Plan (BDP) is supported by a massive six-year background analysis—or a series of analyses—under the title Water Utilization Programme (WUP).

WUP's first part concentrates on Cambodia's Great Lake, the Tonle Sap, and its surroundings. The scopes are in the establishment of the basic data and information infrastructure, hydrological, hydraulic, and water quality modeling etc., and a socio-economic analysis.

The cornerstones for BDP and WUP were laid in 1995, as the MRC members signed the Mekong Agreement. It reformulated the Commission's concerns: With a quotation of MRC's Strategic Plan of the year 2000:

"…from economic development activities such as hydropower, irrigation and flood control, in conjunction with such core activities as hydrographic, hydrologic and meteorological data collection and coalition…" to *"…a balance between the economic, social, and environmental decisions and development. With the majority of the basin's inhabitants being rural-based and poor, socio-economic considerations inevitably assume vital importance in development planning and implementation."*

One of the five strategic goals for implementing these new foci was to formulate the BDP. Besides addressing different sectors such as agriculture, fisheries, hydropower and so forth, it has a strong focus on "cross-cutting themes", one of which is socio-economics (including poverty reduction, and cultural and gender aspects).

BDP should also comply with national planning practices. The Kingdom of Cambodia has committed itself to the regional *War Against Poverty*, which is a broad framework for policy programs for sustainable development and poverty reduction. BDP should comply with this framework, which guides national ministries in their activities.

All these humble initiatives need vigilant and thoughtful implementation work in many aspects in the level of diagnostics, capacity building, communication, planning, and so forth.

Regional co-operation between different provinces exists in the sector of river basin development. There are six provincial river commissions which work on the major water courses including among others the Yangtze and Yellow River. These regional offices of the Ministry of Water Resources formulate i.a. basinwide policies and regulations and development strategies for river basins in co-operation with other departments and provincial governments (Ilomäki 2000).

International conventions and protocols

Among with the economic development and population growth the environmental problems have worsened during the past decades. The problems are not just regional but have expanded and crossed the national borders. Climate change, marine and air pollution, ozone depletion - examples of global environmental problems are numerous. Consequently it has been realized that environmental protection is needed at the global level.

As a response to the global environmental problems a myriad of international agreements have been concluded. The number of multilateral environmental agreements (MEAs) has sharply increased since the United Nations Conference on the Human Environment, the first major international forum on the environment, held in Stockholm in 1972. Today there are more than 200 international agreements, which aim to protect environment in form or another. In addition to the significant number of MEAs the agreements are generally strictly discipline specific. There are conventions concerning e.g. forests, biodiversity, air pollution, wastes, animal species, and desertification.

The great variety of agreements and the multidisciplinary nature of environmental problems hinder their efficient tackling. There are gaps, overlaps and contradictions between many international environmental agreements. In addition environmental problems are highly complex and closely related to socioeconomic factors but the MEAs are created in isolation to large extent. As Domoto (2000) states there is a discrepancy between the fragmented environmental governance systems and the holistic character of the environment itself.

The following list of agreements is from Stokke and Thommessen (2003). The relevant conventions with respect to the topic of this book are included in Table 8.3a.

The less relevant agreements among those listed in this context are in Italics, and omitted from further scrutiny. The objectives of the relevant ones are shortly described in the following and finally listed in Tables 8.3b and c by study countries and status of ratification. The references concerning the agreements are indexed after the tables.

There are different ways how states can declare their consent to be bound by a treaty. The most common expressions are signature, ratification, acceptance, approval, and accession.

Signature of an agreement is an important stage although it does not bind a state to comply with the convention. Signatures are needed to authenticate the text agreed in the negotiations (Kuokkanen 1996). In addition the signing of a convention expresses the state's will to continue with the treaty-making process.

Ratification means an international act whereby a state indicates on the international level its consent to be bound by a treaty. Before the ratification countries have to make necessary modifications in their domestic legislation to meet the international obligations of the treaty. Accession has the same legal effect as ratification but usually takes place after a treaty has entered into force. Acceptance and approval have replaced ratification in some cases when the state's constitutional law does not require the ratification of the treaty by the head of state (Kuokkanen 1996, Stokke and Thommessen 2003).

A treaty enters into force after a certain period of time has passed from the ratification of a treaty by requisite number of countries. For example the UN Framework Convention on Climate Change entered into force on the ninetieth day after the deposit of the fiftieth instrument of ratification, acceptance, approval or accession.

Whether a state signs and ratifies an agreement depends on several issues. Interests of countries play a crucial role in international environmental policy. When the benefits gained from the compliance with an agreement exceed the costs, states are willing to participate in international conventions. It has been realized that the likely costs of environmental protection are generally less than the costs to rehabilitate environmental degradation.

According to Sprinz and Vaahtoranta (2002) country's ecological vulnerability and abatement costs explain the likely behavior of states in international environmental negotiations. Countries with high compliance costs will have lower degree of involvement and they will act as draggers in the negotiations. Meanwhile country's high level of ecological vulnerability increases its will to reduce international environmental problems and work out agreements.

Table 8.3a

Most relevant international commitments in the context of this book

The status with respect to ratification and signing of the commitments is shown in Tables 8.3b and c. The commitments in italics are by now of lesser importance in the study region countries and therefore excluded from the Tables b and c. For marine environment (in addition to the United Nations Convention on the Law of the Sea), marine living resources and nuclear safety conventions see the source Stokke and Thommessen (2003).

Convention	Remarks
General environmental concerns	
Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Århus Convention), Århus, 1998	*Has not been signed by any of the study region countries, and furthermore, has not been ratified by any country in the world, but is considered as a pontentially important convention in coming years.*
Convention on Environmental Impact Assessment in a Transboundary Context, Espoo, 1991	*Has not been signed by any of the study region countries.*
Freshwater resources	
Convention on the Protection and Use of Transboundary Watercourses and International Lakes (ECE Water Convention).	*Has not been signed by any of the study region countries.*
Nature conservation and terrestrial living resources	
Antarctic Treaty, Washington, DC, 1959.	*Consultative parties include India and China among the study countries.*
Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention), Paris, 1972.	The convention's primary mission is to define and conserve sites with outstanding cultural and natural heritage by close co-operation of the nations.
Convention on Biological Diversity (CBD), Nairobi, 1992.	All the study region countries have ratified the agreement. The objectives of the convention are the conservation of biological diversity, the sustainable use of its components and the equitable sharing of the benefits gained from the utilization of genetic resources.
Cartagena Protocol on Biosafety to the Convention on Biological Diversity (Cartagena Protocol on Biosafety), Montreal, 2000.	The objective of the protocol is to protect biological diversity and its conservation and sustainable use from the potential risks originating from the transfer, handling and use of living modified organisms resulting from modern biotechnology.
Convention on the Conservation of Migratory Species of Wild Animals (CMS), Bonn, 1979.	The objective of the convention is to conserve terrestrial, marine and avian migratory species by promoting, co-operating in and supporting research activities relating to migratory species and by providing immediate protection for given migratory species.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Washington, DC, 1973.	The objective of the convention is to ensure the survival of certain animal and plant species by regulating the international trade in specimens of species.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), Ramsar, 1971.	The convention aims to the wise use and conservation of wetlands by providing a framework for national action and international cooperation.
Convention to Combat Desertification (CCD), Paris, 1994.	The convention's objective is to promote effective action against desertification through innovative local programs and supportive international partnerships.
International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), Rome, 2001	The treaty aims to ensure the sustainable use and conservation of plant genetic resources for agriculture and food. Further more equitable sharing of benefits of aforementioned activities is promoted.
International Tropical Timber Agreement, 1994 (ITTA, 1994), Geneva, 1994.	The agreement has fourteen objectives related to the international trade in tropical timber and its sustainable development.
Atmosphere:	
Convention on Long-Range Transboundary Air Pollution (LRTAP), Geneva, 1979, including the Gothenburg Protocol to Abate Acidification, Eutrophication, and Ground-Level Ozone, Gothenburg, 1999.	*LRTAP's aim is to control and reduce the damage to human health and the environment caused by transboundary air pollution. The convention provides an institutional framework bringing together research and policy in the UNECE region (Europe and North America).*

Table 8.3a
Most relevant international commitments in the context of this book
Continued.

Convention	Remarks
Atmosphere:	
Framework Convention on Climate Change (UNFCCC), New York, 1992, including the Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1999.	The objective of UNFCCC is to prevent dangerous anthropogenic interference with climate system by stabilizing greenhouse gas concentrations in the atmosphere at an appropriate level which should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change. In addition the convention aims to ensure that the food production is not threatened. One of the objectives as well is to enable economic development to proceed in a sustainable manner.
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985, including the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987	The objective of the convention is to protect human health and the environment against adverse effects resulting from human activities which modify the ozone layer and to promote co-operation in scientific research to improve understanding of the atmospheric processes.
Hazardous substances:	
Convention on the Ban of the Import into Africa and the Control of Transboundary Movements and Management of Hazardous Wastes within Africa, Bamako, 1991	The convention aims to protect the human health and environment from the adverse effects of hazardous wastes by reducing their generation, adopting precautionary measures, and ensuring proper disposal of hazardous wastes.
Convention on Civil Liability for Damage Caused during Carriage of Dangerous Goods by Road, Rail, and Inland Navigation Vessels (CRTD), Geneva, 1989	*The convention's objective is to ensure a rapid and sufficient compensation for damage caused during carriage of dangerous goods by road, rail, and inland navigation vessels. The convention is not in force and has only two signatories.*
Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), Basel, 1989	Basel convention's aim is to minimize the generation and transport of hazardous waste in an environmentally sound way.
Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (PIC Convention), Rotterdam, 1998	The PIC Convention is established to protect human health and the environment from potential harm caused by certain hazardous chemicals. This is achieved by promoting shared responsibility and cooperative efforts in the international trade and by contributing to environmentally sound use of hazardous chemicals.
Convention on the Transboundary Effects of Industrial Accidents, Helsinki, 1992	*The objective of the convention is to promote prevention of, preparedness for, and response to industrial accidents capable of causing transboundary effects and to enhance international co-operation in these fields. The convention is regional concerning the UNECE region.*
Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region (Waigani Convention), Waigani, 1995	*The convention prohibits the importation of hazardous and radioactive wastes and promotes the environmentally sound management of such wastes. It is open for countries in the South Pacific Region.*
FAO International Code of Conduct on the Distribution and Use of Pesticides, Rome, 1985	The code aims to promote efficient and safe use of pesticides including minimizing adverse effects on human health and environment.
Stockholm Convention on Persistent Organic Pollution (Stockholm Convention on POPs), Stockholm, 2001	The objective of the Stockholm Convention is to protect human health and the environment from persistent organic pollutants (POPs) by taking measures to reduce the releases of POPs.
Marine environment:	
United Nations Convention on the Law of the Sea (UNCLOS), Montego Bay, 1982	The convention consists of 320 articles concerning all aspects of ocean space including inter alia environmental control and economic and commercial activities.

Table 8.3b

Ratification status of international conventions by the study countries

p = party. A state that has ratified, accepted, approved or acceded the convention. s = signatory. A state that has signed, but not ratified, accepted, approved or acceded the convention.

	W Africa	Benin	Burkina F	Cameroon	CAR	Chad	C d'Ivoire	Gambia	Ghana	Guinea	G-Bissau	Liberia	Mali	Mauritania	Niger	Nigeria	Senegal	S Leone	Togo	**Nile**	Burundi	Egypt	Ethiopia	Kenya	Rwanda	Sudan	Tanzania	Uganda
World Heritage…, 1972[1]		p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
CBD, 1992[2]		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
Cartagena Protocol…, 2000[2]		p	p	p	s	s		p	p	s		p	p	p	p	p	p		p			p	p	p	p	p	p	p
CMS, 1979[3]		p	p	p	s	p	p	p	p	p	p	p	p	p	p	p	p		p			p		p	p		p	p
CITES, 1973[4]		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
Ramsar Convention, 1971[5]		p	p		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p		p	p	p	p	p
UNCCD, 1994[6]		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
ITPGRFA, 2001[7]			s	p	p	s	p		p	p		p	p	p	p	s	s	p	s		s	p	p	p		p	p	p
ITTA, 1994[8]				p	p		p		p			p										p						
UNFCC, 1992[9]		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
Kyoto Protocol, 1999[10]		p	p	p				p	p	p	p	p	p	p	p	p	p		p		p	p	p	p	p	p	p	p
Vienna Convention, 1985[11]		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
Montreal Protocol, 1987[11]		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
Convention on the Ban…, 1991[12]		p	s	p	s	s	p	p	s	s	s	s	p		p		p	s	p		s	p	p	s	s	p	p	p
Basel Convention, 1989[13]		p	p	p		p	p	p	p	p	p	p	p	p	p	p	p		p		p	p	p	p	p	p	p	p
PIC Convention, 1998[14]		p	p	p		p	p	p	p	p	s	p	p	p		p	p		p		p		p	p	p	p	p	
FAO International Code…, 1985[8]		p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p	p		p	p	p	p	p	p	p	p
Stockholm Convention…, 2001[15]		s	s	s			s	s	s	s			s	s	s	s	s		s		s			s		s	s	
UNCLOS, 1982[16]		p	p	p	s	s	p	p	p	p	p	s	p	p	s	p	p	p	p		s	p	s	p	s	p		p

	China	**SE Asia**	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Thailand	Vietnam	**S Asia**	B'desh	India	Nepal	Pakistan
World Heritage Convention, 1972[1]	p		p	p	p	p	p	p	p	p		p	p	p	p
CBD, 1992[2]	p		p	p	p	p	p	p	p	p		p	p	p	p
Cartagena Protocol…, 2000[2]	p		p	p	p	p	s	s	p	p		p	p	s	s
CMS, 1979[3]								p				p	p		p
CITES, 1973[4]	p		p	p	p	p	p	p	p	p		p	p	p	p
Ramsar Convention, 1971[5]	p		p	p		p	p	p	p	p		p	p	p	p
UNCCD, 1994[6]	p		p	p	p	p	p	p	p	p		p	p	p	p
ITPGRFA, 2001[7]			p			p			s			p	p		p
ITTA, 1994[8]	p		p	p		p	p	p	p				p	p	
UNFCC, 1992[9]	p		p	p	p	p	p	p	p	p		p	p	p	p
Kyoto Protocol, 1999[10]	p		p	p	p	p	p	p	p	p		p	p	p	p
Vienna Convention, 1985[11]	p		p	p	p	p	p	p	p	p		p	p	p	p
Montreal Protocol, 1987[11]	p		p	p	p	p	p	p	p	p		p	p	p	p
Convention on the Ban…, 1991[12]															
Basel Convention, 1989[13]	p		p	p		p		p	p	p		p	p	p	p
PIC Convention, 1998[14]	p			s		p		s	p				p		p
FAO International Code…, 1985[8]	p		p	p	p	p	p	p	p	p		p	p	p	p
Stockholm Convention…, 2001[15]	p		s	s	s		p	p	p	p		s	p	s	s
UNCLOS, 1982[16]	p		s	p	p	p	p	p	s			p	p	p	p

Table 8.3b

Ratification status of international conventions by the study countries

Continuation: footnotes and web links to the Table

[1] UNESCO 2006. *Convention Concerning the Protection of the World Cultural and Natural Heritage. Ratification Status* (as of 31 March 2005). United Nations Educational, Scientific and Cultural Organization, Paris. http://whc.unesco.org/pg.cfm?cid=246 (10.5.2006).
[2] Convention on Biological Diversity 2006. *Parties to the Convention on Biological Diversity/Cartagena Protocol on Biosafety* (as of 6 January 2006). Secretariat of the Convention on Biological Diversity, Quebec. www.biodiv.org/world/parties.asp (10.5.2006).
[3] UNEP/CMS 2006. *Parties to the Convention on the Conservation of Migratory Species of Wild Animals* (as of 1 December 2005). UNEP/CMS Secretariat, Bonn. www.cms.int/pdf/en/party_list/Partylist_eng.pdf (10.5.2006).
[4] CITES 2006. *Convention on International Trade in Endangered Species of Wild Flora and Fauna. Member Countries* (as of 8 November 2006). CITES Secretariat, Geneva. www.cites.org/eng/disc/parties/alphabet.shtml (10.5.2006).
[5] Ramsar 2006. *Key Documents of the Ramsar Convention. Contracting Parties to the Ramsar Convention on Wetlands* (as of 1 February 2006). Ramsar Convention Bureau, Gland. www.ramsar.org/key_cp_e.htm (10.5.2006).
[6] UNCCD 2002. *United Nations Convention to Combat Desertification*. *Status of Ratification and Entry into Force of the UNCCD* (as of 3 April2002). UNCCD Secretariat, Bonn. www.unccd.int/convention/ratif/doeif.php (10.5.2006).
[7] FAO 2006. *International Treaty on Plant Genetic Resources for Food and Agriculture* (as of 11 January 2006). FAO, Rome. www.fao.org/Legal/TREATIES/033s-e.htm (10.5.2006).
[8] Fridtjof Nansen Institute 2004. Yearbook of International Co-operation 2003/2004. Website version. The Fridtjof Nansen Institute, Lysaker. www.greenyearbook.org/agree/agr-ind.htm (23.4.2004).
[9] UNFCCC 2006. *United Nations Framework for Convention on Climate Change. Status of Ratification* (as of 24 May 2004). UNFCCC Secretariat, Bonn. http://unfccc.int/resource/conv/ratlist.pdf (10.5.2006).
[10] UNFCCC 2006. *Kyoto Protocol. Status of Ratification* (as of 16 January 2006). UNFCCC Secretariat, Bonn. http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf (10.5.2006).
[11] UN 2006. *Status of Ratification/Accession/Acceptance/Approval of the agreements on the protection of the stratospheric ozone layer* (as of 16 December 2005). United Nations Office of Legal Affairs, New York. www.unep.ch/ozone/ratif.shtml (10.5.2006).
[12] African Union 2006. *List of Countries which have Signed, Ratified/Acceded to the Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa* (as of 12 December 2005)*.* African Union, Addis Ababa. www.africa-union.org/root/au/Documents/Treaties/List/Bamako%20Convention.pdf (10.5.2006).
[13] UNEP 2006. *Parties to the Basel Convention* (as of 9 January 2006). Secretariat of the Basel Convention, Geneva. www.basel.int/ratif/frsetmain.php (10.5.2006).
[14] UNEP/FAO 2006. *Signatures & Ratifications. Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade* (as of 3 January 2006). Secretariat for the Rotterdam Convention, Geneva and Rome. www.pic.int/en/ViewPage.asp?id=265 (10.5.2006).
[15] UNEP 2006. *Stockholm Convention on Persistent Organic Pollutants (POPs). Signatures and ratifications* (as of 31 January 2006). Interim Secretariat for the Stockholm Convention on Persistent Organic Pollutants, Geneva. www.pops.int/documents/signature/ (10.5.2006).
[16] UN 2006. *Status of the United Nations Convention of the Law of the Sea* (as of 16 September 2005). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, UN, New York. www.un.org/Depts/los/index.htm (10.5.2006).

Public pressure on decision makers, dramatic instances of environmental degradation and scientific understanding of the environmental problem are traditionally considered in the literature as the central aspects for international environmental action.

Although a state has ratified an agreement it does not ensure the compliance. According to Weiss (1997) there are two critical factors which largely explain states' national compliance with a convention. These are the intent and the capacity to comply. An effective and uncorrupted bureaucracy, economic resources, public support, and technical expertise and know-how increase the capacity.

There are no proper means to oblige states to comply with conventions. To achieve meaningful compliance responsive national lawmaking and enforcement are prerequisites. The parties to a convention have to take measures to make international agreements operative in their domestic law. Consequently the states are responsible and ensure that other actors such as industrial and commercial enterprises, non-governmental organizations and individual actors comply with the domestic measures.

Although the parties of a convention cannot be coerced to comply there are international legal strategies to encourage compliance. These can be divided into three categories which are sunshine principle, positive incentives, and negative incentives (Weiss 1997).

Sunshine principle is the most used method to promote compliance. It includes i.a. monitoring in the form of regular reporting of the implementation and compliance measures taken by a country. The reports are then reviewed and verified in an international process. The sunshine approach relies also on e.g. transparency and access to information, NGO participation in monitoring compliance and informal pressures produced by the parties and secretariats of the convention.

Positive incentives besides the sunshine principle is the other compliance strategy which is frequently used. Financial instruments are often applied to improve the compliance. International environmental agreements have commonly included provisions on providing financing and non-monetary transfers including technical assistance, technology transfer, training or R&D cooperation to developing countries. This is essential as the poor states can seldom cover the abatement costs and the costs of capacity building themselves.

Negative incentives such as sanctions or penalties are mainly used in trade law. Sanctions are rarely applied to environmental law and are often considered as the last alternative.

Fortunately the threshold to violate international environmental agreements is relatively high among the member countries. States are not willing to lose their reputation in taking measures in environmental protection. In addition violation of an international convention may lead to an international boycott of the violator.

Summary

Regional co-operation exists in nearly all of the major transboundary watersheds of the study regions. International institutions working on the development of river basins have been established in the Nile, Niger, Senegal, Mekong, Indus, and Ganges Rivers. Additionally Lake Chad has its own commission. China is not involved in the management of transboundary water courses at the international level.

Not all of the institutions comprises of all the riparians. The sharing of the Nile waters is still determined by a bilateral treaty signed by Egypt and Sudan in 1959. In S Asia the regional co-operation is dominated by the most powerful country, India. The water of Ganges has been a matter of conflict between India and Bangladesh. Tripartite co-operation (including Nepal) in the management of Ganges has not succeeded. Basinwide management of the Mekong watershed is hindered by the absence of China and Myanmar in the Mekong River Commission. In W Africa the basinwide co-operation in the management of international water courses seems to be more comprehensive.

The regional co-operation in the study regions is mainly driven by the governments. This means that the benefit of nations e.g. national economy is often the goal of development activities and the sharing of costs and benefits might be unequal. The involvement of NGOs and local communities in the regional co-operation is thus crucial and should be encouraged.

The number of international environmental agreements as a response to environmental problems has sharply increased during the last decades. In addition the conventions are discipline specific. Consequently the environmental governance systems are fragmented and overlaps between agreements exist.

There is no international court of justice which could punish the violators of multilateral conventions. States have the responsibility for the compliance of various actors including industrial and commercial enterprises, non-governmental organizations and individual actors. Although there are no means to coerce countries to comply with agreements encouragement methods exist. These are positive and negative incentives and monitoring.

Formulation of international environmental agreements is a very complex and time-consuming task. Interests of the negotiating countries are often so divergent that compromises are hard to find. It may also happen that when consensus is finally achieved the agreement is inefficient due to its generality and vagueness. Due to the multidisciplinary nature of environmental problems and their occurrence at international, regional and local levels holistic approaches are required in the formulation of MEAs.

8.4 Opening for globalization

Olli Varis

Arguments such as comparative benefits due to international division of labor and substitution of commodities are used to back the benefits of international trade. Tariff barriers have gone down almost everywhere, easing trade across borders. However, poor economies still feel a need to protect themselves, knowing that wealthiest economies such as US, EU, and Japan, are anything but tolerant in allowing foreign products to enter their markets.

Power and freedom should absolutely be accompanied by responsibility over the others.

Definitions

Globalization is one of the most hated or beloved buzzwords of these days. In the broad meaning of the word, it means opening of the gates and take down the boundaries between nations. While the basic idea is grand and the underlying tendency is inevitable in the contemporary world, plenty of contradictions and side effects are obvious.

On the ideological level, many philosophies have been advocating the friendship and brotherhood of men from different races, cultures, and so forth. Lenin, Lennon, IMF (International Monetary Fund), all the same. Everything OK in principle, yet not always in practice.

On the individual level, most humans are jealous about their own dwelling and territory. Most people like to lock their doors to control who comes in and when, and who enjoys their property. Clear property rights are the fundaments of modern economics.

There are many people, though, who love to enjoy the properties of other people. What is private, what is common are questions where culture plays a colossal role, and tensions exist when different cultures meet, e.g., when Anglo-American, Russian, French, Islamic or Christian ideals are pushed to other cultures.

On a community level, the history is interwoven with conflicts and agreements between groupings of people—be they tribes, families, races, nations, stakeholders, professions, or whatsoever—who guard their situation against the other groupings. Together they would perhaps be stronger, but certain level of grouping makes the situation functional, emotionally attainable, and natural in many other ways.

Most of the strong political powers throughout the history have been associated to a certain level of homogenization of the masses of people under power. Some examples include:

- The 30-year war of Europe in the 17th Century was an important step in consolidating the various German tribes to a large nation.
- Stalin mixed the myriad nations dwelling in the Soviet territory in order to establish the Soviet nation.
- Indonesia has been homogenized to a certain degree by the Bahasa language—a simplified amalgamate of various local languages, which was originally nobody's mother tongue.
- It has often been said that the heterogeneity of the African ethnic structure and its mismatches with the national borders is one reason to the political difficulties in the continent. This might be right in certain level, but certainly a myriad other reasons exist.
- Allowing free trade and mobility of labor and finances within the culturally very heterogeneous Europe has been considered as an important consolidating factor of the continent, which has a past with innumerable conflicts and wars.

Globalization has been defined in many ways. Riggs (1998) documented a panel session on globalization of the World Sociology Congress in July 1998. Figure 8.4a presents the five definitions that were used as the starting point of the panel.

This chapter has a certain focus on economic globalization, but as Riggs (1998) observes, the different aspects of globalization are very tightly chained to one another. The water sector is affected in diverse

Box 8.4a

Globalization and regionalization, an alert for marginalization

After Shen and Varis (2000).

Globalization and regionalization are terms that provoke strong reactions, positive and negative. Globalization is praised for the new opportunities it brings, such as access to markets and technology transfer, fast financial resources mobilization – opportunities that hold out the promise of increased productivity and higher living standards. But globalization is also feared and often condemned because it sometimes brings instability and unwelcome change for the water sector. It exposes the sector to competition and to shocks from outside, which can threaten stable operations. With the acceleration of economic globalization, the impacts on the water sector will be inevitable.

Regionalization is praised for raising levels of participation in decision-making and for giving people more of a chance to shape the context of their own lives. By decentralizing governments in the water sector so that more decisions are made at subnational levels, closer to the stakeholders, regionalization nourishes responsive and efficient governance. But it can also jeopardize the sectoral stability and integration. Regionalization in the water sector requires the sector to build capacity to deal with both the internal issues and the outside environments. If water sector itself cannot be managed efficiently and without a robust and rational institutionalization, it cannot manage the adverse external shocks, such as the Asian financial crisis in 1997, or the droughts in the Horn of Africa.

Globalization will make the world more uniform than ever. This trend would, eventually, lead to homogenization of values, thereby reducing cultural diversity and national identities. Regionalization means that during the development, the nations, regions, provinces, ethnically determined areas, and so forth, should stay strong with their typical culture, society, as well as successful water resources development and water-related behavior.

Freshwater is not a global resource per se, unlike many other nature resources, such as oil, timber, etc., which can be attended in the global trade system. However, water can be and is traded indirectly or virtually in the form of grain, cotton, and many other products, which are produced using water.

Even if a water market could be formulated, it would remain regional, characterized by the feature of a natural monopoly. Water resources management is not a mere management process, in the sense of a large business company. All over the world, we can see that the success stories of water management have various facets. Water resources management is a process that is based on regional culture, history, society and human behavior, besides regional water resources conditions. It could and should not be dressed in a uniform, pretending that all conditions are similar and easy to manage with an approach that works in Europe or North America. In the water sector management, within the globalization process, more attention should be paid to the balance and links between regionalization and globalization, where the government’s role is crucial.

An important evidence of the fading of links within this tripod is the ongoing, massive marginalization of individuals and even nations. In most W African countries, the informal sector is the way to survive for 2/3 of the population, chiefly to the poor. There, this share is growing like it does most other parts of the planet. The informal sector lives beyond the control and regulation of the government, and it is there where malnutrition, poor water supply and sanitation, much of environmental degradation and so forth culminate. Globalization is said to mean integration, but in this axis it means the opposite. Links are missing.

Poverty and marginalization deserve much more concern than they receive in the contemporary globalization discourse. An example of the huge gaps that exist between the macro-level analysts and policy-makers, and micro-level activists was the vivid discussion with unresolved contrasts at the Ganges-Brahmaputra-Meghna session of the 2nd World Water Forum at The Hague in March, 2000. Whereas the former ones presented big numbers of unexploited hydropower, irrigation, etc., potential in the basin, and attributed the development including poverty alleviation to the investments—dominantly from external sources—for mobilizing this potential, the latter ones saw the greatest problems at the community level. The need for links was recognized.

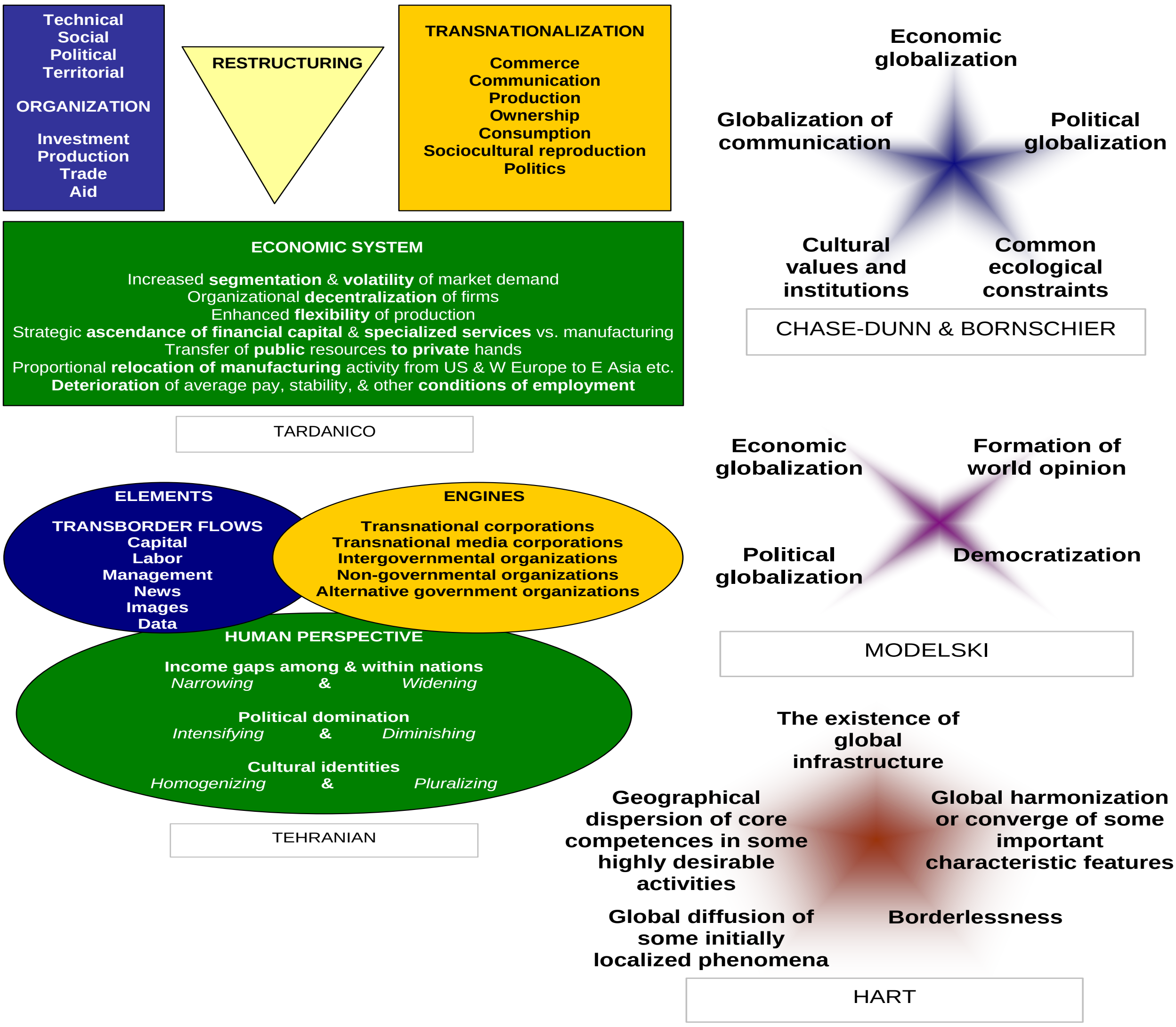
South Asia’s regional report of the 2nd World Water Forum (SASTAC 2000) lists nineteen crucial vision elements on its executive summary. Two of them are particularly interesting here:

- Given the socio-economic conditions, large populations and small-size holdings, food security cannot be left to the uncertainties of the global food market.
- Region can and must be self-sufficient in food; food security for all – at household, national, and regional levels; providing food for vulnerable sections at affordable prices.

Important messages such as these arising from profound regional connaissance must not be dampened out in formulating overall visions and statements as is too often done (e.g. World Water Council 2000).

Globalization or regionalization should not be praised or condemned per se. Rather, these phenomena should be seen as drivers that no development agenda can afford to ignore. While national governments remain central to the development effort, globalization and regionalization require that they are engaged in essential institution-building at both the inside and outside sectors in order to capture the benefits of growth in the 21st Century for the water sector.

Figure 8.4a
Five views to globalization
Source: Riggs (1998).



ways by globalization (Box 8.4a). In very general terms, the effects are derivable from the various issues given in Figure 8.4a.

The world economy integrates rapidly

Along with the neoclassical economic ideas and subsequent liberal policies, the trade barriers have been brought down almost the world over. This is believed to lubricate the economy and bring wealth to people.

World trade increased by 56% in ten years between 1992 and 2002 (World Bank 2004). The ratio of trade to world's total Gross Domestic Product (GDP) grew from 39 to 47%. Perhaps still a more sensitive indicator of global economic integration is the share of gross private capital flows per GDP. This indicator value grew from 10.6% of 1992 to 20.8% in 2002, if calculated over the world.

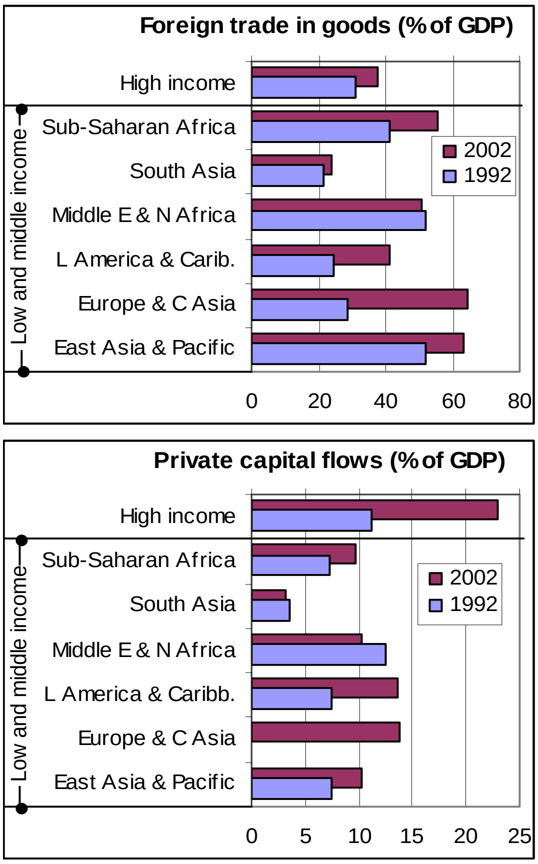
The world's regions differ remarkably in their integration to global markets. High-income countries are ahead of the others (Figure 8.4b) what comes to private capital flows. S Asia comes last. Its rate of integration has been far lower than that of E Asia & the Pacific, or Sub-Saharan Africa.

The role of multinational corporations has grown accordingly. Of total economic output in the world, multinational corporations account for 21%. One third of international trade is intra-firm trade within corporations. One example of the economic volume of a multinational company is the growth of the Finland-bound IT company Nokia (Figure 8.4c). While its net sales are well above the GDP of Nepal,

Figure 8.4b

Integration with the world economy

Trade in goods (imports plus exports) and gross private capital flows as a share of GDP. Source: World Bank (2004).



they are also close to the GDP of Nigeria, or the GDP of the whole Nile Region, Egypt excluded. Nepal had 24 million inhabitants in 2002, while Nigeria had 133 million, and the Nile Region without Egypt as much as 206 million. The Nokia company had 55,500 employees in 2004.

Nokia is one of the fastest growing multinationals, but this simple comparison shows how the big companies exceed large geographic areas in economic volume.

Integration and diversification

Globalization seems to favor flexible and mobile components of the economy such as financial capital and knowledge (Väyrynen 1999). In contrast, the economic value of immobile and fixed assets such as uneducated labor and land go down (cf. Figure 8.4c). This introduces an enormous challenge to the development of low-income countries, particularly their rural areas, in contrast to highly mobile and flexible urban-driven economies (see Box 8.4b).

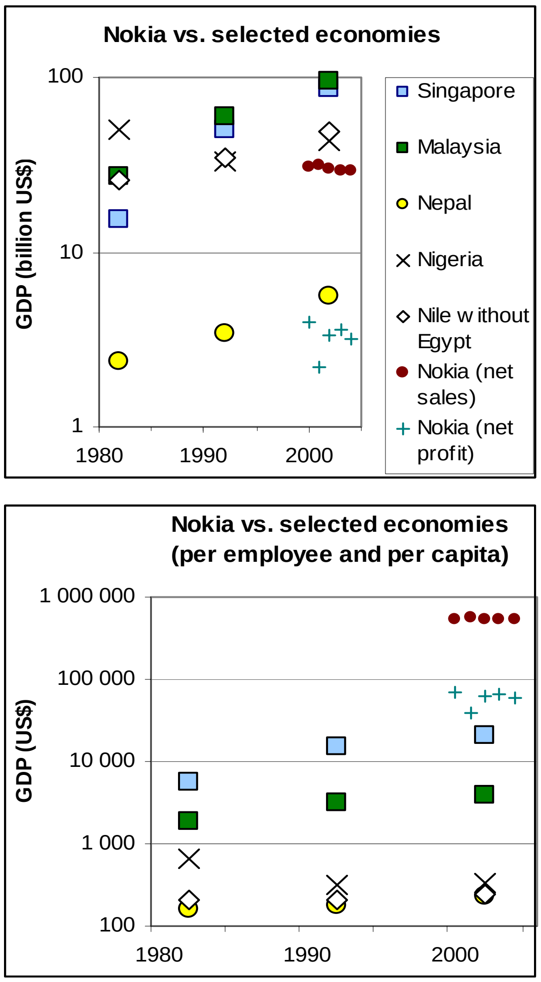
This demarcation respects less and less national borders. Rural areas tend to be drained off of their most flexible capital—educated people—who migrate into cities in masses all over the world. The uneducated stay in countryside. Not everybody, though. Many are pushed into cities because the rural economy does not offer a livelihood for all any more (Chapter 4.2).

The division of the urban population between uneducated people merely "pushed" from rural areas and those with an access to education and capabilities to benefit directly from globalization strengthens. The latter ones, if migrating from rural areas, tend to be "pulled" to cities, rather than "pushed".

Figure 8.4c

Nokia outcompetes hundreds of millions

Net sales and net profits of the Nokia Company compared with selected study countries. Source: World Bank (2004) and Nokia (2005).



Globalization is often blamed for the homogenization of values. A good example is the enormous impact of American and other TV series to family ideals in Latin America, Africa, and Asia. Some say, that TV has been by far the most important factor behind the rapidly decreased fecundity rates in many parts of the world. The rate has been a surprise to most researchers, including the UN Population Office, which must correct its forecasts down every two years when publishing new population prospects (Chapter 4.1).

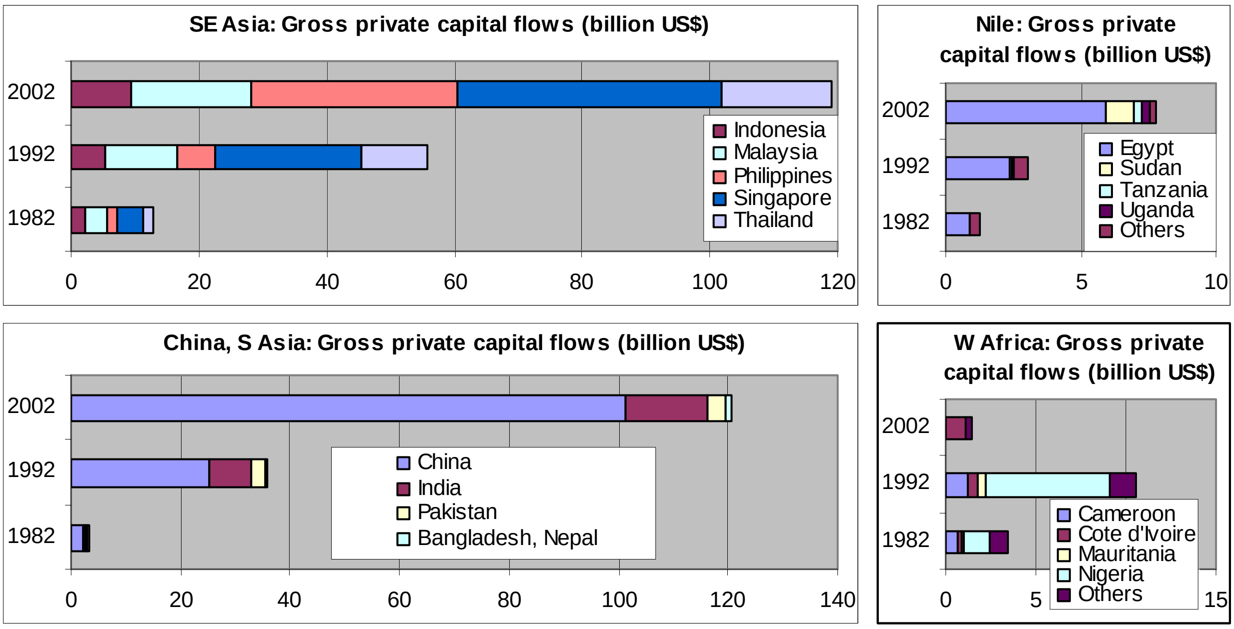
As a consequence of globalization and the advances in information technology, an enhanced fractualization within a geographically defined community takes place: diversification of professions, social strata, and so forth. A university researcher or a computer freak in Bangkok may be more in contact with other individuals with same interests in very different parts of the world than with his or her immediate neighbors.

Communication takes place more and more with a few internationally spoken languages, English above all. Countries such as China will be in trouble, and are already, with the low percentage of population that knows English. On the other hand, Chinese language will be growing rapidly in importance in international business. In other study regions, the old colonial languages continue to bloom, forming an important asset in communication, and the pressures against traditional languages and cultures are substantial.

After all, human resources, social development, and increased education constitute the main assets for facilitating the integration to the global economy in a manner, which is at least to some extent controllable by the policy makers of a country. Capable politicians are needed to steer the society, and capable labor is needed to attract capital so that the wealth of the country is not drained to the hands of others.

In many countries and regions, appropriate governance, and economic and social structures to allow economic integration are missing. In such conditions, a country is in true danger of being subjected to stormy winds that exceed the capacity of the crew to steer the society, and drifting along with these winds without command follows (Box 8.4b).

Figure 8.4d
Private capital flows fluently in China
The chart for W Africa includes only Côte d´Ivoire, Ghana, and Guinea in 2002.
Source: World Bank (2004).



Study regions and world trade

In 2002, the share of the study regions of world's private capital flows was 5.97% (World Bank 2004). SE Asia accounted for 1.81%, China for 1.51%, Hong Kong for 2.22% and S Asia for 0.29%. The Nile region's share was 0.12%, whereas due to the lack of data W Africa's share was neglible (Figure 8.4d).

The poorest countries do not usually get much direct investment, nor do they contribute to capital flows. Hong Kong alone contributes 2.22% of world's private capital flows.

The once very closed China has become the world's leading economy in attracting private foreign direct investments (FDI) in the 2000s. China was third in the global statistics, after Luxembourg and France, in term of FDI. In 2002, 7.8% of all FDI in the world went to China.

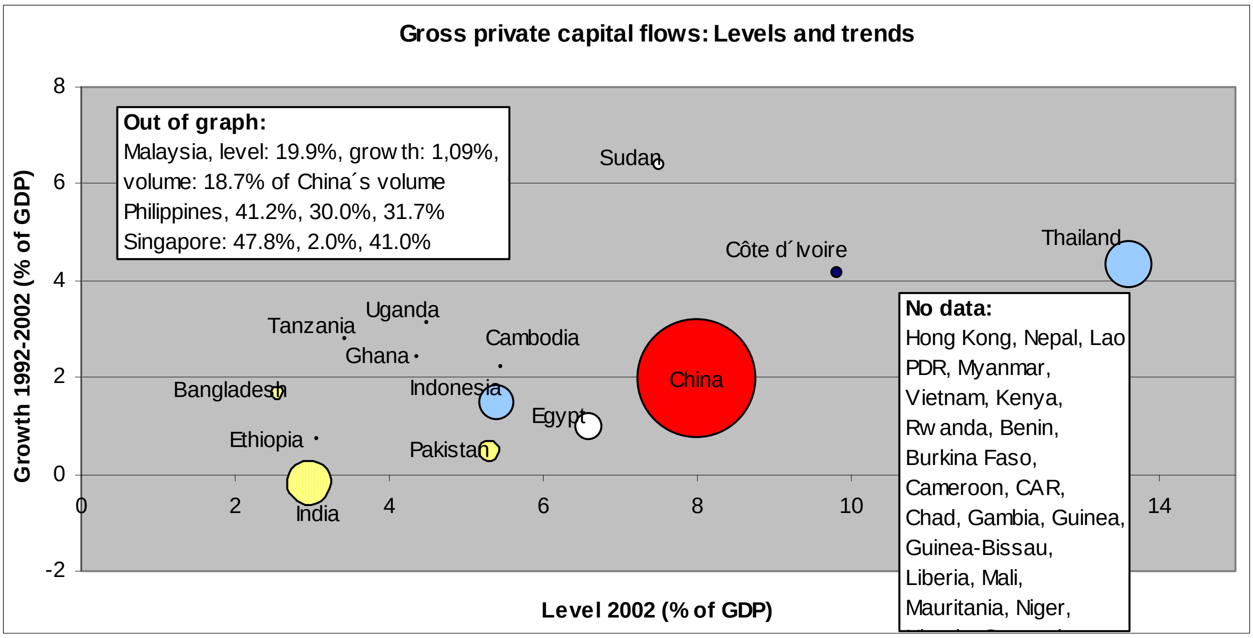
The coastal region has dominated China's imports and exports. In 1994, exports from the coastal region accounted for 86.7% of the national total, and imports for 86.5%. In the same year, the middle region exported 9.6%, and imported only 8.0% of the national total. In the western region, neither imports nor exports were significant, being only 3.7% and 5.5%, respectively (see Chapter 4.4).

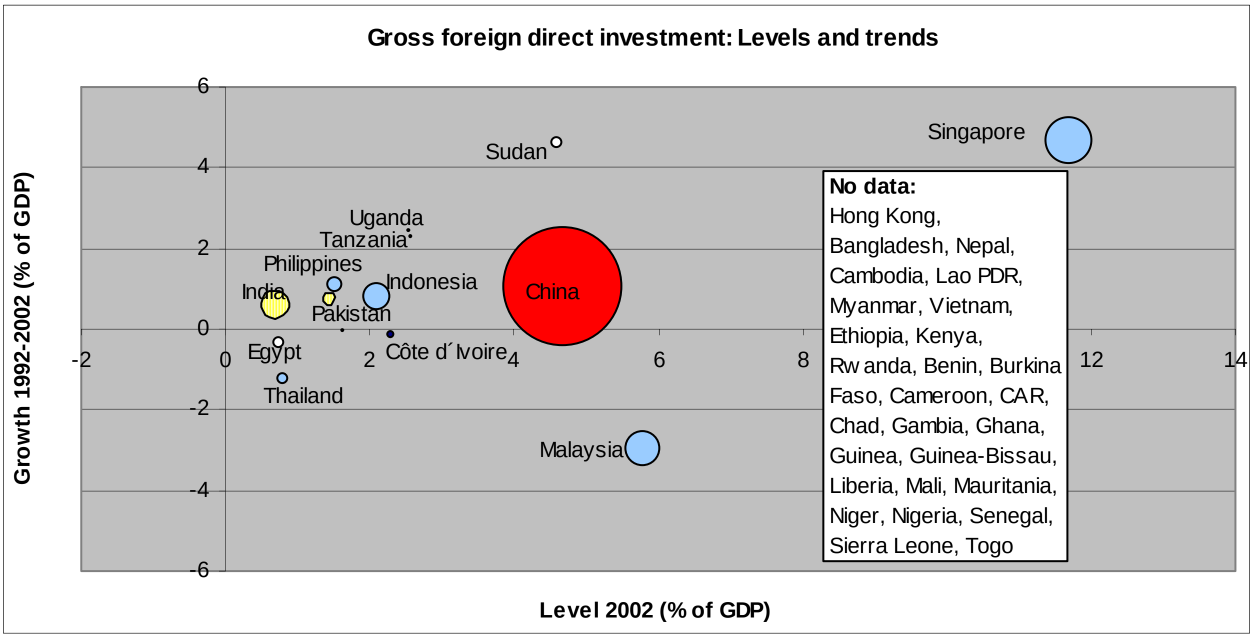
S Asia follows the Chinese trend, but the volumes of capital flows and foreign investments are markedly lower than in China. In the both African regions, there is one country that dominates the regional capital flows. They are the prosperous Egypt and Nigeria, although the figure for the latter is missing for year 2002. Also Côte d´Ivoire and Sudan are doing well (Figures 8.4d and e).

Figure 8.4e

The economies of SE Asia are most globalized

In S Asia gross private capital flows and gross foreign direct investments form little of countries´ GDPs. (Source: World Bank 2004)





Box 8.4b

W Africa: economies are exposed to world markets but people struggle with basic needs

Compiled from Snrech (1998)

Since the independence of W Africa in the late 1950s and early 1960s, the major pressures to the societies of the subcontinent have been "*exceptional population growth and brutal exposure to world markets*."

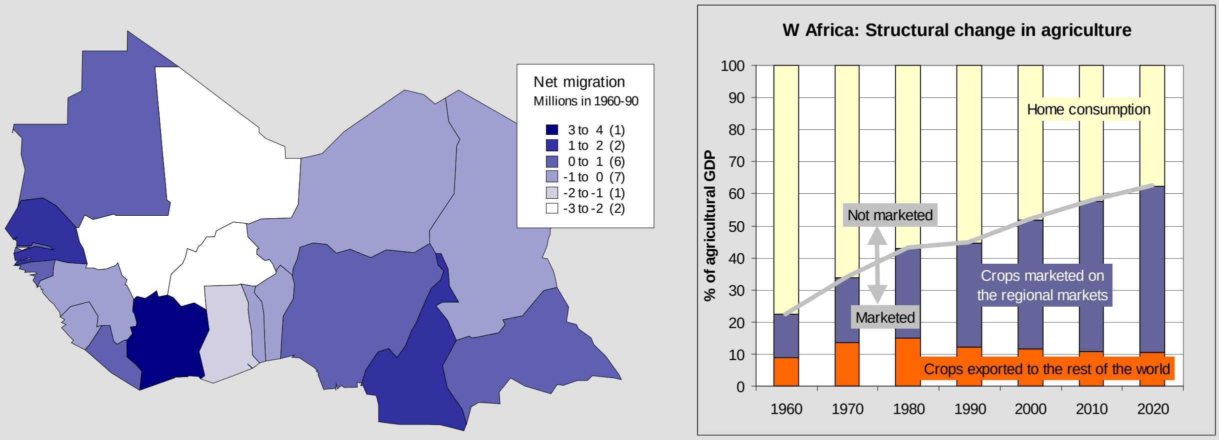
The societies were not prepared to this exposure in the colonial era. Accordingly, the societies have reacted in uncontrolled ways, after the independence. The local élites and governments have lost much of their power, and the informal sector booms (Figure 4.4o, Chapter 8.2).

The most visible consequence has been the massive migration towards south, towards the coast, and to urban areas (Figure 8.4f). 3000 towns and cities have absorbed 66 million new inhabitants.

Figure 8.4f

Migrations and agricultral change in W Africa

A few coastal countries attract migrators (left), and agriculture becomes increasingly market oriented. Yet, export-related farming stagnates. Source: Snrech (1998).



The economies have been based on agriculture and mineral commodity exports. Agriculture is gradually becoming increasingly market oriented (Figure 8.4f), and the rural economy is leaning increasingly on the market of food crops. At the same time, the integration of the agricultural sector to the world market has stagnated, the priorities being in feeding the local population. Subsistence farming is still important. Many of the mineral resources have become very problematic in many ways, such as the diamonds of Sierra Leone, which feed corruption, warlords, and international crime.

Manufacturing industry has not developed (Chapter 4.4, Figure 4.4n). While in S and SE Asia, the share of primary products of export earnings went down from 53% to 20% within the period 1970-1990, W Africa's development was quite different: the share decreased from 93% to 89%.

The economies of W Africa are not competitive in attracting foreign investments to develop their industries, and the exports keep propagating very limited benefits to the societies as a whole. The region also loses market shares of traditional export goods, but is increasingly open for import goods. The most severe issue is not the manufactured goods import to the urban élites, but the massive dumping of subsidized agricultural products to the world market, which destroys the development possibilities of local agro industries. The economies get increasingly indebted, and are forced to concentrate on supplying the people with very basic needs.

These changes have been accompanied with "*a rapid and irrecoverable breakdown of most of the ancient balances within the W African societies*".

WTO: the free trade framework

The World Trade Organization (WTO) has become the symbol of economic globalization. After WTO's web pages, WTO *"is the only global international organization dealing with the rules of trade between nations. At its heart are the WTO agreements, negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. The goal is to help producers of goods and services, exporters, and importers conduct their business."* In other words, the WTO *"is the only international organization dealing with the global rules of trade between nations. Its main function is to ensure that trade flows as smoothly, predictably and freely as possible."*

The WTO has become a unique target of expressions of all types of emotions for and against globalization in the past years. Its operation has largely been hampered by failed summits of trade liberalization in the early 2000s.

The non-member countries of the study regions on December 2005 were (WTO 2005):

- *SE Asia*: Lao PDR, Vietnam
- *Nile*: Eritrea, Ethiopia, Sudan
- *W Africa*: Liberia

Regional trade blocs

One important facilitator of economic integration is due to regional economic blocs and free trade zones. Among the study regions, SE Asia has perhaps the most advanced consolidation within ASEAN. This organization already includes all countries of the region (Table 8.4a). Myanmar, Cambodia, Vietnam, and Lao PDR joined ASEAN just before the turn of the Millennium.

Another important umbrella for SE Asian countries is APEC, which has members even from Latin and North America, as well as Australia and New Zealand. China is also a member of APEC. This organization covered 46% of world's exports in 2002, being more voluminous than the EU with 38% or the NAFTA with 17% (World Bank 2004).

The SAARC of S Asia is not as comprehensive as ASEAN, but increasing gradually in importance. The regional trade is by far not as important in S Asia as in SE Asia. The greatest problems with the functioning of this organization are the complicated political relations between Pakistan and India.

The share of the global exports of ASEAN has grown from 2.0% in 1970 to 6.3% in 2002. In contrast, SAARC's share has stayed in 1.1%.

Pakistan is the only study country, which is a member of the Central Asian bloc called ECO. The other members include Turkey, Iran, Afghanistan, and the Central Asian Republics. It has a share of 1.3% of the global exports.

The African economic blocs are much weaker than the Asian ones (Table 8.4b). The COMESA of Eastern and Southern Africa includes all the Nile Region countries, plus most countries south of the Democratic Republic of the Congo. Its 1.6% share of global exports in 1970 had shrunk to 0.4% by 2002.

The Central African Bloc CEMAC is powered by Cameroon, and incorporates a set of surrounding countries. It has a shrinking regional importance, and its contribution to world's exports is not more than 0.1%.

The W African economic region is lubricated by a common currency, the CFA Franc. It is fixed to the French Franc, meaning that it is also fixed to the EURO. The regional trade blocs ECOWAS and UEMOA have, in contrast to other African blocs, augmented their regional importance during past few decades. However, their contributions to world's exports have halved since 1970, being 0.4% for ECOWAS and 0.1% for UEMOA in 2002 (World Bank 1999).

Trade barriers

One indicator of free trade is the level of trade barriers such as import duties. They are traditionally used to protect domestic industries from foreign competition. Newly established—so-called infant—industries are typical subjects of protection, as well as industries connected directly to natural resources and agriculture.

The tariff barriers were still very high in the late 1980s in S Asia (Figure 8.4g). China’s duties were also over 40%. They both came rapidly down in the 1990s. However India is still having a trade barrier of 33% which is second highest among the study countries. Among the SE Asian countries, Thailand, Vietnam, and Cambodia have protected their industries more than the other industrializing countries (cf. Chapter 4.4).

In the Nile region Burundi and Sudan have clearly higher tariff barriers, 35% and 29.4% respectively, than the other Nile countries. Egypt´s tariff is also above 20%. In West Africa the trade barriers have declined below 20% with the exception of Nigeria where the tariff has risen from 21.8% in 2000 to 30.6% in 2003.

In comparison, the tariff barriers of the US and Japan fall within the range of 5% and 7%, and of the European Union countries between 6% and 9%. In Latin America, they tend to converge to around 10%.

Table 8.4a

Organizations of economic cooperation in Asian study regions

Sources: World Bank (1999), web pages of the organizations, and UNCTAD (2004) for the figures.

	China	Bangladesh, India	Nepal	Pakistan	Cambodia, Myanmar	Lao PDR	Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam	Full name	Other members	Intra-trade as % of total exports 1970	2002
APEC	•						•	Asia Pacific Economic Cooperation	Australia, Brunei Darussalam, Canada, Chile, Japan, Rep Korea, Mexico, New Zealand, Papua New Guinea, Peru, Russia, USA	57.9	73.5
ASEAN					•	•	•	Association of SE Asian Nations	Brunei Darussalam	22.4	22.8
Bangkok Agreement		•				•		*	Republic of Korea, Sri Lanka	2.8	7.4
ECO				•				Economic Cooperation Organization	Afghanistan, Azerbaidjan, Iran, Kazakhstan, Kyrgyz Rep, Tajikistan, Turkey, Turkmenistan, Uzbekistan	2.2	5.5
SAARC		•	•	•				S Asian Association for Regional Cooperation	Bhutan, Maldives, Sri Lanka	3.2	3.9

* 1st Agreement on Trade Negotiation among Developing Member Countries of the Econ & Social Commission for Asia & the Pacific

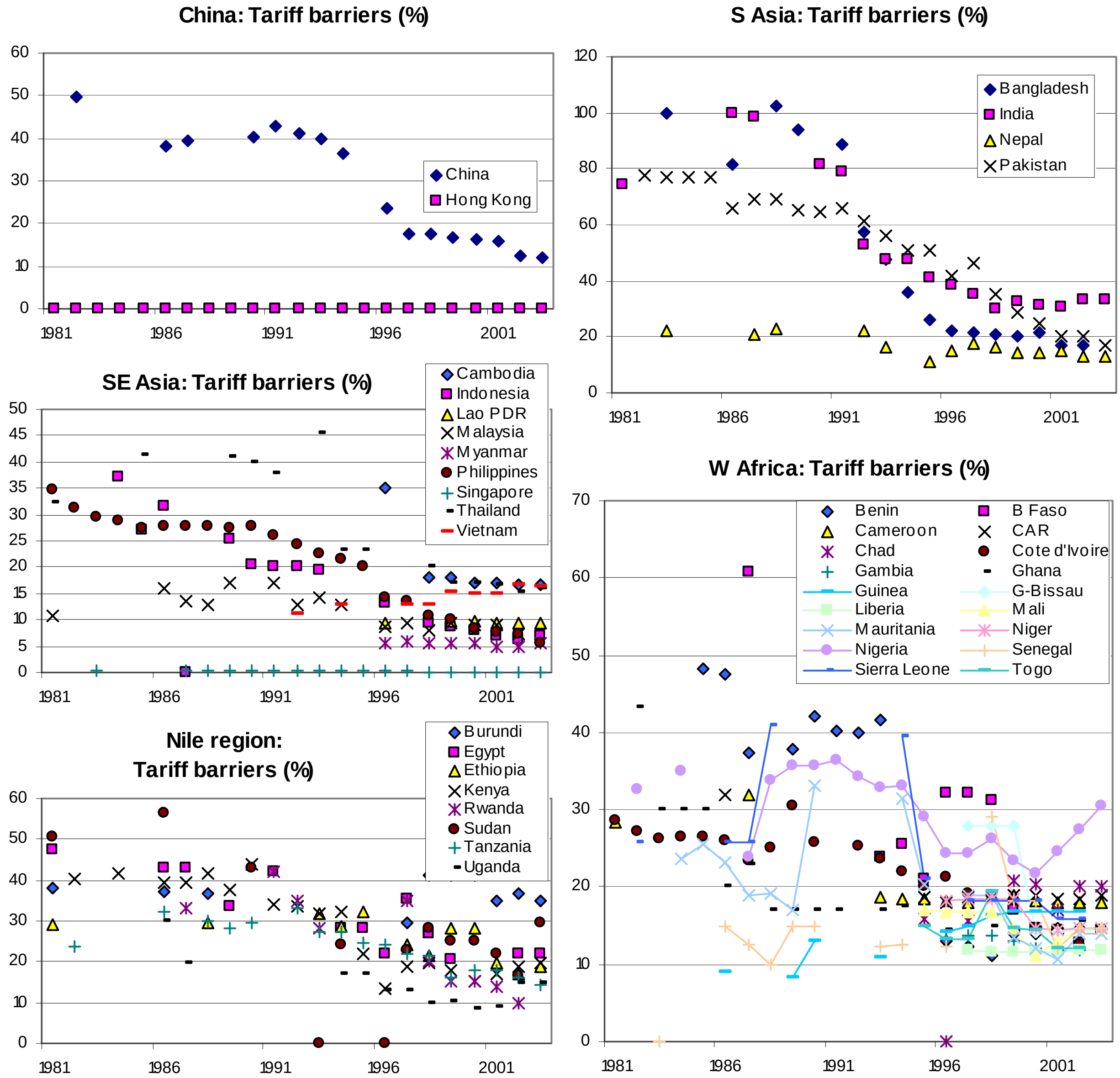
Table 8.4b

Organizations of economic cooperation in African study regions

Sources: World Bank (1999), web pages of the organizations, and UNCTAD (2004) for the figures.

	Burundi, Rwanda	Egypt, Eritrea, Ethiopia, Kenya, Sudan, Tanzania, Uganda	Benin, B Faso, C d'Ivoire, G-Bissau, Mali, Niger, Senegal, Togo	Cameroon, CAR, Chad	Gambia, Ghana, Guinea-Bissau, Mauritania, Nigeria	Guinea, Liberia, Sierra Leone	Full name	Other members	Intra-trade as % of total exports 1970	2002
CEMAC				•			Econ & Monetary Community of Central Africa	Rep of Congo, Eq Guinea, Gabon, São Tomé & the Principe	4.9	1.3
CEPGL	•						Econ Community of the Great Lake Countries	Dem Rep of Congo	0.4	0.4
COMESA	•	•					Common Market for E & S Africa	Angola, Comoros, Dem Rep Congo, Djibouti, Madagascar, Malawi, Mauritius, Namibia, Seycilles, Swaziland, Zambia, Zimbabwe	7.4	5.6
ECCAS	•			•			Econ Community of C African States	Dem Rep Congo, Rep Congo, Eq Guinea, Gabon, São Tomé & the Principe	9.8	1.3
ECOWAS			•		•	•	Econ Community of W African States	Cape Verde	2.9	11.1
MRU						•	Mano River Union		0.2	0.3
UEMOA			•				W African Econ & Monetary Union		6.5	12.6

Figure 8.4g
Tariff barriers of foreign trade converge to 10 to 20%
Source: World Bank (2006).



Food and agriculture: special cases

The more basic needs are in question, the more problematic the free trade paradigm becomes. Food and water are perhaps the most cumbersome commodities for free trade. Food products in particular, since they are more tradable than water. This is not only true in the developing countries, but throughout the world. One must only recall how problematic agriculture is for the EU.

The liberalistic policies include a paradigm of cutting all possible subsidies from the economy. This requires the canceling of subsidies to agriculture and the water sector, which have been important policy tools for most governments of the world in balancing national development and promoting food security and public health.

The consequent stagnation or decrease in public cash flows may hamper the long term development of capital intensive infrastructures in agricultural and water sector, where typically the return periods of investments tend to be very long, and are distributed to many stakeholders.

Epilogue

Obviously, no other alternatives exist to the global human community than live in connection and interaction with one another. Besides, the experience from closed economies have not been too encouraging. The question how is more delicate, and answers are very much region and case specific.

In short, the exposure to and expected success in facing globalization in the study regions can be summarized in the following way:

- *China*: A fluent shift from an extremely closed and controlled society of the 1960s and 1970s to the world's leader in attracting of foreign direct investments. Democracy and human rights questions still remain unsolved. The coastal provinces are far ahead of the landlocked regions.

- *S Asia*: The weak relations of India and Pakistan shed a dark shadow to the integration process of this region. Tariff barriers have gone rapidly down, but capital flows are still very low, yet in growth. Foreign trade plays an exceptionally low role in the economies of the region.

- *SE Asia*: The region has been politically split to the communist-led countries and the western allies, but the gaps are rapidly closing. Singapore, Malaysia, and Thailand attract promptly growing amounts of investments and capital flows are fluent. The insular states follow, but with less tempo. Vietnam, Lao PDR, Cambodia, and Myanmar have jumped into the ASEAN train, and obviously will look carefully how Thailand and Malaysia have succeeded and why in the globalization process.

- *Nile*: Egypt is the leading nation in globalization in this region, yet its growth rate lags behind the Asian study countries. The other economies are very small in volume, yet increasingly integrated to global economy. Exceptions are Rwanda and Burundi, still balancing out their sad 1990s.

- *W Africa*: This region is traditionally exposed fairly much to foreign trade. It has, however, not been able to go beyond the export of raw materials and agricultural products. The manufacturing industry is almost absent, and the wealth from export does not distribute to many hands. Many of the coastal countries, however, might gradually develop social and economic structures that would allow the benefits of globalization to spread more widely and equitably, and not only the side effects.

References to Section 8

ADB 2000. *Strategic Options for the Water Sector: PRC*. Hydrosult, SOGREAH and IWHR, Beijing for Asian Development Bank, Manila.

Baloch, L. 1999. *Poor Pay More for Water*. DAWN Magazine, 7 March 1999.

Bhatia, R. & Falkenmark, M. 1992. *Water resource policies and the urban poor: innovative approaches and policy imperatives*. Background Paper for the International Conference on Water and the Environment, Dublin, 1992.

Bista, D.B. 1991. *Fatalism and Development: Nepal's Struggle for Modernization*. Orient Longman, Calcutta.

Blasco, P. 2000. Narmada, un barrage contre l'oubli. *Globe-Mémoires* 3: 26-29.

Bruns, B. 1997. Water rights questions. *National Seminar on Farmer Water Use Rights*, 15-17 December, Bandung.

Cairncross, S. 1990. Water supply and the urban poor. In: Hardy, J.E., Cairncross, S. & Satterthwaite, D. (Eds.): *The Poor Die Young: Housing and Health in Third World Cities*. Earthscan, London.

Carballo, M. 2000. *Religion in the World at the End of the Millennium*. Gallup International, London. www.gallup-international.com/ (10.5.2006).

Coville, J. 1996. *Cairo: Water, the City and Urban Planning*. Academie de l'Eau, France.

Dick, R.M. 1997. *Groundwater markets in Pakistan: participation and productivity*. Research Report 105. International Food Policy Research Institute (IFPRI), Washington D.C.

Dixit, A. 2000. Personal communication. Nepal Water Conservation Foundation, Kathmandu.

Domoto, A. 2000. *International Environmental Governance. Its Impact on Social and Human Development. Confronting the Millenium: The Future UN*. On the Threshold: The United Nations and Global Governance in the New Millenium. International Conference, 19-21 January 2000, Tokyo.

Drakakis-Smith, D. 1987. *The Third World City*. Routledge, London.

Esim, S. 1996. The Gambia. In: Webster, L. & Fidler, P. (Eds.): *The Informal Sector and Microfinance Institutions in West Africa*. World Bank, Washington D.C.

FAO 1996. *Technical Background Documents* 6-11. World Food Summit, Food and Agriculture Organization of the United Nations (FAO), Rome.

Fidler, P. & Webster, L. 1996. Informal sectors of West Africa. In: Webster, L. & Fidler, P. (Eds.): *The Informal Sector and Microfinance Institutions in West Africa*. World Bank, Washington D.C.

Global Water Partnership 2000a. *West African Water Vision*. The 2nd World Water Forum, 17-22 March, The Hague. West African Technical Advisory Committee of the Global Water Partnership.

Global Water Partnership 2000b. *The Vision for Water in the Twenty First Century for the Countries of the Nile River Basin*. The 2nd World Water Forum, 17-22 March, The Hague.

Green Cross 2000. *National Sovereignty and International Water Courses*. Green Cross International, The 2nd World Water Forum, 17-22 March, The Hague.

Ilomäki, J. 2000. *Institutional Challenge of Developing Transboundary Water Resources*. Research Report 2000:1. Helsinki University of Technology, Water Resources Laboratory, Espoo. www.water.tkk.fi/wr/tutkimus/glob/publications/Ilomaki/indexw.html (10.5.2006).

Jacobs, J.W. 1995. Mekong Committee: history and lessons for river basin development. *Geographical Journal* 161(2): 135-148.

Jauro, A. 2000. *Problems and Challenges on Integrated River Basin Management in the Lake Chad Basin*. The 2nd World Water Forum, 17-22 March, The Hague.

Kabou, A. 1991. *Et Si l'Afrique Refusait le Développement?* L'Harmattan, Paris.

Kliot, N., Shmueli, D. & Shamir, U. 2001. Institutions for management of transboundary water resources: their nature, characteristics and shortcomings. *Water Policy* 3(3): 229-255.

Kuokkanen, T. 1996. The relationship of international and municipal law. In: Lommi-Kippola, C. & Stendahl-Rechardt, K. (Eds.): *The Effectiveness of Multilateral Environmental Agreements – A Report from a Nordic Project*. Nordic Council of Ministers, Copenhagen.

Lahtela, V. 2002. Managing the Senegal River – Local and national development dilemma. *Interna-*

tional Journal of Water Resources Development 19(2): 279-293.

Lambsdorff, J.G. 1999. The 1999 Transparency International Corruption Perceptions Index (CPI) – Framework Document. The Transparency International, Göttingen. www.transparency.org/content/download/2908/18010/file/cpi1999_framework.pdf (10.5.2006).

MRC 2006. *Mekong River Commission (MRC)*. MRC Secretariat, Phnom Penh. www.mrcmekong.org (10.5.2006).

NBA 2006. *Niger Basin Authority (NBA)*. Executive Secretariat of Niger Basin Authority, Niamey. www.abn.ne (10.5.2006).

NBI 2006. *Nile Basin Initiative (NBI)*. The Nile Basin initiative Secretariat, Entebbe. www.nilebasin.org (10.5.2006).

Niasse, M. 2001. Management of Shared Water Courses: The Senegal River Basin. *IHDP Update, Newsletter of the International Human Dimensions Programme on Global Environmental Change*, Number 1/2001. www.ihdp.uni-bonn.de/html/publications/update/IHDPUpdate01_01.html (8.5.2006).

Nokia 2005. *Nokia 2000-2004, IFRS.* Nokia, Espoo. www.nokia.com (8.5.2006).

Nokia 2005. *Nokia in Brief.* Nokia, Espoo. www.nokia.com (8.5.2006).

North, D.C. 1990. *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, Cambridge.

North, D.C. 1997. *The New Institutional Economics and its Contribution to Improving our Understanding of the Transition Problem.* 1st Annual Public Lecture, 7 March, United Nations University/World Institute for Development Economics Research (UNU/WIDER), Helsinki.

Oguntola, J.A. 2001. Conference report. 3.16 Lake Chad Region. *Water Policy* 3(Supplement 1): S121-S124.

Rahman, A., Lee, H.K. & Khan, M.A. 1997. Domestic water contamination in rapidly growing megacities of Asia: case of Karachi, Pakistan. *Environmental Monitoring and Assessment* 44(1-3): 339-360.

Riggs, F.W. 1998. Globalization—key concepts. *Proceedings, World Sociology Congress*, Montreal, July 1998. www2.hawaii.edu/~fredr/glocon.htm (10.5.2006).

Roy, A. 1997. *The God of Small Things.* Harper Collins, New York.

Roy, A. 2000. *The Cost of Living.* Harper Collins, New York.

Sananikone, O. 1996a. Burkina Faso. In: Webster, L. & Fidler, P. (Eds.): *The Informal Sector and Microfinance Institutions in West Africa*. World Bank, Washington D.C.

Sananikone, O. 1996b. Cape Verde. In: Webster, L. & Fidler, P. (Eds.): *The Informal Sector and Microfinance Institutions in West Africa*. World Bank, Washington D.C.

Sananikone, O. 1996c. Chad. In: Webster, L. & Fidler, P. (Eds.): *The Informal Sector and Microfinance Institutions in West Africa*. World Bank, Washington D.C.

SASTAC 2000. *Water for the 21st Century: Vision to Action—South Asia.* The 2nd World Water Forum, 17-22 March, The Hague. The South Asia Technical Advisory Committee of the Global Water Partnership (SASTAC), Aurangabad.

Serageldin, I. 1994. *Water Supply, Sanitation, and Environmental Sustainability, the Financing Challenge*. World Bank, Washington D.C.

Sharma, P.N. 1997. *Participatory Processes for Integrated Watershed Management*. PWMTA-FARM Document 7. Food and Agriculture Organization of the United Nations (FAO), Kathmandu.

Sharma, N.P., Damhaug, T., Gilgan-Hunt, E., Grey, D., Okaru, V. & Rothberg, D. 1996. *African Water Resources, Challenges and Opportunities for Sustainable Development.* World Bank Technical Paper 331. World Bank, Washington D.C.

Shen, D. & Varis, O. 2000. World Water Vision: Balancing Thoughts after The Hague. *Ambio* 29(8): 523-525.

Snrech, S. 1998. West Africa undergoing long-term change. In: Cour, J.-M. & Snrech, S. (Eds.): *Preparing for the Future–A Vision of West Africa in the Year 2020*. Club du Sahel, Organisation for Economic Co-operation and Development (OECD), Paris.

Sprinz, D.F. & Vaahtoranta, T. 2002. National Self-interest: a Major Factor in International Environmental Policy Formulation. In: Tolba, M.K. (Ed.): *Encyclopedia of Global Environmental Change. Volume 4: Responding to Global Environmental Change.* John Wiley & Sons Ltd., Chichester.

Stokke, O.S. & Thommessen, O.B. (Eds.) 2003. *Yearbook of International Co-operation on Environment and Development 2003/2004.* Earthscan, London.

Tafesse, T. 2001. The Hydropolitical Assessment of the Nile Question: An Ethiopian Perspective. *Water International* 26(4): 578-588.

Tanzeema, S. & Faisal, I.M. 2001. Sharing the Ganges: a critical analysis of the water sharing treaties. *Water Policy* 3(1): 13-28.

Todaro, M. 1997. *Economic Development*. 6th Ed. Longman, London and New York.

Transparency International 2002. Corruption Perceptions Index 2002. The Transparency International, Göttingen. www.transparency.org (10.5.2006).

UN 1978. *Register of International Rivers.* United Nations, New York.

UNCTAD (United Nations Conference on Trade and Development) 2004. *Development and Globalization: Facts and Figures.* United Nations, New York and Geneva.

Usher, R. 2000. Silence is not always golden. *Time*, February 7th: 22.

Varis, O. & Keskinen, M. 2003. Socioeconomic analysis of the Tonle Sap Region, Cambodia—building links and capacity for targeted poverty alleviation. *International Journal of Water Resources Development* 19(2): 295-310.

Varis, O. & Lahtela, V. 2002. Integrated water resources management along the Senegal River – Introducing an analytical framework. *International Journal of Water Resources Development* 18(4): 501-521.

Varis, O. & Somlyódy, L. 1997. Global urbanization and urban water: can sustainability be afforded? *Water Science and Technology* 35(9): 21-32.

Väyrynen, R. (Ed.) 1999. *Globalization and Global Governance.* Rowman and Littlefield, Lanham.

WCD 2000. *Dams and Development. A New Framework for Decision Making.* The Report of the World Commission on Dams. Earthscan, London. www.dams.org/ (10.5.2006).

Weiss, E. 1997. Strengthening national compliance with international environmental agreements. *Environmental Policy & Law* 27(4): 297-305.

Wolf, A. 1999. The transboundary fresh water dispute database project. *Water International* 24(2): 160-163.

World Bank 1989. *Working Papers on the Urban Informal Sector in the Sahel.* World Bank, Washington D.C.

World Bank 1997. *The State in a Changing World. World Development Report 1997.* The World Bank, Washington D.C.

World Bank 1999. *World Development Indicators 1999 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2004. *World Development Indicators 2004 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2006. *Data on Trade and Import Barriers. Trends in Average Tariff Rates for Developing and Industrial Countries, 1981-2003 (Unweighted in %).* The World Bank Group, Washington D.C. http://siteresources.worldbank.org/INTRANETTRADE/Resources/tar2002.xls (11.5.2006).

World Water Council 2000. *World Water Vision: Commission Report. A Water Secure World: Vision for Water, Life, and the Environment.* World Water Council (WWC), Marseille. www.worldwatercouncil.org/fileadmin/wwc/Library/Publications_and_reports/Visions/CommissionReport.pdf (11.5.2006).

WTO 2005. *Understanding the WTO: The Organization. Members and Observers.* World Trade Organization (WTO), Geneva. www.wto.org (11.5.2006).

9 POLICY TOOLS: RURAL DIMENSION

Cities grow with an incredible pace (Chapter 4.2). Plenty of opportunities are offered to those that migrate from rural areas to urban centers. But only some among the masses that migrate are the lucky ones that end up benefiting from those opportunities. For the others, the reality is not too rosy. No jobs, no proper housing, no wealth and the often cumbersome process of getting rooted in a new society which is very different from the one in which the centuries-old roots used to be.

Urbanization must be viewed from both the rural and the urban direction in order to understand its character—which varies from country to country, city to city and town to town. On one hand the urban centers attract individuals with the opportunities they offer. On the other hand rural areas push landless, jobless, marginalized and other poor people to urban areas. Although these two characteristic reasons to urbanization almost always overlap to a varying extent, it is often useful to distinguish between them due to their very different implications to the livelihood of the people as well as to any sort of policy making.

It is of particular importance—in order to work against the negative social and environmental consequences—to attempt at minimizing the number and share of individuals that are pushed away from rural areas. Many countries try to restrict and regulate their migration, yet a sustainable solution can only be achieved through the development of rural livelihoods. Investing in education of rural children, by improving the economy in rural areas by promoting development of agriculture, forestry, fisheries and other rural economic activities, decentralizing government activities and so forth are typically tools to achieve this goal.

The rural dimension is a somewhat overlooked issue in the urbanization discourse, although it is of foremost importance in most regions that urbanize rapidly. In particular, in the study regions, this is the case. Four out of five rural dwellers of this planet live in these regions, and it is a big issue how their livelihoods develop in coming few decades. The global urbanization and the future welfare of cities and towns in most of the world are impacted by this development.

9.1 Increasing agricultural production

Tommi Kajander and Olli Varis

Human population grows and food production should grow accordingly. Changing diet towards more meat and rice consumption adds to the escalating food demand. IFPRI estimates that during the first two decades of the millennium, food production must grow by 40%. Meanwhile the degradation of water and land resources and the increased competition for the utilizable resources put even more pressure on the agricultural production systems.

Overview

In the past decades agricultural production has experienced an incredible boost. Due to the Green Revolution food production outpaced population growth. In developing countries food availability per person has grown by 32% to 2580 Kcal/day since the early 1960s (Alexandratos 1998). China and India with a total population of 2.3 billion have virtually achieved cereal self-sufficiency. The progress has however been uneven. Sub-Saharan Africa still struggles with major problems in food availability and production. The Green Revolution is not yet there.

The growth in cereal yields has been declining in most of the world since the beginning of 1980s. While the annual yield growth rate in developing countries was 2.9% between 1967 and 1982, it was 1.9% from 1982 to 1994 and is estimated to decrease to 1.2% (1993-2020). The decline is a result of growing water shortages, reduced investments in crop research and irrigation infrastructure, and the already high level of agricultural inputs in places (Rosegrant et al. 2001, van Hofwegen and Svendsen 2000).

The land is subjected to growing pressures by the mankind. Not only the rising demand for agricultural production requires more land and more intensive exploitation of the land already in production. Even more pressure is put to land by the expanding urban areas, transportation and industrial facilities. Consequently further expansion of cultivated area has stagnated, especially in the Asian study regions. In the Nile Basin and W Africa where population densities are lower, considerable potential for extending cropland still exists.

As long as population grows, the demand for food will increase. The rising level of per capita income, which promotes consumption of meat and rice add to the requirement to produce more and more. In this chapter the augmentation of agricultural production is scrutinized in two dimensions. At first the topic is approached by the land and crop potential. Then the major options to intensify agriculture including irrigation, fertilization, development of new crop varieties and crop protection are discussed. Finally urban agriculture, which commonly draws less attention but contributes significantly to food security is discussed.

Increasing agricultural production

There are two principal means to increase agricultural production – expand the land under cultivation or increase the yield per unit land area. As will be discovered in the following section there is still some potential for expansion of cultivated area in places. Gregory et al. (2002) estimated contributions of new cultivated areas to crop production range from 18% in S Asia to 47% in Sub-Saharan Africa. This means that the intensification measures in agriculture play the major role in meeting the growing food demand.

New land to agriculture

From the food production standpoint the central issue is whether there will be enough agricultural land for the needs of a growing population. When considering the total land area of the world and its suitability to agriculture it can be noticed that just 11% can be farmed without limitations (Figure 9.1a). By introducing drainage and irrigation nearly half or 49% of the world´s land area is suitable for agriculture.

The FAO finds no reason for concern about land sufficiency (Alexandratos 1995). The FAO estimates that in developing countries, China excluded, the total amount of used and potential arable land amounts to 1.8 billion hectares, of which 48% is in Latin America and 44% in Africa. On the other hand, in S Asia and the Near East, for example, there is little possibility of taking new areas into use. The FAO foresees that by the year 2010 the amount of arable land will increase by 90 million hectares from the present. The additional need for irrigated arable land is estimated to be 23 million hectares or approximately 20%.

Figure 9.1a

Soil limits agriculture

Out of the total land area of the world only 11% can be farmed without irrigation, drainage or other improvement (source: FAO 1995).

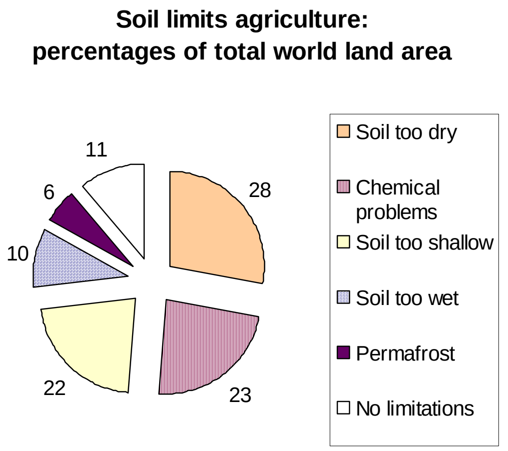
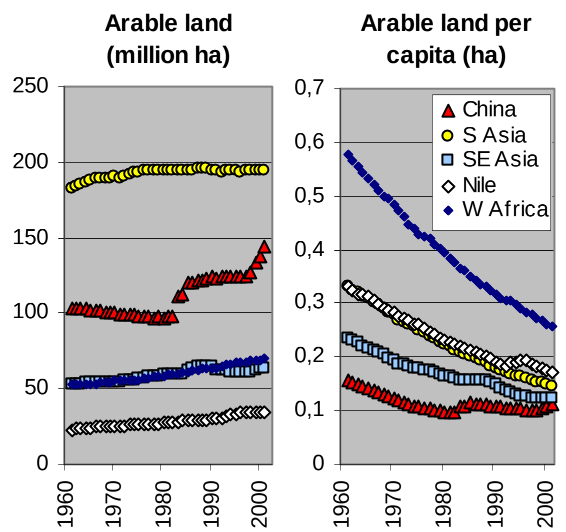


Figure 9.1b

Expansion of arable land in study regions

The expansion has been slow during the past decades. Between 1961 and 2001 the total area of arable land in the study regions grew by 22.1% from 4.15 million km^2 to 5.06 million km^2 (source: World Bank 2004).



As illustrated in Figure 9.1b the expansion of arable land area in the study areas has been fairly slow during the last four decades. Between 1961 and 2001 the total cultivated area in the study regions has grown by 22.1% or 91.5 million hectares. In S Asia the arable land area has increased the least by just 6.3% while in the Nile Basin (Ethiopia excluded), China, W Africa, and SE Asia the figures are higher – 50.2%, 38.9%, 33.0% and 20.6% respectively. However in the case of China the statistics are unpunctual (see Chapter 2.5). The expansion of arable land has stagnated in the Asian regions but still takes place in the African regions. This is understandable as the Nile Basin and W Africa have the biggest potential for extending cropland.

When looking at the figures as per capita the situation seems disturbing. The decline has been most significant in S Asia and W Africa where the figures were 0.146 and 0.259 ha/capita, respectively, in 2001. This is less than half of the level of 1961. Although the arable land per capita has decreased least of all (by 39%) in China the figure is very close to the critical limit of 0.1ha/capita (Fischer et al. 2001) which is considered as an ultimate limit for self sufficiency in agricultural production.

Land and crop potential

According to FAO (Alexandratos 1995; Figure 9.1c), the region with least potential for extending rainfed cropland is S Asia. The countries could maximally exploit 20% more land than they do at present. China is missing from the assessment, but it is likely, that they have even less potential than S Asians do. China´s arable area is expected to decrease by at least 10% till 2030 (Niu and Harris 1996).

Pakistan and Bangladesh have practically no potential left, and in Pakistan, the rate of irrigation is already very high. Therefore, Pakistan appears to exploit its land already very close to the maximal level, and there is very little extension to be expected. India still has potential left, around 22%, but other competing land uses—urban and industrial uses and forestry with expanding desertification—probably set the actual potential much lower. Competing water uses, particularly pressures to reduce the water share allocated to irrigation by industrial and urban water use priorization adds to this picture (Postel 1992). India's real potential appears to lie in the improvement of the efficiency of its existing farming systems (Pike 1995). The same may apply to the whole subcontinent.

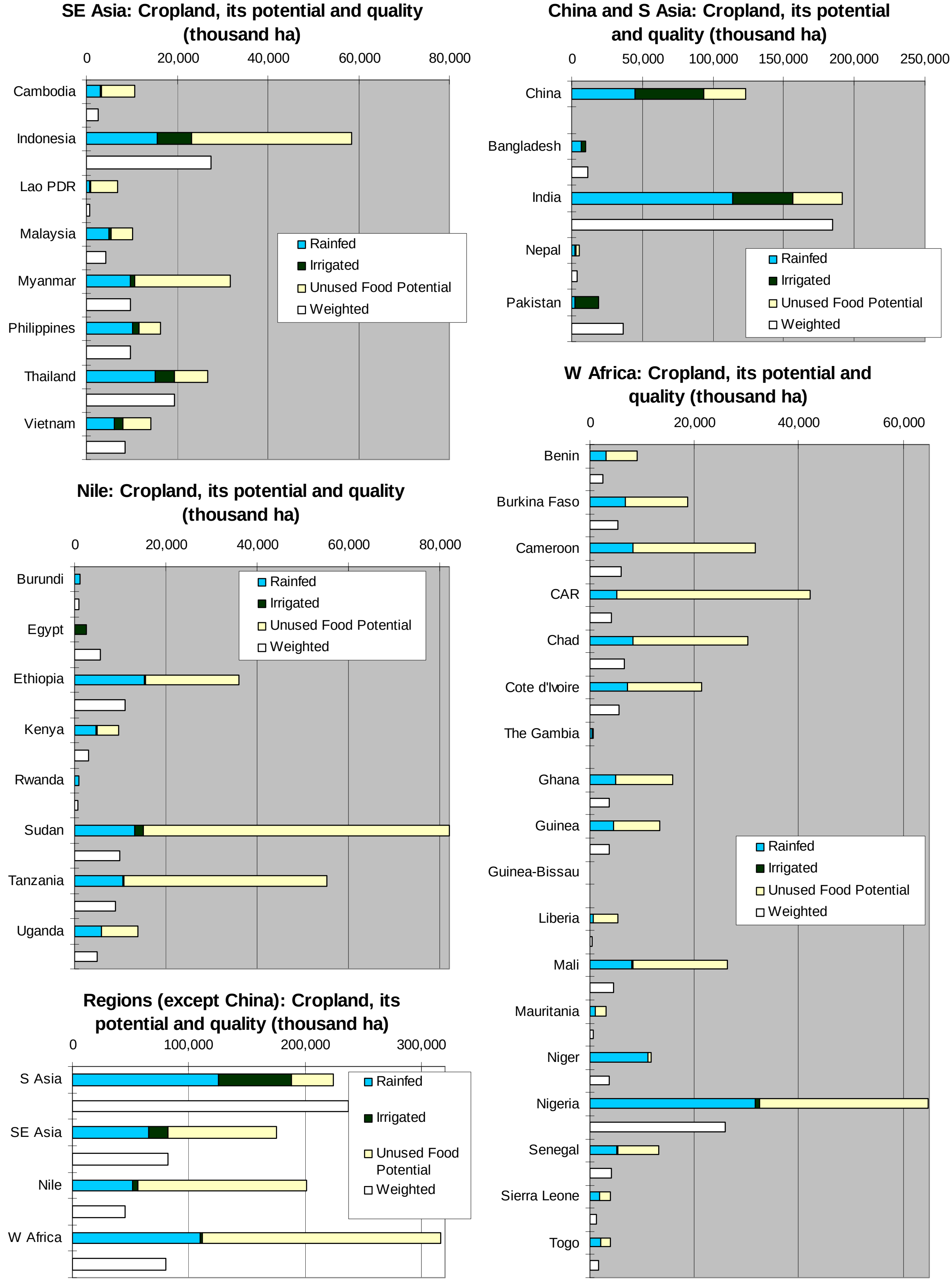
SE Asia, in turn, has much more potential according to FAO: it could more than double its cropland. Even the "rice-basket" of the region, Thailand, could still have almost 40% more cropland than it has at present. According to FAO, Lao PDR has an eightfold potential to the present, and even the most populated country, Indonesia, exploits only 40% of its potential cropland. These potentials, however, must be considered with caution due to the various other pressures to land use.

The Nile region appears to be best off in terms of potential, among the study regions. It is exploiting only less than 30% of its potential cropland. Here, however, the constraints are most clearly elsewhere. Practically all the water of the basin is already utilized, and the Nile brings no water to the Mediterra-

Figure 9.1c

Cropland at present, its extension potential, and quality

Present cropland quality has been estimated by soil types, and weighted accordingly. This weighted area represents most closely the crop potential of the existing cropland. FAO's weight indices calculated for the regions are: S Asia 1.25, SE Asia 1.00, Nile 0.79, and W Africa 0.72 (cf. low left panel). Data by Alexandratos (1995), except China: cropland at present from World Bank (1997).



nean. Therefore, most of the land potential is expected to remain uncultivated, although it will remain to be seen what will happen in reality: the pressures for more extensive agricultural production is growing with the population pressure. Rainfed production would possibly have the biggest potential in this region, particularly if realized in a way that evaporation losses would be kept close to the present level.

What comes to W Africa, the region exploits now slightly over one third of its cropland potential. There is also water potential left (Figure 2.3b), most of it being in the coastal countries, from Guinea to Ghana. The land potential in this region, particularly in the arid and semi-arid, partly desertified countries, tells a somewhat biased story since much of the soil in the potential land is not most suitable to crop production.

This region has suffered very heavily on droughts, and from climate changes. The climate particularly west of the Greenwich meridian has turned much drier and warmer during the last decades. This trend has been stronger than in any other part of the world (Hulme 1992, Hulme et al. 1994, IPCC 1998; Figure 4.3b).

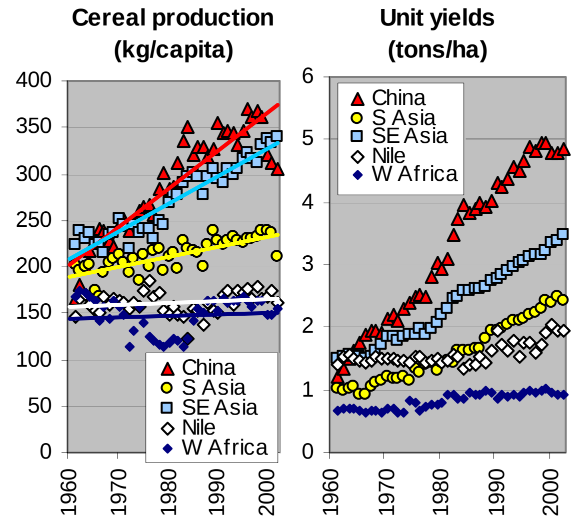
As a conclusion, the trend in the last decades has been, that arable land area has stagnated in most parts of the world (Chapter 2.5); W Africa being one of the few exceptional areas where notable increase has still been taken place. Whether this trend will continue, or the arable land area will start to grow as suggested by FAO (Alexandratos 1995), is open, but remarkable growth, particularly in Asia is very questionable.

More yield per unit area of land

In the middle of the 1960s India struggled with food insecurity (see figure 5.3e). The famines drove the country to the road of agricultural modernization. Predominantly this meant the introduction of new crop varieties with higher yields, expansion of irrigation, and fertilizer and pesticide use. The agricultural reform got its name: the Green Revolution. Similar strategies were implemented elsewhere as well. The major poles of the Green Revolution were in S and SE Asia including the province of Punjab in Pakistan, the provinces of Punjab, Haryana, Andhra Pradesh, Tamil Nadu and Kerala in India, Sri Lanka, the islands of Java and Bali in Indonesia and the peninsular Malaysia. In China the modernization of agriculture was strongly driven as well (Colombel 1998).

Intensification of agriculture, which can be seen as increased unit yields has occurred in every study regions during the past four decades (Figure 9.1d). The development has been strongest in China where the cereal yields per hectare have quadrupled to 4,866 kg/ha since 1961. In S Asia, SE Asia, W Africa and the Nile the growth rate of average cereal unit yields has been more modest but still 138%, 133%, 39% and 38%, respectively, since 1961. This means that the unit yields were 2,410 kg/ha, 3,490 kg/ha, 935 kg/ha, and 1,958 kg/ha in 2002. It should be noticed that the figure of the Nile Basin is greatly increased by the efficient agriculture of Egypt, which produces more than seven tons of cereals per hectare.

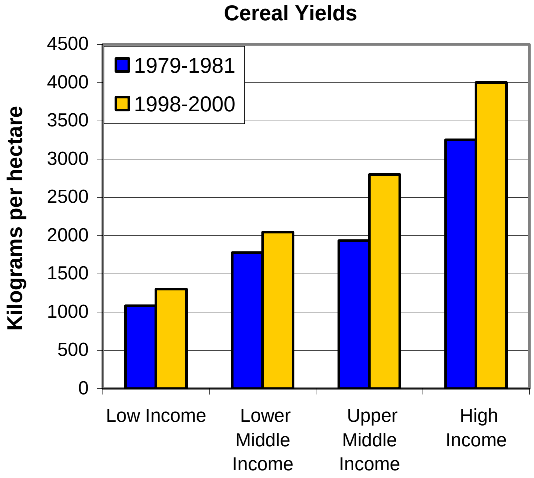
Figure 9.1d
Cereal production by region
Cereal production per capita and unit yields. Source: World Bank (2004).



When considering the cereal production on the per capita basis, the past four decades have been more or less progressive in every region. The population has grown more rapidly in S Asia and the African study regions than in China and SE Asia which reflects to the cereal production per capita figures. Food production has outpaced population growth in every study region except W Africa. China and SE Asia have increased considerably their cereal production per capita - from 165 kg/cap. and 224 kg/cap. in 1961 to 306 kg/cap. and 339 kg/cap. in 2002, respectively. In S Asia the growth has been just 5% while in the Nile region it has been slightly better (11%). W Africa is the only region were cereal production per capita has decreased 7% equaling to 155 kg/cap. in 2002.

Intensification of agriculture is dependent on financial resources. High income countries are able to use high external inputs and invest to e.g. modern irrigation technologies. Adequate financial resources enable extensive intensification measures in agricultural production. As shown in Figure 9.1e high income countries produce considerably bigger cereal yields than countries of lower income level.

Figure 9.1e
Cereal yields in 1979-81 and 1998-2000
The cereal yields of low income countries lag far behind those of developed countries (source: World Bank 2001a).



Major options to intensify agriculture

Gregory et al. (2002) divide the intensification of agriculture in three categories (I, II, III) depending on the level of external inputs to the agricultural system (Table 9.1a). The type I intensification with low external inputs aims to minimize food shortage. It is commonly followed by the land clearance for cultivated areas. Financial capital is scarce which limits the use of external inputs. This type is prevailing in the Sub-Saharan Africa. Although these “pre-green revolution” systems are the most environmentally benign they are not adequate to meet the growing food demand.

Type II intensification or Green Revolution which aims to maximize food production encompasses agricultural systems using high input technologies. Site preparation includes fully mechanized tillage. Utilization of irrigation, fertilizers, pesticides and herbicides is extensive. Cultivars are used instead of ordinary crop varieties. Unit yields can be considerably increased. Unfortunately environmental impacts such as degradation of water, land, and ecosystem resources are often considerable as well (See Chapters 6.2 to 6.5). As mentioned in the first paragraph of the previous section, the major poles of Green Revolution were in S Asia, China, and SE Asia.

The adverse environmental impacts of high input agricultural systems are commonly emphasized while the considerable indirect environmental benefits – decreased climate change forcing and conservation of biodiversity – have been forgotten. Green revolution has saved the equivalent of 17.7 gigatons of carbon between the years 1965-1995 from being released to the atmosphere. This is due to saved forest area and reduced methane emissions (Verchot et al. 2001). Without green revolution, the agricultural area would have doubled in that period. An estimated 426 million hectares of forest and grassland have been saved.

Type III intensification is a more environmentally benign version of the Green Revolution. Its main objective is to provide high yields by improving the efficiency of external inputs. The “doubly green revolution” applies i.a. integrated nutrient management which includes the use of appropriate combinations of fertilizers and manures and improved rates and timing of fertilizing. Genetic modification technologies and integrated pest and weed management are playing an increasingly important role in type III intensification as well. Examples of doubly green revolution, in addition to the developed countries of northern hemisphere, can be found in S America.

As scrutinized in the previous section the unit yields have grown steadily all around. The development is largely enabled by the new crop varieties, irrigation, and fertilizer use. These three factors are often referred as the tripod of Green revolution. Other biophysical major options to increase unit yields include

Table 9.1a
The categories of intensification types and the major management options to increase unit yields
Source: Gregory et al. (2002).

Category\Management option	Site preparation	Choice of germplasm	Fertilizing	Irrigation	Pest, weed control
Type I: Low external inputs “pre-green revolution” Main objective: Minimizing food shortage	Manual	Crop selection	Fallowing; farmyard manure (FYM), legumes	Rainfed / limited irrigation	Above- and belowground biodiversity
Type II: High external inputs “green revolution” Main objective: Maximizing food production	Full mechanized tillage	Cultivar selection	Mineral fertilizers	Irrigation	Chemical
Type III: improved efficiency of inputs “doubly green revolution” Main objective: Maximizing profit and other land functions	Conservation / minimum tillage	Genetically modified (GM) and non-GM cultivar selection	Mineral and organic fertilizers, legumes	Irrigation and surface mulches	Cropping system design

site preparation and pest and weed control. In the following the major options are approached including analysis concerning the trends in irrigation and fertilizer use in the macroregions.

Irrigation

Irrigation has played a major role in the augmentation of agricultural production. Irrigated agriculture provides about 40% of the global food production although just 17% of the world's cropland is irrigated (FAO 2000a). Irrigation systems enable agricultural production in arid and semi-arid regions. Several harvests per year can be obtained in areas where normally just one is got. However agriculture is by far the most water consuming sector. Globally water withdrawals for irrigation correspond to nearly 70% of the total water withdrawals.

Introduction of irrigation increases yields significantly (Table 9.1b). In four Indian states the average grain yield from rainfed agriculture has been just 0.58 tons per hectare while one hectare of land irrigated by canal water has given on average 2.2 tons of grain. Groundwater irrigation seems to be considerably more beneficial as it has enabled unit yields of 4.3 tons per hectare. The fact that groundwater irrigation contributes more to agricultural productivity than surface irrigation has been proven i.a. by Shah et al. (2003).

Table 9.1b

Groundwater irrigation increases yields more than canal water irrigation

Average grain yields per hectare of rainfed land and land irrigated by groundwater and canal water in some Indian states (source: Chambers 1988 cited in Singh and Singh 2002).

		Average grain yield (t/ha)		
State	Years	Rain-fed	Canal	Ground water
Punjab	1977-79	1.08	3.24	5.46
	1963-65	0.75	1.18	3.06
	1950-51	0.37	0.94	1.75
Haryana	1978-79	0.38	2.36	5.74
Andhra Pradesh	1977-79	0.42	3.43	5.69
	1957-59	0.47	2.27	3.11
Tamil Nadu	1977-79	0.49	2.60	6.53
	1964-66	0.61	2.14	4.00
	1956-58	0.66	1.69	3.37
	Average	0.58	2.2	4.3

When comparing the irrigated area as percentage of the arable land in the study regions it can be noticed that the agricultural production in China and S Asia relies heavily on irrigation (Figure 9.1f). An area of 52.6 million hectares or 42.4% of the arable land was irrigated in China in 1998 compared to 30.4 million hectares or 29.4% of the arable land in 1961.

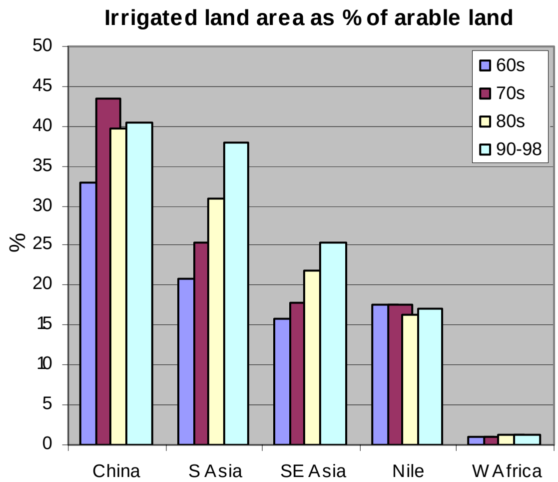
In S Asia the expansion of irrigation has been most significant. The irrigated area has more than doubled from 35.9 million hectares or 19.6% of arable land in 1961 to 82.0 million hectares (42.3% of arable land) in 1998. While the share of irrigated area in India, Nepal and Bangladesh has remained below 50% it was 84% in Pakistan in the late 90s. The combination of arid climate (in general) and national policies striving towards self sufficiency in food production explain the extensive irrigation including the world's largest surface irrigation system in the Indus Basin.

Although SE Asia is relatively abundant with water resources the irrigated area has increased considerably. Since 1961 the irrigated area has doubled to 16.5 million hectares or 26.7% of the arable land in 1998. Indonesia and Thailand alone irrigated areas of 4.82 and 4.75 million hectares respectively. Together this is nearly 60% of the total irrigated area in SE Asia. If considering the irrigated area as percentage of the arable land, Vietnam which irrigates over half of its crop lands leads the statistics. Most of the irrigation water in the macro-region is used to cultivate rice.

Figure 9.1f

Irrigated area as percentage of arable land

The irrigated area has grown most dramatically in S Asia while the agricultural production in W Africa relies almost entirely on rains (source: World Bank 2001a).



If the agricultural sector in the Asian study regions has taken the advantage of irrigation, the same can not be said about the African study regions. During the past decades the share of irrigated land has been relatively stable in the Nile region. The irrigated area of 5.75 million hectares, which has grown by 40% since 1961, is mostly found in Egypt and Sudan. To feed their growing populations these two countries irrigated 3.3 and 1.95 million ha of land, which is 91% of the total irrigated area in the Nile Region.

Table 9.1c

Irrigation and its potential in African study region countries

The irrigation potential (1,000 ha) and the percentage of irrigation potential in use (source: FAO 1997a).

Country	Senegal	Niger	Lake Chad	Nile	Others	Total
Benin		100 (1%)			200 (5%)	300 (3%)
Burkina Faso		5 (17%)			159 (15%)	164 (15%)
Burundi				80 (0%)	105 (0%)	185 (0%)
Cameroon		20 (10%)	100 (14%)		170 (2%)	290 (6%)
Central African Rep.			500 (0%)		1400 (0%)	1900 (0%)
Chad			835 (2%)			835 (2%)
Côte d'Ivoire		50 (0%)			425 (17%)	475 (15%)
Egypt				4420 (70%)		4420 (70%)
Eritrea				150 (10%)	38 (35%)	188 (15%)
Ethiopia				2220 (1%)	1417 (0%)	3637 (1%)
Gambia					80 (2%)	80 (2%)
Ghana					1900 (0%)	1900 (0%)
Guinea	5 (0%)	185 (3%)			330 (28%)	520 (19%)
Guinea Bissau					281 (6%)	281 (6%)
Kenya				180 (3%)	173 (0%)	353 (2%)
Liberia					600 (0%)	600 (0%)
Mali	10 (3%)	556 (34%)				566 (33%)
Mauritania	165 (28%)					165 (28%)
Niger		222 (30%)	48 (4%)			270 (26%)
Nigeria		1678 (40%)	502 (16%)		150 (47%)	2330 (35%)
Rwanda				150 (1%)	9 (0%)	159 (1%)
Senegal	240 (30%)				100 (0%)	340 (21%)
Sierra Leone					807 (4%)	807 (4%)
Sudan			4 (13%)	2750 (70%)	30 (35%)	2784 (70%)
Tanzania				30 (33%)	960 (0%)	990 (1%)
Togo					180 (4%)	180 (4%)
Uganda				202 (5%)		202 (5%)
Sum	420 (28%)	2816 (33%)	1989 (6%)	10182 (50%)	9514 (4%)	24921 (14%)

In W Africa the agriculture is almost totally rain-fed. Although the irrigated area has nearly doubled from 452,000 hectares to 884,000 hectares between 1961 and 1998, still just 1.3% of the arable land was irrigated in the late 1990s. Nigeria and Mali have the largest irrigated areas – 233,000 ha and 138,000 ha, respectively. There are only two countries in W Africa, which irrigate more than one tenth of their arable land: Mauritania (10.8%) and Guinea (11.4%).

As might be expected there is a considerable irrigation potential left in most of the African study countries. Table 9.1c indicates that out of the total irrigation potential 14% is developed. There are four countries – Egypt, Mali, Nigeria, and Sudan - which use more than 30% of their potential. Yet the figure of Egypt (70%) seems to be low as the country utilizes nearly all of its renewable water resources and further extension of irrigation in a sustainable way is difficult.

The international agricultural community argues that expansion of irrigation is a prerequisite to reduce hunger and poverty. Estimates of the required increases in irrigated area varies from 29% to 34%. Meanwhile agricultural water use is estimated to increase by 12% to 27% (FAO 2000b, IWMI 2000, Shiklomanov 2000); cited in Molden et al. 2001). These scenarios presume that irrigation water is used significantly more efficiently than nowadays for which there is great potential – most of the irrigation in the Third World is realized by water consuming surface irrigation. The average irrigation efficiency in developing countries is just 43% (FAO 2000a).

See the section about intensification of irrigation in Chapter 10.4.

Fertilization

According to IFPRI (1996) soil infertility is the single most important factor which limits the crop yields worldwide. For example improvements in crop cultural practices and varieties have just a marginal effect on crop yields if nutrients are not available.

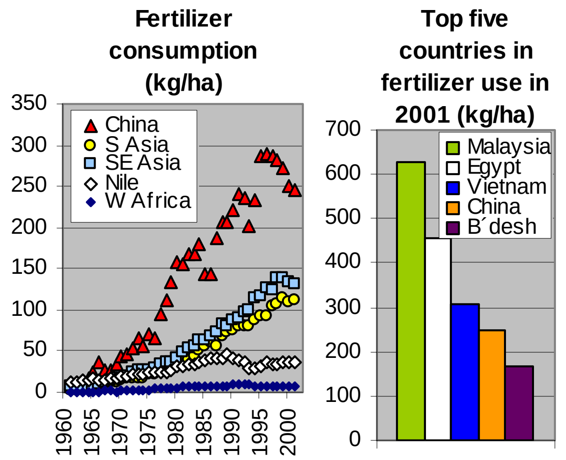
As shown in Figure 9.1g, China has increased its fertilizer use from 7 kg/ha in 1961 to 246 kg/ha in 2001. When comparing the figures at national level China is behind Malaysia, Egypt, and Vietnam. Although SE Asia is well represented in the top five countries in fertilizer use, its poorest nations - Cambodia, Lao PDR, and Myanmar - apply less than 20 kg of fertilizers to one hectare and keep the regional average figure well below China. Such extreme intra-regional difference can be found in the Nile Region as well. The agricultural sector in Egypt consumed 457 kg of fertilizers per ha in 2001 while the second highest figure, found in Kenya, was just 31 kg/ha.

In W Africa fertilizing is still rare. On average the fertilizer consumption was only 8 kg/ha in 2001. Côte d'Ivoire and Senegal had the region's highest unit consumption by applying 20 kg and 16 kg of fertilizers to one hectare of cultivated land.

Figure 9.1g

Fertilizer consumption

Among the study regions the average fertilizer consumption has grown most significantly in China. At national level Malaysia and Egypt use fertilizers most of all (source: World Bank 2004).



On the global level the amount of nitrogen applied by human beings to the fields exceeds already all natural inputs to the nitrogen cycle. Excessive use of fertilizers is causing serious environmental degradation of terrestrial, freshwater and marine ecosystems. It is no wonder as half to two-thirds of nitrogen fertilizers run off from the agricultural systems (Vitousek et al. 1997).

Fortunately alternative practices to extensive inorganic fertilizing exist. Tilman (1998) reports about organic agricultural systems, which use no synthetic fertilizers or pesticides but give similar yields as the conventional systems. Soil fertility can be improved by the incorporation of nitrogen-fixing legumes or phosphate releasing plants, and the use of manures (green and animal), composts, and cover crops (Pretty et al. 2003).

Crop protection

Pests (insects, diseases, and weeds) can cause significant losses in agriculture if not properly dealt with. It is estimated that worldwide 40% of the crops are lost due to insects, diseases and weeds (Oerke et al. 1994, cited in Kropff et al. 2001). According to Engel et al. (2002) weeds alone may induce crop losses ranging from 20 to 60%. Crop protection is definitely a fundamental part of an efficient agricultural production system. The annual use of 2.5 million tons of pesticides which has increased 42-fold since 1945 (IFPRI 1996) has surely for one's part contributed to the increased unit yields.

However, problems related to pesticide use are considerable. Development of pesticide resistance leads often to ever-increasing use of chemicals, which are highly toxic. Each year pesticides cause 220,000 deaths and 3 million poisonings mainly in the developing countries (IWMI 2002). Adverse environmental impacts concerning soil, water, and animal populations occur as well. In addition high cost of pesticides affects the income level of poor farmers.

Along with the better understanding of the ill effects of pesticide use the concepts in crop protection have changed towards integrated pest management (IPM). This is an ecological approach, which takes advantage of the biological control of the pests, host plant resistance and appropriate farming practices. Numerous examples exist in which the application of IPM has increased yields even when the pesticide use is cut to zero (Pretty et al. 2003).

Development of crop varieties

New varieties can be developed by breeding existing crop plants. Varietal production creates new crop varieties, which are more resistant to plant diseases and insects and have greater stress tolerance. Consequently the unit yields increase. Breeding activities have focused on several major crops including inter alia rice, wheat, maize, sorghum, pearl millet, barley, lentils, beans and potatoes. Major efforts have taken place in the development of new rice varieties.

The high yielding varieties (HYV) – one of the principal factor in the Green Revolution – were introduced in the Third World in the mid 1960s (Evenson 2000). The development of new varieties of rice – the most important crop in terms of economic value – started in Asia and peaked in the 1980s when the varietal release rates per year were highest. Since then the number of released varieties in Asia has declined indicating a possible exhaustion in the varietal discovery. However the expansion of HYVs has been tremendous. By 1998 modern varieties were cultivated on more than 90% of the irrigated land in Asia.

In Africa the release of new varieties has been significantly lower. This is because most of Asian HYVs were developed for irrigated and favorable rain-fed conditions and therefore the transfer of these varieties to African ecosystems is not simple (Evenson 2000). Fortunately in the past years considerable steps in the field of varietal production have been taken in Africa as well. FAO (2002a) reports about the New Rice for Africa (NERICA) which is a crossing of hardy African rice species and higher-yielding species imported from Asia. This new variety can increase yields by 25% with low inputs. If minimum amounts of fertilizers are applied yields can be increased even by 250%.

If the development of new crop varieties by breeding has contributed considerably to agricultural production in the Third World, what is the potential of genetic engineering then? The issue of genetically modified (GM) crops is highly controversial. Proponents argue that gene manipulation might be the environmentally friendly solution to food insecurity problems. Meanwhile the opponents claim that adoption of GM crops lead to the loss of biodiversity and health hazards. It is also alleged that the benefits of the mainly privately funded agrobiotechnology would not reach the poor small farmers in the Third World.

The area of transgenic crops has increased significantly – from 1.7 million ha in 1996 to 52.6 million ha in 2001. Out of the global transgenic crop area USA grew 68% while the share of developing countries was 26% (James 2001). In 2005 the share of the Third World climbed to 38% out of the global area of approved biotech crops of 90 million ha (James 2005). Transgenic crops were cultivated at 7% of the global arable land.

In 2005, the only study countries which cultivated GM crops were China, India and the Philippines. Their cultivated areas were 3.3 million ha (*Cotton)*, 1.3 million ha (*Cotton)*, and 0.1 million ha (*Maize)*, respectively.

Herbicide tolerance, which is deployed in 71% of the GM crops is the most dominant trait followed by insect resistance (James 2005). By cultivating these crops – mainly soybean and maize – the level of yields can be maintained or increased with minimum use of pesticides and herbicides, which reduces the health hazards and has a positive effect on the environment. Crops with increased tolerance to abiotic stress (e.g. resistance to drought and salinity) are under development and might improve crop production especially in the developing countries (Engel et al. 2002).

Serageldin (1999) considers the biotechnology revolution very relevant to food security, poverty reduction, and environmental conservation in developing countries. However major issues concerning ethics, biosafety, and intellectual property rights have to be addressed to realize the promise that bioengineering holds for smallholder agriculture in the Third World.

The social and human dimension

The above scrutinized intensification options of agricultural production are biophysical. In addition there are the social and human dimensions, which are strongly related to agricultural production.

Education and the skills of farmers explain significantly the inter-country and inter-farm variations in agricultural performance (Alexandratos 1995). Basic education gives farmers the basis for embracing further training and agricultural extension work. Agriculture is a strongly research driven sector which experiences perpetually new innovations applicable to small farmers. Extension work and training are essential in disseminating the knowledge and information (concerning e.g. Integrated Pest Management) to farmers (Pickett 1991, in Seyoum et al. 1998).

The yields depend largely on the efficiency of the management of irrigation, fertilization and crop protection. It is commonly agreed that the participation of all stakeholders including the farmers is important in achieving efficient and sustainable management of agricultural systems. For example the transfer of irrigation management from states to farmers has proved to increase the efficiency of irrigation. ICARDA (2000) reports about participatory research, which involves farmers in selecting genotypes. Such practice has improved the adoption of new crop varieties by farmers.

Ecological footprint of a city

A city utilizes the ecological productivity and water from an area, which is much larger – typically over ten times its own area. The bigger is the distance between the sites of the production of organic matter and its use, the more demanding it is to close the material cycles and use the wastes as a resource for production. The wealthier the city is, the more capable it is to draw resources from distances, and typically, the bigger are its ecological footprints (Rees 1992).

The UN City Summit ’96, HABITAT II, paid special notice on the possibilities of reducing cities’ ecological footprint (UNCHS 1996). The following three points cover most of the issue:

- *Increased biomass production* within the city or its vicinity (crops, fish, trees, etc.).

- *Waste minimization or increased use of organic waste* as a fertilizer in food or other biomass production (waste water used for urban agriculture, organic waste used for compost, improved reclamation and recycling of materials).

- *Increased efficiency in the use of resources* imported into the city (fresh water, fuels, mineral resources).

These issues are discussed in the following from the standpoint of urban agriculture.

Urban agriculture

Urban areas need not only be consumers of food and water. Much can be done to increase food production, material recycling, and resource use efficiency of urban areas in order to close material cycles and reduce their ecological footprints. Urban farming produces food for 12% of the world's population, but it has largely been neglected by authorities and researchers.

According to FAO (1996), the number of urban farmers is 200 million in the world. They provide food to 700 million people, about 12% of the world's population. Plants that are difficult or expensive to transport and have a quick rotation, such as vegetables and fruits, are best suited to urban farming. Small livestock and aquaculture are important parts as well. In developing countries, commodities such as vegetables, fruit, pork and poultry that are produced in urban areas, provide some 10-40% of nutritional needs of urban households. This is a major contribution to food security and nutrient recycling in cities.

Urban agriculture is most developed in Asia; roughly 50% of urban households farm in Asia. In Shanghai, 85% of vegetable consumption is supplied by urban farms. In Karachi, the number is 50% and in Katmandu, it is 30%.

In Africa and Latin America, urban farming is intensive in many areas. In Nairobi, 17% of households raise livestock. In Kenyan towns, almost 2/3 of households grow food and 50% raise livestock (Lee-Smith et al. 1987). An average urban household in Latin America saves 10-30% of its food costs by spending 1-1.5 days a week in its urban garden.

Neglect or promote urban farming?

Urban farming has, however, been largely neglected by authorities in the city or in upper levels, and in research and statistics (UNCHS 1996). Severe political and regulatory obstacles are set to urban farmers. The rural appeal is not seen as beneficial to the city. In Tanzania, illegal water tapping and use by urban farmers has been estimated to consume 1/3 of urban drinking water supply.

Urban agriculture can make a major contribution to the development of a sustainable city, and FAO (1996) recommends the promotion of urban agriculture. Farmers should be assisted in obtaining improved seeds, in forming co-operatives, and providing biological wastewater treatment processes. Solutions to waste recycling and prevention of pollution problems should be developed in association with urban farming practices. Farming should be better taken into account in urban land use planning.

In summary, urban farming has a huge potential in reduction of organic waste problems, in reduction of transport needs, in providing food security, and in closing of material cycles. However, it typically increases markedly freshwater demand in urban areas.

Summary

The need to increase food production is evident as long as the population and their per capita incomes grow. In the past four decades agricultural production has outpaced population growth all over. The growth of cereal yields per hectare in the study regions between 1961 and 2001 varies greatly from 38% in the Nile Region to 300% in China. In W Africa the cereal yields are less than 1000 kg/ha while in China the production is nearly 5000 kg per hectare.

Augmentation of agricultural production can be achieved by expanding arable land or by increasing unit yields. Expansion of farmland has stagnated in the Asian study regions while in the Nile Basin and W Africa regions increase has still taken place. However, the intensification of agriculture will play a major role in meeting the demand for food all over. Five major options to increase unit yields exist including site preparation, plant protection, choice of germplasm, fertilizing, and irrigation. Extensive use of the latter three is commonly referred as the Green Revolution.

Systematic intensification of agriculture has taken place in the Asian study regions. Irrigated area has doubled in S and SE Asia and grown by 73% in China during the past four decades. Fertilizer use has increased exponentially. The development of new crop varieties has been intense in Asia since the mid 60s. Such a strong occurrence of Green Revolution has had adverse environmental impacts including degradation of water and land resources.

Although unit yields have grown in the Nile Basin and W Africa, Green Revolution in a larger scale has not taken place in these regions (with the exception of Egypt). The share of irrigated land of all arable land is still just 1.3% in W Africa and has been constantly close to 17% (out of which 91% is in Egypt and the Sudan) in the Nile region since the 60s (see Box 9.1 about the cumbersome introduction of commercial agriculture in the Senegal River basin).

In 2001 fertilizer consumption in the latter region varied between 0.3 kg/ha in Rwanda to 31 kg/ha in Kenya (457 kg/ha in Egypt) and was on average just 8 kg/ha in W Africa. Release of new crop varieties has also been slow in Africa.

Although the food demand will gradually decrease along the stagnating population growth, the feeding of mankind will remain a great challenge. Degradation of land and water with the increased competition for the available resources will create an ever-continuing need to intensify agricultural production. In systems with high external inputs the focus changes to increasing the efficiency in the use of inputs. Biotechnology, integrated pest and nutrient management and water saving irrigation will play a crucial role on the way to sustainable but productive agricultural systems.

Box 9.1

The Senegal River case

This case study documents the cumbersome history of introducing commercial agriculture to the basin of the Senegal River, W Africa. This basin has been subjected to severe famines and an array of other, partly related development malaises during the past fifty years. Sources: Varis & Lahtela (2002) and Lahtela (2002, 2003).

The Senegal River

Senegal River is a 1,800 km long lifeline in the Sahel shared by four nations: Guinea, Mali, Mauritania, and Senegal. The rainy uplands of Guinea are the source of a major part of the river water. It is then conveyed through the lowlands, which become increasingly arid towards the mouth of the river.

The river and the surrounding valley have supported its population variably through the centuries in the harsh and highly variable climatic conditions. The traditional livelihood methods and ways of using the river in cyclical matters have been the only possible way until the introduction of modern agriculture in 1950s to the valley.

Through the history there has been a high frequency of dry climatic periods, which has forced people to leave the valley, causing mass starvation and conflict. The last few decades have seen an augmentation of various problems in this fragile valley. Severe droughts have hit the region, the population growth rate has been extreme, the economy has declined, food security has been unstable, and, consequently, there have been numerous mass migrations, mainly to the mushrooming cities such as Dakar, Bamako, Conakry and Nouakchott.

Inconsistent plans and policy interventions

Since the last five decades, the river has been seen as a means of enhancing the national economies of its member states. An attempt at food self-sufficiency, boosted by the problem of feeding the growing urban population and the possibility of future droughts, are the major driving forces of some national and international organizations. Large-scale schemes for modernizing agriculture, hydropower generation, and enabling navigation are listed as the major means of supporting such attempts. So far the success of these has been flimsy and mostly negative (Varis & Fraboulet-Jussila 2002, Varis & Lahtela 2002, Lahtela 2002, 2003 and Niasse et al. 2004).

After gaining independence

Guinea gained its independence from France in 1958, and the other three riparian countries in 1960. The modernization of the economy of the hitherto traditional African livelihoods and economy of the Senegal valley had started a decade earlier with the introduction of irrigated rice to the farmers. This was not successful due to various reasons. Obviously the climatic and other natural conditions were not suitable and the economic, social and institutional structures were not suited to commercial rice farming at that time. The modern institutions started to see daylight after the independence. In the case of Senegal, the key institution has ever since been the State Development Corporation SAED (Société d'Exploitation des Terres du Delta du Fleuve Sénégal). The first international river basin organization is the OMVS (Organisation pour la Mise en Valeur du Fleuve Sénégal), which came into being in early 1970s.

The SAED continued the policy of promoting highly-mechanized irrigated rice farming on a large-scale. Its focal area was on the river delta and there were very few activities upstream. The policy continued unsuccessful with low yields, stumpy market revenues, growing indebtedness, unemployment and out-migration of large amounts of people. The main reason, after Scudder (1988) and Adams (1999) was that the peasant's own small-scale irrigation developments and organizations were demolished. The SAED initiative yielded in the accumulation of contrasts between the traditionally based small-scale irrigation-schemes and village developments (bottom-up) and the government-promoted rice irrigation schemes (top-down). No comprehensive planning was done, the governmental activities through SAED being centered to the commercialization of agriculture (Scudder 1988, Adams 1997). The scale of livelihoods, markets and so forth, the cultural and habitual factors all were not properly understood and addressed in the governmental plans which obviously ignored the bottom-up direction and thus failed.

1970-1990

The Senegal River development schemes in their modern form date back to early 1970s when OMVS - the river organization of Mali, Mauritania, and Senegal - issued its management plan (PNUD-OMVS 1974). It included three components: irrigation, navigation, and energy. This was to be carried out by constructing a hydropower dam in Mali (Manantali dam) and a salt-wedge dam (Diama dam) in Senegal (Figure 9.1h). The dams have been built, but the original three goals of the project have not been fully met (Lahtela 2003); around the mid-1990s it became evident that the original goals of the project were not met. Currently, the electricity and irrigation projects are still ongoing, being heftily downsized and delayed, whilst the navigation project is defunct.

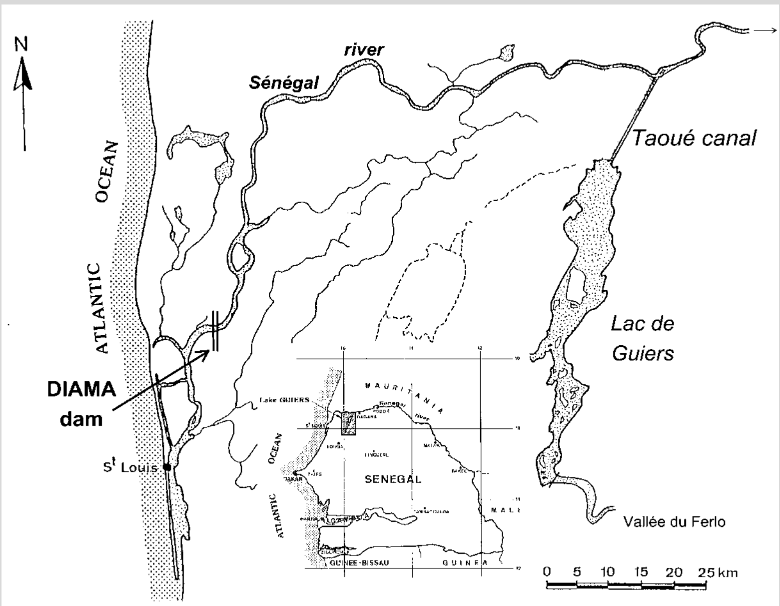
At the same time, the SAED extended irrigation activities from the Delta to the river valley. Small irrigation schemes, PIVs (périmètres irrigués villageois), were implemented in villages. PIVs were successful during the drought years, since material and equipment were provided for the farmers free of charge. Yet, when support from the state ended, the schemes failed to fulfil their goals and the costs exceeded the benefits.

After 1990

In 1994, the Senegalese government adopted a Master Plan for the Integrated Development of the River's Left Bank, which aimed to achieve the best possible compromise between social, economic, and ecological imperatives. Yet, in 1995, the World Bank approved two agricultural sector related programs presented by the same government, which did not take into account the objectives of the Master Plan accepted only one year earlier. The discrepancy becomes important when it is noted that at the end of 1990's SAED introduced a construction and rehabilitation program for irrigation schemes - also contradicting the objectives of the Master Plan (Adams 1997).

Other schemes from the 1990s include the Cayor Canal project, the Fossil Valleys Revitalization Program, and the Manantali Energy project. These are not directly aimed at IWRM but are linked with river development. For the moment, the Cayor Canal project is shelved and the Fossil Valleys is still open. The Manantali Dam's hydropower station has been producing the planned 200 MW of electricity to the networks of Mali, Senegal and Mauritania since 2002 (Madamombe 2005).

Figure 9.1h
Map of Lac de Guiers in Senegal, West Africa.



9.2 Fishery and aquaculture

Tommi Kajander

Aquatic resources contribute continuously more and more to world's food security. Despite the stagnation of global marine capture, inland catches have still considerably increased. However aquaculture production—which has grown more than any food production sector during the past years—will contribute most to the rising demand of fish.

Overview

FAO (2000c) estimates that around 15 to 20% of animal protein consumed by humankind is derived from aquatic animals. Fish is the fastest growing source of food in developing countries and is eaten more than any other type of animal protein. In 1999, the world average consumption of fish, crustaceans, and molluscs was 16.3 kg per person. In comparison 38.0 kg of meat per person was eaten. Among the world's thirty countries with highest proportion of fish consumption, twenty-six are developing nations. Fish is particularly important in the nutrition of the poor.

In addition to the nutritional value, fisheries have a strong economic and social impact in many parts of the world but especially in the Third World. More than 30 million people and their families gain livelihood from fisheries and aquaculture. The trade of fish has reached large scale – almost 40% of all fish production is internationally traded. Consequently fisheries have become a significant source of currency for many developing countries. Revenues from fish exports from the Third World tripled from US$ 5.2 billion in 1985 to US$ 15.6 billion in 1999 (FAO 2002d).

Marine capture

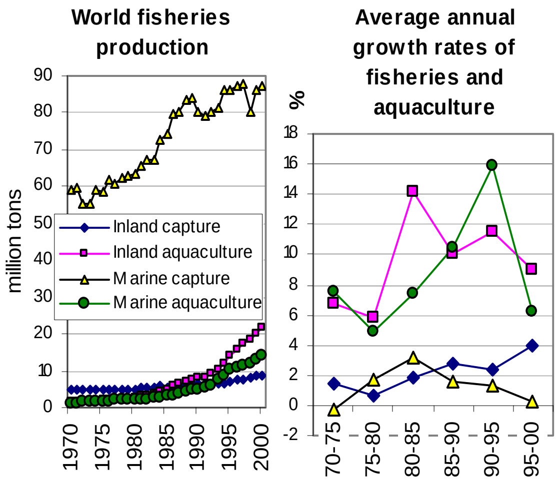
Marine capture fisheries of the world produced 87.3 million tons of seafood in 2000, which was 66.3% of the world's total fisheries and aquaculture production. The biggest marine capture producers are China, Japan, United States, Russia, and Peru. The share of marine catch from total fishery production has decreased rapidly in the 1990s as the figure was still 80.4% in 1990. As shown in Figure 9.2a below, marine capture production has increased steadily till the late 80s after which stagnation has taken place. While the average annual growth rate of marine capture was 3.2% between 1980 and 1985 it was only 0.3% between 1995 and 2000.

The retardation of the global marine capture production indicates that marine fish catch is approaching its upper limits. FAO (2002d) estimates that the maximum sustainable marine production is at around 100 million tons a year. Only 25% of the world´s fishery stocks are underexploited or moderately exploited. Meanwhile 47%, 18%, and 9% of the stocks are fully exploited, over exploited and depleted, respectively. Prevalence of under exploited or moderately exploited stocks are found in the Eastern and Western Indian Ocean and the Western Central Pacific (FAO 2000c).

Figure 9.2a

World fisheries production and its growth rate in the past three decades

World marine capture fisheries production has stagnated and reached its peak in 1997 (Data: FAO 2002b).



Extensive fisheries development has direct and indirect adverse effects on marine ecosystems. Besides reducing the abundance of target stocks, fishing activities affect non-target species as the bycatches are often very high. This has impacts on the whole food-web. Destructive fishing techniques including i.a. dredging, trawling, long-hauling, electrofishing, and the use of explosives have already destroyed large areas of important fish habitats like coral reefs and seagrasses which are vital for many species.

The number of overexploited populations and adverse impacts of fisheries on marine ecosystems indicate that marine fisheries management is often unsustainable. This is mainly due to the persistent sociopolitical pressure for greater harvests i.e. short-term benefits (more jobs and profits) and uncertainty in predicting the effects of management (Botsford et al. 1997). To achieve sustainable development of marine fisheries, ecosystem approach, elimination of destructive fishing practices, and establishment of marine protected areas should be promoted.

Inland water capture

In 2000, production from inland capture fisheries equaled 8.8 million tons and contributed 6.7% to the world total fishery production. More than 90% of the inland catches came from developing countries. Top five countries in inland fisheries production including China, India, Bangladesh, Indonesia, and Tanzania (top down) are all located in the study regions.

Unlike the marine capture, global inland water capture production has not shown signs of stagnation. Fresh water capture is the only fisheries sub-sector which average annual growth rate has increased in the 1990s. Between 1990 and 1995 the inland water production grew on average by 2.4% while the growth rate was 3.9% in the latter part of the decade (Figure 9.2a). However it should be noticed that in many areas the state of information on inland fisheries is poor and the inland catches can be couple of times higher in reality than reported (FAO 2000c).

The state of freshwater biodiversity is worrying. More than 20% of the world's freshwater fish has become extinct, threatened or endangered (Revenga et al. 2000). Major threats for the long-term sustainability of inland fishery resources are land-based activities such as agriculture, forestry, irrigation, power generation, industrial and urban development which cause environmental degradation and loss of fishery habitat. In addition over-fishing, destructive fishing techniques, and species introduction increase the pressure on inland water stocks.

Among major reasons behind the great opposition to the construction of large dams are their adverse impacts on fish stocks and catch. Large dams are definitely harmful to inland water biodiversity but on the other hand they create great potential to fish stocking and capture. De Silva (2003) estimates that only in Asia 2.5 million tons of fish could be produced by culture-based fisheries i.e. fisheries based on regular stocking of fish in inland water bodies (natural and man-made lakes). Culture-based fisheries, which seldom involve external inputs (e.g. feed) are environmentally less perturbing than traditional aquaculture practices.

Aquaculture

Aquaculture is the most rapidly growing sector of fisheries and it is the main factor behind the world's growing fish consumption per capita figures. During the past two decades aquaculture quadrupled its share of world total fisheries production from 6.4% in 1980 to 27.0% in 2000. The sector is strongly driven by Asian production, which contributed 89% of the world's aquaculture production.

Despite the great momentum aquaculture has gained, its annual growth rate has been decreasing during the late 90s (Figure 9.2a). FAO (2000c) has estimated that up to 2015, aquaculture will continue to grow annually by 5% to 7%. This will however require intensification measures.

Several constraints and issues concerning aquaculture have emerged. ICLARM (1999a) points out three concerns. First of all the sustainability of aquaculture production is uncertain due to environmental degradation, disease outbreaks, and increased competition with other sectors for water and land resources and feeds. Secondly, the inequity of distribution of benefits from aquaculture is commonly considered as a problem; the poorest, often landless people benefit the least (Lewis 1997). Finally ICLARM states that small-scale rural sector activities are inadequately integrated into rural development policies (agriculture, livestock, and water).

The sustainability of aquaculture production is definitely one of the most discussed issues. Adverse environmental impacts of aquaculture are widely reported in the literature and include i.a. land use changes (e.g. conversion of mangroves into shrimp ponds), pollution (outputs of dissolved nutrients, suspended solids and organic matter from the farming ponds, salinization of fresh water supplies, uncontrolled use of chemicals) and bio-diversity impacts (introduction of exotic species, destruction of wild fry stocks; Neiland et al. 2001, Tovar et al. 2000).

Along with the increasing competition for natural resources, increased environmental concerns, and relatively low efficiency of farming systems in many places, growth in aquaculture production will largely come from intensification measures. In such activities the environmental, economical and social sustainability of the systems has to be promoted.

Examples on environmentally friendly practices in aquaculture exist and include e.g. integrated aquaculture in crop-animal systems (Prein 2002). In such systems nutrients are efficiently recycled by using otherwise unused waste materials including plant wastes, animal manure and offal for feeding of fish.

Aquaculture can also be integrated in crop systems like paddy fields. Integrated aquaculture in paddy fields is common in the rice producing areas including SE Asia and China (Liu and Cai 1998). Fish farming in the rice fields is beneficial for both – rice and fish. Fish consume weeds and insect pests – the enemies of rice – which reduces the need to use herbicides and pesticides. On the other hand fish produce CO_2 and excreta (meaning nutrients) for the consumption of rice. Consequently production of paddy increases and fish can be harvested.

In addition to integration of aquaculture to other production systems biotechnology can play a major role in production growth. According to Hew and Fletcher (2001) transgenic fish will represent a new generation of broodstock. This will increase the intensity and capacity of aquacultural output.

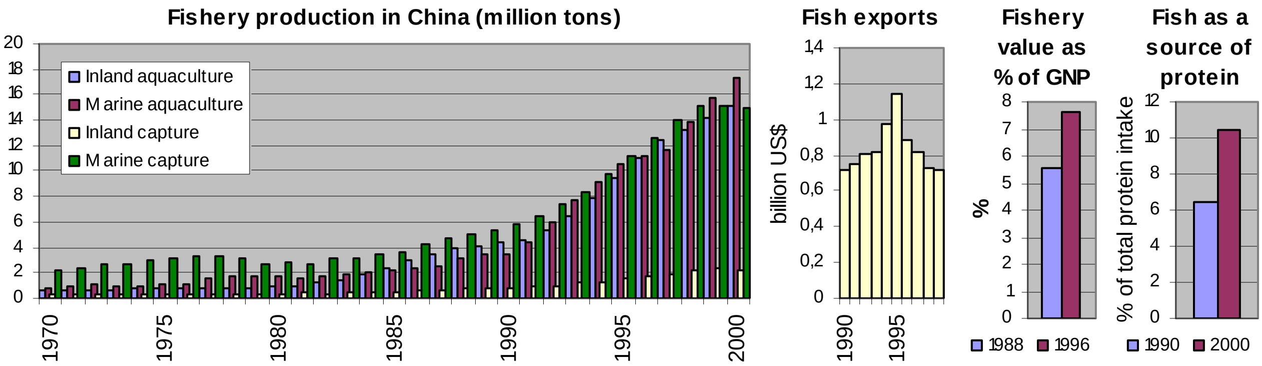
China

China is by far the world's leading country in terms of fisheries production. The total production of 43.1 million tons in 2000 meant that more than 1/3 of aquatic production in the world was produced in China. 17.1%, 25.4%, and 71.0% of the global marine and inland capture, and aquaculture production respectively came from China. Growth of the total fishery production per capita from 4.8 kg in 1970 to 33.6 kg in 2000 is beyond comparison.

Figure 9.2b

Fisheries production and its economical and nutritional dimensions in China

China develops strongly its aquaculture, which quadrupled its production in the 1990s. Inland and marine capture has been declining since the past few years. Fisheries production plays an important role in the Chinese national economy and diet as well (Data: FAO 2002b,c; World Bank 2001a and ICLARM 1999b).



Marine capture has increased dramatically in the 1990s. In 1990 marine catch equaled 5.85 million tons compared to 15.17 million tons in 1999. In the turn of the millennium marine capture production decreased by 212,000 tons being 14.96 million tons in 2000.

Most of the inland capture production in China comes from the culture-based fisheries, which are treated as components of the inland fish production in FAO fisheries statistics. With an annual growth rate of 52% (between 1979 to 1997), the catches of fish, stocked in reservoirs without feeding, have increased dramatically (De Silva 2003). However it seems that inland capture is approaching its limits. In the 1990s the annual growth rate of inland catches in China averaged 6.8%. However catches declined from 2.29 million tons in 1999 to 2.23 million tons in 2000.

Aquaculture production in China was 32.4 million tons in 2000 and contributed 75.3% to the total fishery production. Such a great percentage is found in no other study country. The inland aquaculture produces mainly different kind of carps and accounted for 46.8% of the total aquaculture production. According to FAO (2000c) intensive systems relying increasingly on formulated feeds are dominant in the coastal provinces while traditional integrated systems are more common in the poorer and remoter provinces.

The growth of fisheries and aquaculture production has been so strong that it reflects to China's national economy. As illustrated in Figure 9.2b above, fish export, although decreasing since 1995 is a considerable source of foreign currency. In 1999, China earned US$ 716 million by exporting fish. The increasing share of fishery value as of GNP is noteworthy as well. Despite the significant growth rate of GNP per capita (8.0% annually in the 1990s) fishery value as % of GNP increased from 5.5% in 1988 to 7.6% in 1996.

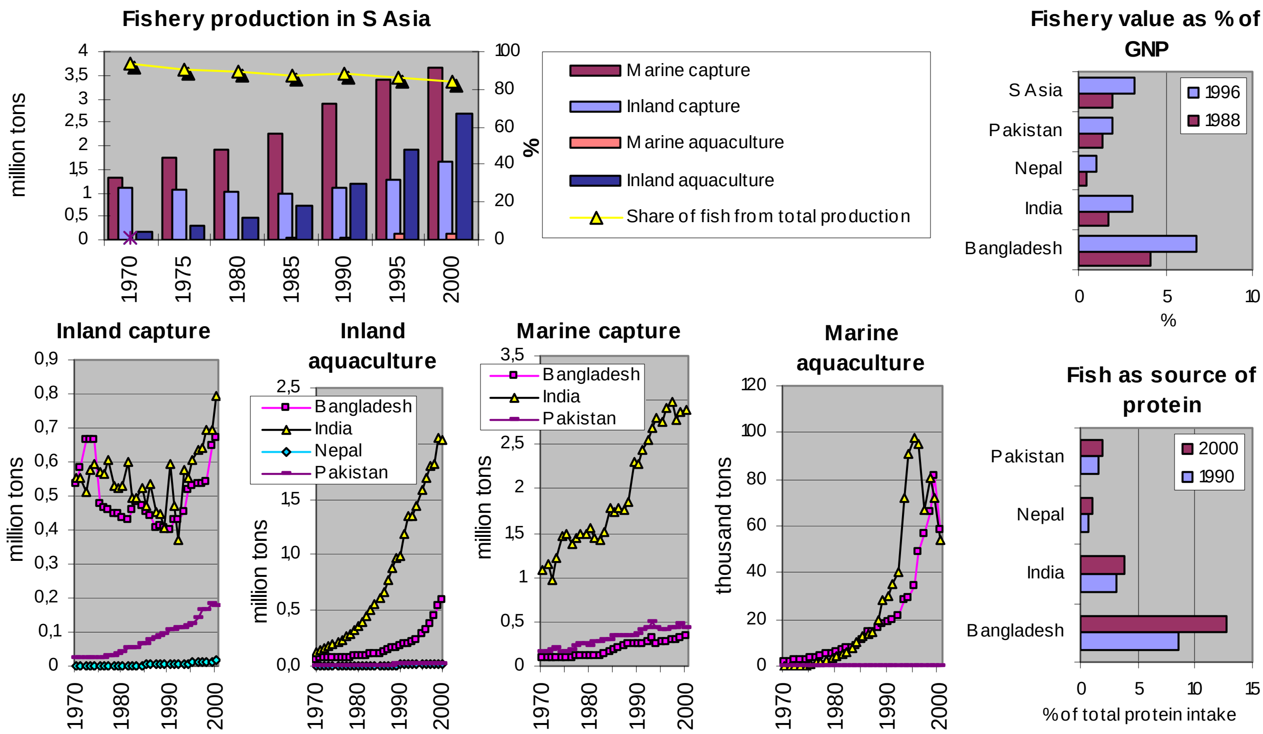
Fisheries and aquaculture development can be clearly seen in the nutrition of Chinese people as well. In 2000, fish provided 10.4% of total protein, which was notably more than 6.4% in 1990.

S Asia

The total fishery production in S Asia exceeded 8 million tons in 2000. During the past three decades the production, out of which 88% is fish, has tripled and is increasingly relying in aquaculture (Figure 9.2c). As per capita basis (6.1 kg/capita), it can be noticed that S Asia is behind the other study regions in the statistics. However the Indian subcontinent is the only study region where fisheries' value as a percentage of GNP and fish as source of protein has increased in every nation. Out of the S Asian study countries Bangladesh relies most on fisheries when considering total fishery production per capita (12.1 kg/capita), fishery value as % of GNP (6.8%) or fish as source of protein (12.7% of total protein intake).

Most of the fishery production or 45.8% is marine capture from the Indian Ocean. Marine capture has still increased in Bangladesh while in India and Pakistan marine catch reached its peak in 1997 (2.98 million t) and 1993 (499,000 t), respectively. What comes to inland capture production such stagnation in catch statistics cannot be found. Although inland capture declined considerably between the mid 70s and late 80s in Bangladesh and India, new records in inland catch were set up in 2000. Meanwhile inland capture in Nepal and Pakistan has grown steadily from 1,800 t and 24,000 t in 1970 to 16,700 t and 176,000 t in 2000, respectively.

Figure 9.2c
Fisheries production in S Asia
S Asia is the only study region where the fishery value as % of GNP (1988-1996) and fish as source of protein (in 1990 and 2000) has increased. The fishery production takes mostly place in India and Bangladesh (sources: FAO 2002b,c; World Bank 2001a, and ICLARM 1999b).



As in the other Asian study areas aquaculture has gained considerable momentum in S Asia. In 2000 aquaculture accounted 34.7% of the total fishery production. Out of this share just 4% (or 112,000 tons) took place in marine areas although S Asia has plenty of coastline. The region's aquaculture production – inland and marine – takes almost entirely place in Bangladesh and India, which contribute 99% to the total aquaculture production. Inland aquaculture production has grown exponentially in the abovementioned countries. Also marine aquaculture has grown considerably during the past three decades till the middle 90s after which a sharp decline in production has taken place.

Fisheries play an increasingly important role in national economies in S Asia. As can be seen from Figure 9.2c above, the fishery value has grown more rapidly than GNP in every country between 1988 and 1996. The share of fishery value of GNP in the whole study region has grown from 1.9% in 1988 to 3.2% in 1996. Relative to national economy, fisheries play the most significant role in Bangladesh where the value of fishery contributed 6.8% to GNP in 1996. The export value of the fish catch in S Asia was 109.0 million US$ in 1999 out of which India’s share was 86.7 million US$.

Along with the growing economical dimension fisheries’ nutritional importance has increased in the region in the past decade. The share of protein supplied by fish has grown all over and varied from 0.97% in Nepal to 12.7% in Bangladesh in 2000.

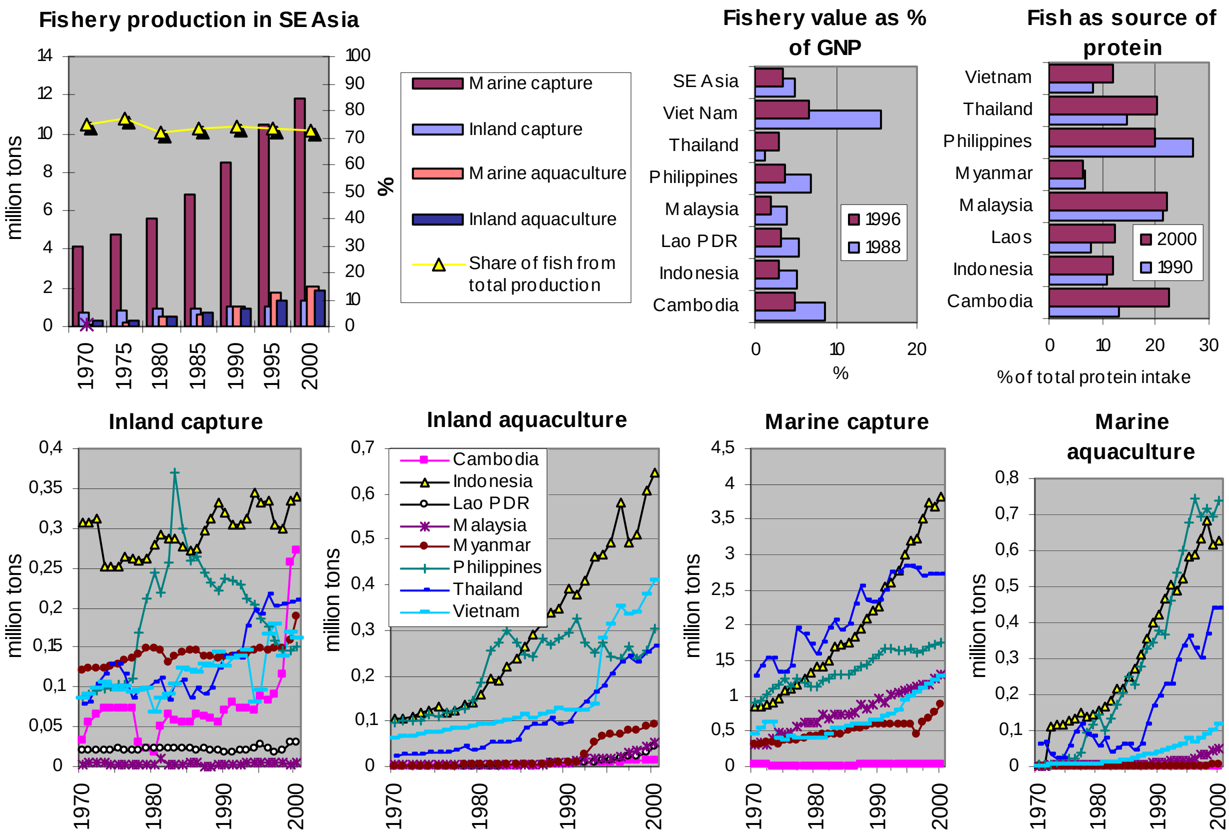
SE Asia

SE Asia produced 24.5 kg of fish per capita in 2000, which was more than in any other study region. The great significance of aquatic products in SE Asia can be easily realized when considering the geography of the region. The area is surrounded by marine waters and encompasses just one land-locked country, Laos. In addition the freshwater resources in the area are abundant including the mighty Mekong River, which provides annual catches exceeding one million tons.

Figure 9.2d

Fisheries production in SE Asia

Indonesia is the leading country in terms of Inland and marine capture and inland aquaculture. Although fishery value as % of GNP (between 1988 and 1996) has decreased in all the SE Asian study countries (except Thailand) fish is increasingly important as a source of protein in most of the countries (Data: FAO 2002b,c; World Bank 2001a, and ICLARM 1999b).



Marine fisheries capture has still increased by 2.5% annually in SE Asia in the latter half of the 1990s. Indonesia, Thailand, and Philippines – the top three producers – contributed 70.4% to the total marine catch in the region. Thailand is the only country where marine capture has declined between 1995 and 2000 with an annual rate was of 0.8%. Marine catches have grown most in Myanmar (7.9% between 1995 and 2000).

Also inland fisheries capture in SE Asia has increased in the latter part of the 1990s. The average annual growth rate between 1995-2000 was 4.8% when the inland fisheries produced 1.36 million tons in 2000. The considerable growth is mainly explained by the changes in the compilation of statistics in Cambodia (see the inland capture chart above). In Philippines the inland capture has sharply declined since the early 1980s. The country has been struggling with problems in other fisheries and aquaculture production as well (see Box 9.2).

Aquaculture production has grown rapidly to 3.87 million tons in 2000 and contributed 22.8% to total fishery production. However there are signs of slow down of the growth of the sector. While the average annual growth rate of aquaculture production for five-year periods since 1970 has varied between 6.7% and 10.5% it was only 4.1% between 1995 and 2000. The figure for marine aquaculture was just 2.5% indicating that the growth in farming of fish, crustaceans, mollusks and seaweeds in the SE Asian marine areas has significantly slowed down. However the world's top five countries in farmed shrimp production include Thailand (1), Indonesia (2), and Vietnam (5) which produced 529,000 tons of shrimp or nearly half of the global shrimp production in 1998 (Neiland et al. 2001) most of which was exported.

Box 9.2

Fisheries and aquaculture production in stages of decline and depletion in the Philippines

Sources: FAO 2002b,c; World Bank 2001a, ICLARM 1999b, and Guerrero 1999.

During the past decade the total fishery production has increased just by 0.3% in the Philippines. The very slow growth can be seen in the national economy and nutrition of the people. The share of fishery value as the share of the GNP decreased sharply from 6.8% in 1988 to 3.8% in 1996. During the 1990s Philippines lost its leading position among the study countries as a country where the biggest share of protein was intaken from fish. While in 1990 every Filipino got as much as 26.8% of total protein intake from fish, the percentage was 19.9% in 2000.

The minimal growth of total fishery production is due to the slow increase in marine capture, collapses in inland capture, and stagnation in inland and marine aquaculture production.

Guerrero (1999) lists the main reasons to fisheries resource depletion in the Philippines as follows:

- overexploitation
- environmental degradation due to deforestation, mining industries, agricultural and shoreline land development
- low aquaculture productivity due to diseases, inadequate supply of seed and limitations in culture technologies used
- underutilization of offshore and EEZ resources
- inefficient utilization of fisheries products due to poor post-harvest practices

Overexploitation of the fisheries is significant and widespread in the country. All the major bays in the Philippines have been over-exploited, nearshore demersal stocks have collapsed being nowadays just 30% of the levels in the 1940s, and the present fishing for small pelagics is exceeding the resource sustainable limits by 100%. Environmental degradation has concerned i.a. mangroves and coral reefs. At present just 146,000 ha of mangroves have vegetation compared to 500,000 ha in 1920. The degradation of coral reefs is disturbing – 70% of the coral reefs have been damaged.

Fish play a very important role in the diet of SE Asian people. The fish consumption per capita was 24.5 kg in 2000 which is more than in the other study regions. When examining the share of fish as % of total protein intake it can be noticed that the figure is over 10% in every country except Myanmar. In Cambodia and Malaysia as much as 22.5% and 22.0% of the total protein intake was supplied by fish in 2000.

What comes to the fishery values in SE Asia it can be noticed that between 1988 and 1996 the growth of GNP has outpaced the growth of fishery value in the countries with the exception of Thailand where fisheries contributed 3.1% to GNP in 1996 compared to 1.3% in 1988 (Figure 9.2d). Despite the dramatic decrease from 15.5% to 6.7% between 1988 and 1996, Vietnam had the region's highest fishery value as share of GNP. Although the significance of fisheries value as a contributor to national economies has decreased, the export earnings from fishery products have increased considerably in the 1990s. During the decade the value of exported fish more than doubled, being 629 million US$ in 1999. The biggest exporters were Indonesia (39.5% of total), Vietnam (20.2%), and Thailand (19.0%) (FAO 2002b).

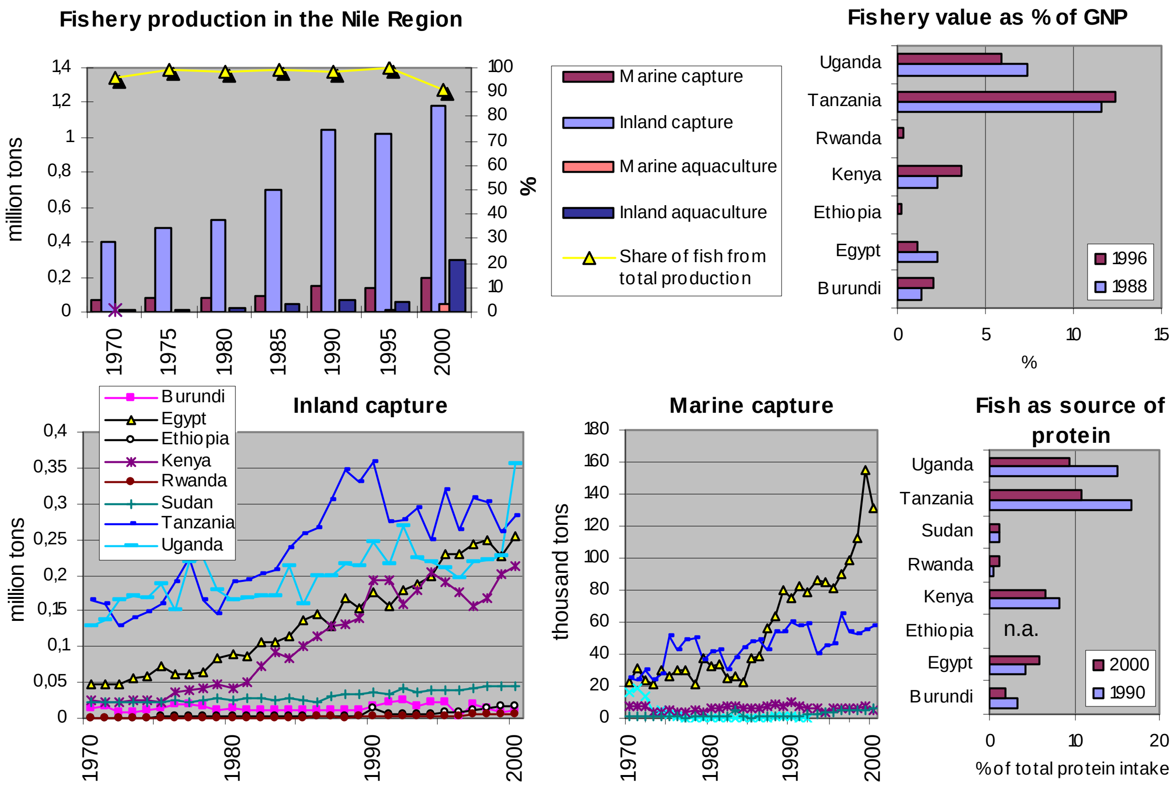
Nile Basin

Marine capture production in the Nile Region takes place in the Mediterranean, Red Sea and Western Indian Ocean. The annual marine catch of 200,000 tons in 2000 is clearly lowest among the study regions and contributed just 11.7% to Nile region's total fishery production. Although the marine capture production declined as much as 15.7% in Egypt between 1999 and 2000, the country provided 65% of the region's total marine catch.

Despite the great potential for marine capture increases in the Wastern Indian Ocean (FAO 2000c), catches in Tanzania and Kenya have remained low. This is due to fact that fishing activities are based on traditional small scale methods and concentrated near the shore. Access to open waters is very limited as the fleet of fishing vessels is practically non-existent (Jiddawi and Öhman 2002).

With a share of 70% inland fishery is the main contributor to the total fishery production in the Nile Region. Although inland capture production decreased in the first half of the 1990s by an annual average of 0.45%, the latter part of the decade showed once again increases in catches (3.0% per year between 1995 and 2000). Out of the 1.18 million tons captured in 2000, biggest share or 30.1% came from Uganda. Tanzania – once a leading country in inland catches – has evidently reached its limits in inland capture production.

Figure 9.2e
Inland and marine capture, fish as protein source and fishery value in the Nile Region
In Uganda and Tanzania fisheries are economically and nutritionally more important than in other countries in the Nile Region (sources: FAO 2002b,c; ICLARM 1999b, and World Bank 2001a).



Strong development of aquaculture production has just recently started in the Nile Region. The output of 349,000 tons in 2000 was no less than fivefold than in 1995. Nowadays aquaculture contributes clearly more (20.4%) to the total fishery than marine capture (11.7%). Also noteworthy is Egypt's dominant role: The lowest riparian of the Nile accounted 97.4% of the aquaculture production in the Nile Region.

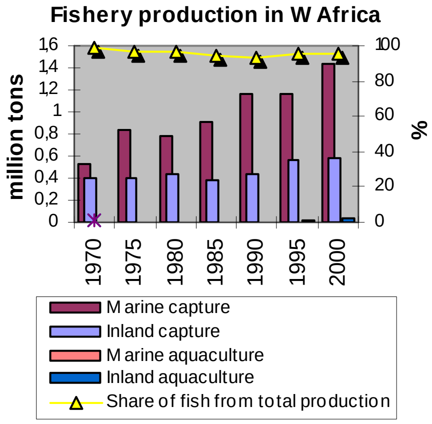
The leading countries in inland catches – Tanzania and Uganda – have the biggest fishery value as the share of GNP in the region. In the former as much as 12.4% of GNP came from fishery production while the figure was 5.9% in Uganda in 1996. In these two countries fish is a very important source of protein. Although the share of protein got from fish has decreased quite a lot during the past decade it was still 10.9% in Tanzania and 9.5% in Uganda in 2000.

W Africa

W Africa is the only study region where the fish production per capita has decreased since the 1970s. While in 1970, 8.2 kg of fish was produced per capita the amount equaled 7.8 kg in 2000. Such slightly decreasing trend in per capita production can also be seen in the share of protein got from fish. Fish has lost its significance as a protein source in every W African country except in Chad, Guinea, Niger, and Senegal (Figure 9.2g). In 2000, the people living in the coastal nations of Ghana, Senegal, Gambia, and Sierra Leone got a considerable share of their total protein intake from fish – 20.8%, 14.8%, 13.6%, and 13.2%, respectively.

Inland fisheries capture production in W Africa is showing signs of stagnation. The inland catch in the

Figure 9.2f
Fishery production in W Africa
Aquaculture's contribution to fisheries production is neglible in W Africa.

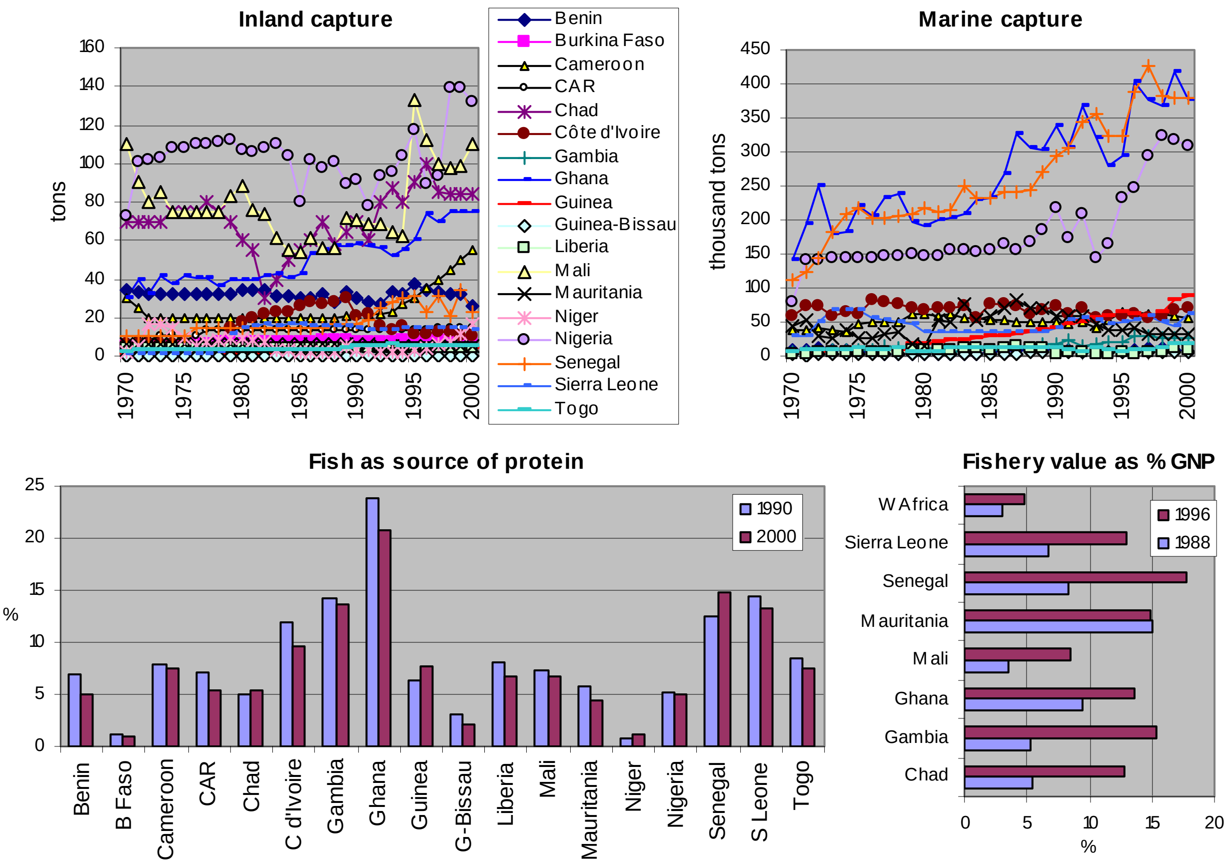


region increased only by 0.6% between 1995-2000 and equaled 589,000 tons in 2000. The biggest inland capture producers in the region were Nigeria (132,000 tons) and Mali (110,000 tons). However inland catches in these two countries have decreased and were at a higher level in the late 1990s (Figure 9.2g).

During the same period marine catch grew by 4.2%, which is a lot when considering the global marine capture growth rate of 0.3%. Despite the high average annual growth rate, marine capture production of 1.44 million tons in 2000 was 33,800 tons less than in 1999.

What comes to the marine fishing activities in W Africa, the fishing policies of EU have aroused a lot of discussion. The fishery co-operation agreements between European Union and W Africa aim to give EU the access to the foreign fishery resources, secure employment for European seafood processing industries and supply European consumption markets (Kaczynski and Fluharty 2002). Such large-scale marine capture production will lead to over-exploitation of the W African coastal resources if significant changes in the EU fishing policies are not made.

Figure 9.2g
Inland and marine capture, fish as protein source and fishery value in W Africa
Nigeria, Mali, and Chad lead the inland capture statistics while 74% of the marine capture comes from Ghana, Senegal, and Nigeria. Fishery value as % of GNP reached 4.7% in W Africa in 1996 being over 15% in Senegal and Gambia (sources: FAO 2002b,c; ICLARM 1999b, and World Bank 2001a).



As Figure 9.2f shows aquaculture development has begun just recently in the region. According to FAO (2002b) no aquaculture was practiced in W African marine areas. The aquaculture production of 28,000 tons in 2000 came almost totally from Nigeria, which contributed 92% of the total production. Although aquaculture has great potential to foster economic growth, food security and rural development in Africa its development is still in its infancy. According to Brummet and Williams (2000) there are three reasons behind the slow development of African aquaculture. These are the lack of tradition of fish and water husbandry, the social and political constrains limiting the investment and retarding expansion and the exiguous employment of appropriate development models to promote growth.

The countries in which fishery value contributes most to the national economy are listed in Figure 9.2g and include Chad, Gambia, Ghana, Mali, Mauritania, Senegal, and Sierra Leone. It can be noticed that between 1988 and 1996 the share of fishery value as proportion of GNP has grown considerably in all these countries with the exception of Mauritania. Senegal which marine capture production of 379,600 tons was highest in the region got as much as 17.8% of its GNP from fisheries in 1996. The small nation of Gambia, which inland and marine catches totaled just 29,000 tons, got the second highest share of GNP (15.4%) from fishery resources. The figure is very high compared to 5.3% in 1988.

Summary

During the past decades world fisheries production has increased faster than global population. Since the early 1960s the average consumption of fish, crustaceans, and mollusks has grown by more than 70% and was 16.3 kg/capita in 1999 (FAO 2002d). This means that around 15 to 20% of animal protein consumed by humankind is derived from aquatic animals. In many developing countries the nutritional importance of fish is significantly higher. In addition to nutritional value, fisheries play a remarkable role in many national economies and labor markets.

The growing global fisheries production is increasingly based on aquaculture production, which has developed very fast. The marine capture production has stagnated in the 1990s while inland catches have still grown. The great promises of aquaculture as a main contributor to food security are commonly addressed but include environmental and social concerns.

China is the world's leading country in terms of fisheries production as 1/3 of the global production comes from China. Aquaculture production in China is extensive – 71% of global aquacultural output is of Chinese origin and three-quarters of national fisheries production is contributed by aquaculture. The strong development of the Chinese fisheries and aquaculture sector reflects to national economy and nutrition. In 1996, fishery value contributed 7.6% to GNP and in 2000 fish provided 10.4% of total protein.

Among the study regions S Asia relies least on fish in terms of total fishery production per capita (6.1 kg/capita in 2000). However fishery and aquaculture production, which comes mainly from India and Bangladesh, has increased. Notably aquaculture has grown its share and accounted 34.7% of total fishery production in 2000. S Asia is the only study region where the fishery value as share of GNP (in 1988 and 1996) and fish as source of protein (in 1990 and 2000) has increased in every nation. Out of the S Asian countries Bangladesh relies most on fisheries, which contributed 6.8% to GNP in 1996 and supplied 12.7% of total protein in 2000.

SE Asia produced the considerable amount of 24.5 kg of fish per capita in 2000. Marine capture production has still increased in each country with the exception of Thailand. Aquaculture production has increased its share but has slowed down in the recent years. Half of the world's aquacultural shrimp production comes from SE Asia which has induced environmental degradation i.e. loss of mangroves. Generally the fishery value as the share of GNP has decreased in the region being highest in Vietnam (6.7% in 1996). Meanwhile the share of protein derived from fish has increased, exceeding 20% in Cambodia, Malaysia, and Thailand in 2000.

The African regions differ from the Asian ones in terms of aquaculture production, which has just recently started in the Nile Region and is negligible in W Africa. The total fishery production in the former region is uniquely dependent on inland fisheries as these contributed 70% to the total production. Despite the existing potential for marine capture increases in the Western Indian Ocean (FAO 2000c), catches have remained low in Kenya and Tanzania. Out of the countries in the Nile Region, Tanzania is most dependent economically and nutritionally on fisheries as it got 12.4% of its GNP (in 1996) and 10.9% of protein (in 2000) from aquatic resources.

W Africa with a long coastline has steadily increased its marine capture production while inland catches are showing signs of stagnation. While the whole region got 4.7% of its GNP from fisheries in 1996, the figure exceeded 15% in Senegal and Gambia. When examining the share of fish as source of protein, Ghana jumps out with 20.8% of total protein derived from fish.

9.3 Rural development

Suzanne Ebert and Tommi Kajander

Rural development aims to distribute wealth to a larger proportion of rural population. It can be accomplished through land reform, introduction of new technologies and the implementation of social programs. Today's rural development involves an integrated, holistic approach.

Overview

The need for development programs can be seen in characteristics of rural poor (Nafziger 1997):

- Rural poor still account for over 80% of the total number of poor people in the 114 developing countries (Jazairy et al. 1992)
- 3/5 to 4/5 of their income is spent on food
- About 60% are undernourished and hundreds of millions are severely malnourished
- One of every ten children born die within the first year, another dies before the age of five, and only five reach the age of forty-five.
- Average life expectancy is about forty-five years, compared to seventy-seven years in developed countries.

Table 9.3a illustrates some of the differences between developing and developed countries in the rural areas.

Table 9.3a
General indicators show the differences between developing and developed countries
Source: World Bank (2004).

Indicator	Unit	Low income countries	High income countries
Agricultural Machinery	Tractors per 100 hectares of arable land	0.69	4.4
Fertilizer Consumption	kg / ha of arable land	71.0	123.0
Land use, permanent cropland	% of land area	1.5	0.5
Rural population density	people per km^2	510.4	205.0

The concept of rural development is a term that encompasses many aspects and ideals. There is no uniform definition for rural development. In fact, the development concept has changed dramatically over the past fifty years. One way to describe rural development as seen today is that according to FAO (1997b):

"*Sustainable agriculture and rural development (SARD) involve three goals: 1) to increase agriculture production in ways that ensure access by all people to the food they need, 2) to help people satisfy their social and cultural aspirations, and 3) to protect and conserve the capacity of the natural resource base to continue to provide production, environmental, and cultural services.*"

History

The idea of sustainable agriculture (methods of agriculture that safeguard the possibility for future generations to live as well or better than the current population) is becoming synonymous with rural development. But years ago, the idea of sustainable agriculture was not well known. The following paragraphs give a brief overview of rural development in the world and its progression to the concept we have today.

After the end of the Second World War, many economic plans and investment programs were geared towards the industrial sector. During the 1950s, success was indicated by growth per capita, with less emphasis on income distribution, employment, and other socio-economic variables. The most profit could be made if resources were distributed to the industry sector. Economists believed the benefits from these profits would trickle down to the poor.

Even after the implementation of "industry-oriented" investment programs, improvement was not evident in rural areas. The rate of migration to urban areas was increasing at an excessive rate, and the income gap was widening. Economists, such as B.F. Johnston, J.W. Mellor and W.H. Nicholls, wrote that the interdependence between the rural and industrial sectors was more connected than thought of before (Eicher and Staatz 1988). Eventually, a new wave of agricultural research was started, spawned by the attitude that agriculture was a positive force in development.

New agricultural research led to the development of high yield grain varieties (HYV), improved fertilizers, and more effective pesticides. With these new input tools, the food shortage in the Third World countries, such as India, could be controlled. The first round of HYV crops produced increased amounts of grains and rice. This event was called the Green Revolution. But the livelihoods of the poorest rural people still did not improve. Why? The Green Revolution was helpful to many wealthier farmers who could afford the technology and large land plots in areas with a favorable climate for the HYV seeds. Many small farmers, and the landless, were left out of the benefits.

During the 1970s, researchers began to study what else had to be done in order to help the poorest. The trend towards an integrated, holistic, “bottom-up” approach to rural development began to take shape. This idea is still popular today, which includes development schemes that not only benefit agriculture, but also health, education, social, political, and institutional aspects. Even though various governments and organizations may implement slightly different objectives to rural development, the integrated approach is still embraced by all.

Structure and role of agriculture

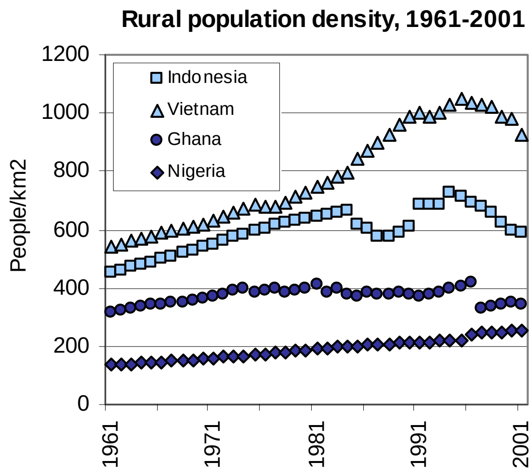
As stated before, rural development today commonly emphasizes a holistic approach, which also includes social, economic, and political reform programs. While these areas are important to rural development, development of agriculture still remains the main action. Since agriculture is vital to almost all rural poor people, this section will highlight the structure of the agrarian systems of LDCs (Less Developed Countries). Increasing agricultural production is discussed in Chapter 9.1.

The role of agriculture is:

- A source of food and raw materials
- A source of labor force to other sectors
- Saving for investment
- A source of foreign exchange
- A market for manufactured goods

Generally, there are two main types of agriculture: 1) in developed countries where a highly efficient agriculture is characterized by high output per worker, and 2) the inefficient and low-production agriculture of developing countries, where most food is used to meet a minimum level of subsistence for families and small communities (Todaro 1997). Most developing countries are weighed down by low agriculture productivity, with the farm as the basic unit of production. Even though this is a common characteristic for all poor regions, the structure of the agriculture system differs. In parts of Asia, large areas of land with a high rural population density are held in the hands of a few rich, elite landowners. In Africa, more land is available to farm, but the amount of cultivated land is limited by low technology and shortage of labor during peak times.

Figure 9.3
Rural population density
The number of people living on rural land is higher in Asia than in Africa, as shown by the examples in the graph. More people in rural Asia mean less land per person and family subsistence farming. Even though there is a lower density of people in Africa, agriculture is still plagued by low production and crop yields. Source: World Bank (2004).



The main problem in the Asian agricultural system is that there are too many people on too little land (Figure 9.3). According to Myrdal, three circumstances have led to the fragmentation of the traditional pattern of land ownership (Myrdal 1968):

1) The intervention of European rule.

2) The progressive introduction of monetized transactions and the rise in power of the moneylender.

3) The rapid growth of Asian populations.

Before the European rule, families had the right to farm their own land, which was monitored and regulated by the village and community. After the arrival of British, French and Dutch, the colonial rule introduced the European land tenure system and encouraged private property ownership. This caused the distribution of land and tax collection to be controlled by a single landowner, as opposed to the entire village. The private ownership of land also gave rise to the moneylender. According to Todaro (1997):

"A moneylender is one who lends money at higher than market rates of interest to peasant farmers to meet their needs for seeds, fertilizers, and other inputs. Activities of moneylenders are often unscrupulous and can accentuate landlessness among the rural poor."

Moneylenders could then collect land when loans to the poor defaulted. Eventually, the economic status of peasant farmers in Asia deteriorated. The rapid rate of population growth added to the problems in Asian agriculture in the last thirty years. There is less land to farm and more people to feed. With the combination of these three circumstances, the average peasant landholdings are now less than one hectare. With such small landholdings, small differences in crop yield can force families into debt and distress.

In Africa, agriculture is mainly based on subsistence farming to support the family. As opposed to the shortage of land in Asia, there is a larger amount of land available for farming, although it is beginning to diminish rapidly. According to Todaro (1997), low-productive subsistence farming results from three circumstances in Africa (cf. Box 9.3): 1) a low level of technology and means to cultivate land, relying on human labor and traditional tools, 2) a family can only cultivate a small plot with human labor, which depletes the soil's ability to produce higher yields, and 3) the farming schedule is planned around the rainy season, which causes scarce labor during planting and weeding times.

Although there are differences between agrarian structures, every rural farmer is plagued by low-productivity, life in poverty, and subsistence cultivation. Action in land reform, improved farming practices and greater price incentives are needed to help those in need. Various forms of rural development are summarized in Table 9.3b.

Table 9.3b

General types and characteristics of Rural Development

Source: Griffin (1974)

Development Strategy	Objectives	Major beneficiaries	Dominant form of tenure	Ideology	Representative countries
Technocratic	Increase input	Landowning elite	Large private and corporate farms, plantations, various tenacy systems	Capitalist	Philippines, Brazil, Ivory Coast
Reformist	Redistribute income (and wealth); increase output	Middle peasants, 'progressive' farmers	Family farms, cooperatives	Nationalist	Mexico, Egypt
Radical	Social change; redistribute political power, wealth, and output	Small peasants and landless laborers	Collectives, communes, state farms	Socialist	Vietnam, China, Cuba, Algeria

Box 9.3

An average male African head of a rural household

Adapted from EC (2000).

If you are an average male African head of a rural household today:

- You have a family of five, and earn $170 a year each, slightly more than half from your farm.
- Your family cultivates about two thirds of a hectare by hand.
- If you started farming in 1970 and are now approaching fifty you saw your income fall by 40% in the years 1978-1987, but now you have almost caught up, and are earning just about the same in real terms as you did in 1970.
- All the work in your farm is done with hand tools – hoes, machetes, knives or sickles – and your family, primarily your wife, does most of it.
- If you plant seeds, you use the ones you saved from last year's crop, or occasionally you may buy neighbors seeds from the ones they have saved.
- You don't use any fertilizer; in fact even if you wanted to, you probably could not get it in your community.

- You sell about one fifth of what you grow, mostly in local markets. Of your sales, about one quarter is coffee, one quarter is starchy staples (e.g. root crops), one quarter is cereals (maize) and the last quarter is shared among legumes, oilseeds, and a few fruits.
- You live 40 km from a tar-sealed road.
- If you want to start some new enterprise, you'll need to save your own funds. If you manage to get a loan, the interest rate will be 40% or more.

Factors for agricultural transformation

In order to reduce rural poverty, development must be made in many areas, including:

- Agrarian reform and land redistribution
- Capital
- Credit
- Research and technology
- Extension services
- Access to water and other inputs
- Transport
- Marketing and storage of crops
- Price and exchange rate policies
- Improving rural services

Before starting any transformation through a rural development program, the current situation must be assessed. Hunter (1978) recommends investigating the following factors: (1) the physical and environmental situation, (2) the social structure, attitudes and stresses within the community, (3) the technology presently available, and (4) any forms of economics involved and important in the community. Although various organizations and governments have different guidelines and rules of program implementation, the inclusion of the previous factors in most integrated rural development schemes is a common practice.

Introducing new technology into rural areas can be risky. For most of the small farmers, their main asset is their local knowledge concerning agriculture, craft and labor skills. Farmers are hesitant to accept change, and must feel that their risks are covered. Losing only a small amount of income can destroy the well being of the family. Since peasant farmers live on a year-to-year or seasonal basis, they are usually more interested in making sure the crop does not fail than in the long-term income benefits.

Technology used should depend on available resources. Japan has a fifty times higher ratio of farm workers per cultivated hectare, as does the United States. Therefore, it has emphasized biological and chemical technology (such as new seeds and fertilizer) rather than mechanical technology (Nafziger 1997).

The use of rural development for positive agricultural transformation is not only restricted to involvement and investment directly to poor communities, but also to the development of organizations and groups in which the poor can voice their concerns and views (Shepherd 1998). These organizations should be able to function satisfactorily after the government has stopped direct action into poor communities. This empowers the community to continue development efforts on their own.

Land reform

The purpose of land reform is to improve income distribution among the poor. Land is a valuable resource that can increase income through production of crops or livestock. In most countries, the ownership of land is the largest single determinant of the existing, inequitable distribution of wealth in rural areas. Land reform, a major element in rural development, can occur in a number of ways:

- Land privatization
- Settlement programs (e.g. moving people to government-owned land where they can farm or graze animals)
- Establishment of new land rights and laws for the poor
- Redistribution for large land sources

Land reform programs became popular in the early 1970s when governments and development agencies began to focus on income distribution, employment, migration and other microeconomic factors as opposed to macroeconomic factors. Since the 1960s, almost all countries in the world have passed land reforms laws in one way or another (de Janvry 1981).

Generally, most land reform programs have not lived up to expectations or have failed all together. Some reasons for this include political opposition by landlords and other dominant community figures, and transfer of land to relatives to keep the land within the family. In addition new landowners do not often have access to services, credit, water, seed, fertilizer, and improved technology in order to have adequate production levels. Problems in land reform are analogous to those for small-scale entrepreneurs in urban areas when they try to expand their businesses and provide jobs.

One case where land reform failed is seen in the Philippines. In 1954 reform measures were launched to redistribute land resources. At that time about 42% of land was owned by 0.36% of the families. This was due to the dependence of the country on mass production of crops for export, power of the landowning class, and regulations not being enforced. The reforms did not work. In 1987 an estimated 80% of land was still controlled by 20% of the families, a small improvement, but not enough to help the peasant farmers.

The most successful land reforms have taken place in Asia including China, Vietnam, Japan, Taiwan, and South Korea (Griffin et al. 2002). The impacts of the program in South Korea between 1945-1954 is illustrated in Table 9.3c. The reforms only allowed land holdings up to three hectares. Landlords had to turn land over to tenants, and received compensation 1.5 times the value of the annual production of the land.

Table 9.3c

Land reform´s effect on land distribution in South Korea

The biggest changes occurred in the distribution of land ownership while the size of holdings remained nearly intact (Griffin et al. 2002)

Tenure category	Land distribution (%)	
	1945	**1954**
Full owner	13.8	50.4
Part owner	34.7	39.3
Full tenant	48.8	7.2
Other	2.7	3.1
Size of operational holdings (ha)	**Land distribution (%)**	
	1947	**1953**
Below 0.5	41.2	44.9
0.5-1.0	33.3	34.2
1.0-2.0	18.8	16.5
2.0-3.0	5.3	4.3
Above 3.0	1.4	0.1

Some factors helped the long term success of the land reforms, such as: (1) inflation in the 1950s that weakened the position of the farmland owners, (2) aid from the USA, (3) an agricultural development program, especially strong after 1972, and (4) the fact that South Korea was not dependent on crop exports (Dixon 1990, Douglas 1983).

According to Griffin et al. (2002) land confiscation has been a significant factor in all the successful land reforms. Unfortunately the political power of large landowners in many countries (e.g. Brazil, India, Pakistan, and Philippines) and international opposition is so strong that redistribution of the land by confiscation is not possible. The other alternative, full compensation according to the market prices of land, is economically impossible. The Asian success stories in land reform seem to be difficult to achieve.

The future of rural development

Rural development has gone through many changes over the past forty years, and still is. The amount of aid given to developing countries, which was largest in the 1970s and 1980s, is decreasing. Developed countries are experiencing “aid fatigue”, the emergence of other spending priorities (such as Eastern Europe), and the performance failure of previous projects. Therefore, the promotion of rural development is being taken up by another sector, the civil society, which will draw on resources of society and anthropology (Shepherd 1998).

Though rural development is mostly dependent on small-farmer agricultural progress, it encompasses much more. For example, development should also improve gender equality. Past land reform programs allocated land to men, which reduced incomes of women and affected their health as well as family health because of no land left for subsistence farming. It has also increased the women’s dependence on men (Gabriel 1991). See Chapter 5.2 for more information on gender issues in study region countries.

Governments must continue to provide support systems such as necessary incentives, economic opportunities, and access to needed inputs to enable small cultivators to expand their output and raise productivity (Todaro 1997).

9.4 Decentralization

Marko Keskinen

Along with the wave of globalization in trade, finance and environmental issues, another worldwide force—namely decentralization—is reshaping development efforts everywhere. One of the basic ideas behind localization and decentralization is to enhance people's participation in politics and increase local autonomy in decision-making. Decentralization is a term with many meanings, though.

Introduction – what is it all about?

In most countries decentralization reflects a broader process of political and economic reform. Political changes around the world have given voice to local demands and the need to bring economic and political systems closer to local communities. Decentralization can help simplify complex bureaucratic procedures and increase government officials' sensitivity to local conditions. Moreover, decentralization can help ministries reach larger numbers of local areas with services and allow greater political representation for diverse political, ethnic, religious and cultural groups in decision-making. Thus it can relieve top managers in central ministries of routine tasks, allowing them to concentrate more on policy (Rossi 2001, Litvack et al. 1998, Litvack and Seddon 1999).

Decentralization may increase political stability and national unity by allowing citizens to better control public programs (Box 9.4a). In some cases even the preservation of a national political system or at least its stability is claimed to require the decentralization of power. Burki et al. (1999) suggest that *"in a fundamental sense, democratization, and with it, decentralization, can be seen as a strategy to maintain political stability—to provide an institutional mechanism for bringing opposition groups into a formal, ritualized bargaining process. As such, it constitutes an alternative to civil war or other forms of violent opposition"*.

In addition to political reasons, rapid technological changes and global integration of factor markets have changed the size of government needed to manage economic systems. On one hand, economic mobility and globalization have led to the creation of different kind of supranational bodies to manage the growing economic integration among nations.

Box 9.4a

Uganda

After Azfar et al. (2001), except the last paragraph, which is from World Bank (2000).

The 1995 constitution of Uganda provides a general framework for decentralization, which is spelled out in more detail in the 1997 local governments act (LGA). There are five levels of local government: village, parish, sub-county, county and district. Of these, only the district and sub-county levels have both political authority and significant resources. Local governments are said to have "autonomy," i.e., legislative and executive authority within their listed areas of jurisdiction. The district council list includes primary and secondary education, a range of primary health services (including certain hospitals and health centers, maternal-child health, communicable disease and vector control, and health education), and basic services in the areas of water provision, roads, planning and licensing. A number of the listed areas, including primary education, community-based health services, hygiene, and low-level health units, are to be devolved by the district to lower-level councils.

Local government revenue sources are defined in the law to include the graduated (head) tax, property tax, and a list of licenses and fees. Local governments may adopt additional taxes, but only with the approval of the ministry of local government. This essentially limits local governments to minor variations from the list, since the law provides no standard by which the minister approves or disapproves of proposed new revenue sources.

Uganda still faces problems with implementing decentralization. Limited local capacity and resistance from central ministries have hobbled the transfer of responsibilities. The revenues local governments control (primarily user charges and local taxes) have not increased as much as expected, and grants still account for 80% of local resources. Despite increased participation, local services and management have not become significantly more responsive to local preferences—although this is now improving. Even with these difficulties, however, decentralization has been much more successful in maintaining national unity than the previous policies of centrally imposed controls.

On the other hand, an increasing number of public services can be efficiently provided by decentralized and often also privatized organizations. The collapse of several centralized economic systems has encouraged regional and local governments to get more strongly involved in the political and economic process as well. Moreover, there are arguments that stress that the persistence of poverty in most countries has actually its origins in problems of governance rather than in an inadequacy of resources and that these problems can most efficiently be solved through decentralization (Litvack et al. 1998, de Jong et al. 1999, UNESCAP 2000).

It is good to remember that centralization and decentralization are not either-or conditions – these both forms of administration co-exist in different political systems (Box 9.4b). In most countries an appropriate balance of centralization and decentralization is essential to the effective and efficient functioning of government. It is, therefore, necessary to put in place a better system of co-operation between the national, regional and local levels of decision-making. Central Ministries often have crucial roles in promoting and sustaining decentralization by developing effective national policies and regulations for decentralization as well as strengthening local institutional capacity to assume responsibility for new functions. Even in the midst of decentralization, national governments therefore retain important policy and supervisory roles (Litvack et al. 1998, Litvack and Seddon 1999, FAO 2001). In the literature there are rationales for both decentralization and centralization – one useful summary is provided by Litvack et al. (1998).

Definition – what does it actually mean?

Decentralization is not easily defined; it has many forms and several dimensions. A specific care must therefore be used in defining and labeling decentralization as well as interpreting and applying different theories, terms and forms related to it. Decentralization can be seen and used as both a public sector reform model and a strategy for development.
There have been several different ways of defining decentralization and its different forms. For instance in the 1960's United Nations used the concept of local level governmental systems, partnership systems, dual systems and integrated administrative systems whereas some others applied the forms of territorial and functional decentralization.

Box 9.4a
Decentralization in China
After World Bank (2000).

China is formally constituted as a unitary state, and the dominant political party—the Chinese Communist Party—recommends candidates for the posts of governor and mayor for ratification by the People's Congress. But political and economic power has dispersed markedly in recent years, particularly since the reforms of 1978. The number of posts controlled directly by the central organization of the party declined from 13,000 to 5,000, and central planning has largely been abandoned. Under such conditions, local leaders have more incentives to generate local economic prosperity than to follow some nationally determined economic goal, and they have acquired substantial autonomy in designing and implementing policy. China's central government can no longer unilaterally recapture the powers it has conceded and may not even want to.

China's approach relies on negotiations rather than rules to define relations between the central government and the four subnational tiers—provinces, prefectures/cities, counties, and towns. The allocation of responsibilities across tiers of government is not clearly defined except for health and education, which are controlled by the provinces. On the revenue side, until the early 1990s local governments were responsible for administering and collecting a large proportion of central government taxes, but their loyalty shifted away from the national government to the subnational level.

In 1994 new reforms created separate tax administrations for national and local taxes, a step that increased the central government's share of tax revenues but remains highly unpopular. Five years later the principle that taxes belong to the central government unless specifically assigned to localities is still widely contested at the local level. Further, subnational governments continue to rely on extrabudgetary funds—some of them illegal—for the largest share of revenues. These funds, combined with frequent (and also illegal) provincial deficits, confer substantial fiscal independence on provincial administrations.

The Chinese style of decentralization does allow for considerable subnational autonomy. It creates incentives for local officials to work toward local prosperity and has also been an effective tool for instituting market reforms. But over time, the absence of clear rules may threaten its successes. Decentralization has accentuated a pre-reform tendency toward a fief mentality that hampers efforts to unify the national market and periodically threatens central control over macroeconomic stability. Moreover, while administrative discretion has helped preserve the momentum for growth and reform, it has also created opportunities for rents that can be appropriated through financial corruption or political patronage. Official statistics show that by the end of 1998, 158,000 officials had been penalized by the Party's Commission for Discipline Inspection, and corruption was one of the main themes of the National People's Congress, China's parliament, in March 1999.

Today one of the most common definitions is that decentralization is the transfer of fiscal, political and administrative authority and responsibility from the central government to the lower-level government organizations and/or to the private sector (Box 9.4c). Thus decentralization would include three major forms; the fiscal, political and administrative one. Since decentralization is at times considered to include the transfer of market and/or spatial responsibility, the number of different forms of decentralization can climb up to five. These are dealt with later on.

Problems in implementation

Although decentralization is implemented widely around the world, in most countries the progress toward decentralization has been rather slow. The reasons for this are many. In some cases, national governmental officials feel threatened by a change that some of their power is taken away from them. In other cases, local citizens and officials might not be prepared to take on the type of responsibilities envisioned to them in reform policies. After years of neglect and lack of training under centralized governance, the knowledge and skills about local organization has been lost. In many cases change of any kind is perceived too risky and all participants tend to favor retaining the status quo (Agrawal 1999).

Decentralization is often also implemented incompetently. This is partly due to the fact that decision makers are not always fully controlling the pace or genesis of the decentralization process. And even when they do so, models of decentralization are often exported directly from one country to another without regard for local political traditions, regulatory frameworks or property rights. And still, prevailing circumstances and institutions of a country have naturally a great impact on the success and consequences of the decentralization process (World Bank 2000).

Decentralization does have potential disadvantages as well, and is therefore opposed by many. It may not always be efficient, especially for standardized, routine and network-based services. Decentralization can sometimes make co-ordination of national policies

Box 9.4c

Decentralization in Malaysia – success in strong federal state

The following example from decentralization in Malaysia is taken from UNDP (1999).

Malaysia is an example of a strong federal government that lays stress on participatory democracy. The efforts to redefine the role of government have focused on making the private sector the engine of growth and on privatization of many public service operations. The delegation of power to local government level is taking place, and a system for power sharing is being created which relies on consensus building, active co-ordination, high consultation and a system of political action committees.

One key to progress in this effort is the consistency of purpose that has resulted from the fact that the same political party has been in place since 1957. As members of the same party, local authorities have the confidence of central leaders, and it is therefore felt that they can be trusted with increased power. Another key is the fact that strong central agencies have been put in place within the prime minister's department to co-ordinate the efforts of the central organization – twenty-five ministers, eighty federal departments, and 100 statutory bodies and public enterprises.

Reforms in the public service have been managed by one of these special units in the prime minister's office, the Malaysian administrative modernization and management planning unit. These reforms have stressed a new, service oriented culture, emphasizing such values as quality, productivity, accountability, discipline, responsiveness, integrity, moral and ethical judgment and transparency.

Among the many specific examples of decentralized operations, the following two can be cited:

- A decentralized system of planning and implementation of development projects was introduced in 1991. This system put in place a bottom-up, vertically and horizontally coordinated mechanism for planning, monitoring and evaluating development plans and programs using development councils at federal, state and district levels, development working committees at federal and state levels, and ministerial development committees at federal, state and district levels.

- A feature of civil service arrangements which facilitates this system is that managers at all levels in all agencies come from the same service, and as such are able to cut across institutional and regional boundaries to build consensus and facilitate collaboration.

The Malaysian experience highlights the importance of integrity in government and the civil service for achieving results in decentralization efforts. A sense of fair play and justice in treating all interests equally and an emphasis on professionalism and service-oriented values within the civil service, will produce the desired benefits in the long term. A strong service tradition, coupled with the continuity of national policies, helps to ensure consistency and positive direction toward decentralization goals.

more complex and allow functions to be captured by local elites. Since decentralization can increase the variance of public service performance, it also easily creates inequality and dissatisfaction (Box 9.4d).

Distrust and collision of interests between public and private sectors may undermine co-operation at the local level as well. Moreover, some of the statistical data on decentralization suggest that the states, which have more tiers of government tend to have higher perceived corruption and may actually do a worse job of providing public health services (Litvack and Seddon 1999, Treisman 2000).

From theory to practice

There is often a big difference between the formal arrangements –constitution, laws, regulations and policy discussions– for decentralization and what is actually happening in the country (Box 9.4e). Any analysis of decentralization must therefore start by looking not only at the formal arrangements but also at the actual practices and working institutions. An essential element of decentralization is also the need for a clear division of responsibilities and a functional system of accountability (World Bank 2002a).

It is important to notice, that much of the literature on decentralization is based on experiences collected from industrial countries. Yet most of the current decentralization takes place in developing countries, where the institutional set-up and framework is often completely different. Generally many of the institutions that are well established in industrial countries are weak or even non-existing in developing ones.

This means that there is an uncompromising need to identify what institutions are important for a successful decentralization in industrial countries and how these institutions differ in developing countries. With the help of this information the potential ways to compensate the weak institutions in the short run can be found and the basic elements of key institutions in the long run can be built. Also, there are studies that claim that whether decentralization in fact improves or harms public sector performance seems to depend mostly on formal institutional arrangements as well as their interaction with social practices (Litvack et al. 1998, Azfar et al. 2001).

In order to make most out of the existing institutions and structures, program planners must be able to estimate the strengths and weaknesses of public and private sector organizations in performing different types of functions. They must first analyze the types of decentralization already present in a country and only after that they will be able to plan and tailor appropriate policy plans for decentralization.

The success of decentralization also depends on proper training for both national and local officials in

Box 9.4d
The Philippines
After Azfar et al. (2001).

Decentralization in the Philippines was mandated by the democratic constitution of 1987. The local government code (LGC), enacted in 1991 and implemented in 1992-93, significantly increased the responsibilities and resources of subnational governments. In addition, it mandated regular elections for local executives and legislative bodies. The code devolved "basic services" to local governments—these include most health services along with such infrastructure provision as school, clinic and local road building. Local government units (LGUs) have authority to create their own revenue sources (within firm limits), as well as to enter international aid agreements. The president exercises general supervision of the legality and appropriateness of LGU actions (this is the basis for central government suspension of local administrations).

There are seventy-seven provinces, sixty-nine cities, 1538 municipalities, and 41,359 barangays in the Philippines. Under the LGC, the provinces administer tertiary health services (e.g., hospitals) are involved in social welfare services and infrastructure provision. Whereas provinces are envisioned in the code as dynamic mechanisms for developmental processes and effective governance within their component local governments, municipalities are expected to be the primary general-purpose units of government and the suppliers of most basic public services. Municipalities have responsibility for primary health care, disease control, purchase of supplies and equipment necessary for this, as well as municipal health facility and school buildings. Cities have essentially the equivalent of the combined authority of provinces and municipalities, and have only barangays as their component LGUs. The barangay, the lowest formal level of government, is described in the code as the primary planning and implementing unit of government policies. In practice, the barangays have little policymaking or planning capacity, although they have significant fiscal resources in comparison to their responsibilities.

The implementation of decentralization has proceeded unevenly. It apparently progressed steadily until 1995, then the momentum stalled and demoralization started setting in. This was particularly true among devolved personnel in the health sector, who received little support—the 1995 legislative proposal in congress to address this by renationalizing parts of the health sector was vetoed. Other signs have been more positive. Recently observers have seen evidence of innovation at the local level, a deepening of decentralized operations, local management becoming more project- than handout-oriented, and increasing pressure for improved performance (especially in public services).

Box 9.4e

Decentralization in Tanzania – shifts in decentralization policies

After Agrawal (1999).

Tanzania's experience of local government and decentralization represents a move from conventional devolution to local authorities, to a deconcentrated version of decentralization through local administrative systems, to reestablishment of local authorities in a new form. Analyses of decentralization in Tanzania recognize three phases: pre 1972, 1972-1982 and post-1982.

Soon after independence in 1961, the local government inherited from the British, consisting of rural and urban authorities, began to suffer encroachment of its powers and revenue-raising capacity. Regional and area commissioners were political appointees, chiefs were abolished and a hierarchy of elected commissioners was established at the regional, district and village levels. Finally in 1972, on the recommendations of a commission of inquiry and management consultants, the local authorities were totally dismantled.

They were replaced by what was called decentralized local administration but, in hindsight, was merely administrative deconcentration. The objective of the 1972 reforms was to have a single set of institutions at different levels that would provide services. The regional and district committees became responsible for the provision of virtually all local services. New local structures, the ward development committees elected by all adult villagers, were created to complement the efforts of the committees through schemes emphasizing self-help and participation. Although the reforms in combination with villagization in Tanzania had a positive impact on spatial equity, standards of local services continued to decline because the entire structure of local administration was dependent on the central government, and in contrast to the pre-1972 local authorities, had little legislative or financial autonomy. The prevalence of political appointees and centrally designated government officials meant that the new institutions of decentralization became a means to further top-down administration instead of encouraging popular participation.

In 1982, district councils were reintroduced with more responsibilities, including the power to raise revenues. The role of the committees at the regional and the district levels was cut back to coordination, consultation and provision of technical services. The major problem after that has been the limited availability of finances to the local governments – both because of their limited ability to raise finances locally and because of declining funding from donors.

The Tanzanian experience is important because of its political relevance to the region and for the example it has set in terms of promoting local-level participation through representative bodies below the district level. The self-help component in local governance has been small, but it is growing and becoming significant. In addition, the Tanzanian political system has, on the whole, facilitated decentralization efforts.

decentralized administration. Technical assistance is often required for local governments, private enterprises and local non-governmental groups in the planning, financing and management of decentralized functions (Litvack and Seddon 1999).

It is quite clear that decentralization, at least when implemented incompletely, increases the variance of public service performance. Weak administrative, technical or financial capacity at local levels leads to less efficiently delivered services. While centralized ministries were capable of delivering a fairly standardized level of services nationwide, decentralization may improve services in some areas and worsen them in others. This means that the public opinion in latter areas can easily turn against decentralization (Burki et al. 1999, Litvack and Seddon 1999).

The difficulties in carrying out decentralization can be seen from the recent opinion poll conducted in Latin America. It shows a sharp decline in support for democracy almost everywhere in the region. The opinion is also less favorable to privatization than it was three years before. These results suggest that region's relatively young democracies have yet to prove themselves to many citizens. When their own financial well-being and the public services of the area are threatened, people tend to put their faith back to old, centralized times. These tendencies can also be seen in the transition economies of Europe (Economist 2001).

Reasons for decentralization

Whatever the case of decentralization and its implementation, it is widespread in the developing world due to a variety of reasons (Litvack et al. 1998):

- advent of multiparty political systems in Africa,
- deepening of democratization in Latin America,
- transition from a command to a market economy in Eastern Europe and the former Soviet Union,
- the need to improve the delivery of services to large populations in E Asia's centralized countries,
- the ethnic and geographic diversity in S Asia as well as ethnic tensions in other countries,

Box 9.4f

Decentralization in Cambodia – first steps in commune administration

After CCC (2000) and (2001) and People's Daily (2001).

With the royal government setting a date for commune elections (3rd of February 2002), local governance and commune administration reforms in Cambodia become a reality. The law on administration of communes, which was signed into law in March 2001, provides a basis for the people of Cambodia to play a greater part than ever before in the processes of public decision-making that affect their lives. For the first time, elected commune councils will be charged with setting local taxes, devising commune development plans and supervising the implementation of those plans. For ordinary villagers throughout Cambodia, this is therefore the most important and visible of the government's administrative reforms.

Underpinning the law on administration of communes is a government commitment to decentralization, which represents a sharp departure from the practices of the past. Cambodia's communes, with state-appointed commune chiefs, have only ever been associated with controlling, regulating and recording the affairs of the commune. With decentralization, all of this is meant to change. State-appointed commune chiefs will be replaced with popularly elected commune councils, with between five and eleven councilors. While the communes will continue to have an important role as agents of the central government, their primary focus will become the development of the commune.

- the attempt to keep centrifugal forces at bay by forging asymmetrical federations and greater local autonomy, and

- the simple reality that central governments have often failed to provide effective public services.

Political pressure drives unarguably most decentralization efforts (Boxes 9.4f to i). But whatever its origins, decentralization can have significant reflection for resource mobilization and allocation and ultimately also for macroeconomic stability, service delivery and equity. Thus decentralization can greatly affect economic development and poverty reduction (Litvack et al. 1998).

Decentralization indicators

As the concept of decentralization has several meanings depending on the context, there are many indicators, which do not always give the same impression of a country's level of decentralization. The World Bank (2001c) keeps collecting a broad list of indicators to its web pages. Dozens of indicators are included, but the data typically has a poor geographic representation to allow any broader comparisons.

An example of these indicators—the share of subnational revenues of total revenues within a country—is given in Figure 9.4a. The higher the share, the less centralized the country is. Now, the size of a country introduces an obvious bias to this indicator: the smaller the country is the lower the share tends to be.

One interesting source of information among the many available is the UN Bureau Economic and Social Affairs. In its analysis of national population policies (UN 2001), several indicators on spatial distribution of population are included. Without a thorough scrutiny of those indicators among the study region countries, the most important of them are presented in Figure 9.4b.

Case studies from study regions

Due to the enormous size of the study area (China, S Asia, SE Asia, the Nile Basin and W Africa), the phase and pace of decentralization process as well as the way decentralization is actually implemented differ hugely among the countries. This has, of course, close connection to the fact that also the quality and type of the government differ considerably – some governments are more undemocratic, ineffective and corrupted than others (Treisman 2000).

Moreover, since there does not exist easily adaptable and extensive statistical data of decentralization and its different indicators from the whole study area, the overview of decentralization is presented through various examples and case studies. Although presenting just situation in their own country, these examples include at least one country from each study region (Boxes 9.4a to i).

It must be emphasized that all these examples are based on information and, more significantly, interpretation of the source presented at the beginning of each example. The difficulty to measure the real influence and success of decentralization can be understood from the examples of decentralization in Côte d'Ivoire (Box 9.4i).

Epilogue – what did we learn?

Decentralization covers a variety of concepts, which must be carefully analyzed before determining if projects should support reorganization of financial, administrative and political systems. Its different forms and types should be well distinguished since they often have different characteristics, policy implications and conditions for success (World Bank 2002b).

Under appropriate conditions all forms of decentralization can help broaden participation in political, Box 9.4g

Decentralization in India – a decentralizing federation

After World Bank (2000).

India has a federal constitution that gives its states substantial fiscal and regulatory powers. But three elements undercut those powers. First, the constitution has also strong unitary features, enabling the central government to dissolve state governments and take over their administration. Second, central planning—which until recently governed India's economy—blunted the economic powers of states. Third, national parties traditionally dominated subnational politics. Thus state budgetary outcomes were the result of centrally defined development policies and, in practice, state-level regulatory powers had little meaning.

The relative centralization of India's federalism is changing, however. The gradual weakening of central planning and the growing strength of regional parties in national coalition governments are strengthening state governments and allowing them a larger role in defining their development priorities. But most states are having difficulties growing into their new role. Many are saddled with excessive debt and unsustainable wage and pension bills and have few incentives to mobilize their own resources. A few states, including Andhra Pradesh, Uttar Pradesh, Orissa, and Haryana, are improving their financial situation and are making increasing use of the powers constitutionally granted to them.

The trend toward greater decentralization in India was reinforced in 1992 by the passage of the 73^{rd} and 74^{th} Amendments, which offered constitutional recognition to local governments. Until then, the constitution had made no mention of local governments, which were effectively creatures of the states. States were not under any obligation to hold regular local elections, and state-run agencies controlled most local functions, including urban planning and local infrastructure. Under the amendments states continue to define local governments' powers and resources and name their chief executive officers. They also retain the power of supersession—that is, the right to dissolve a local government and take over its powers. However, the amendments suggest a list of local responsibilities for inclusion in state constitutions and call for the creation of state-level financial commissions to oversee fiscal relations between states and local governments. Most important, states are required to hold elections within six months of superseding a local government.

Implementing the Amendments has been slow, yet some states progress more than others. With one exception, all states have held local elections and are observing the supersession rule. The proposed local functions are now part of most states' legislation, and a number of states have set up finance commissions that have submitted recommendations. However, state governments have been slow to implement these recommendations and to enable local bodies to execute the newly devolved functions. Recent assessments show that Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, and West Bengal have made the most progress in devolving powers to local governments.

Box 9.4h

Decentralization in Senegal – development from the grassroots level

After Africa Recovery (2001), Farvacque-Vitkovic (2000), UNCDF (2001), and ARD (2001).

Senegal is no stranger to decentralization. Since the independence in 1960, Senegal has been pursuing a policy of gradual but prudent decentralization. These different decentralization initiatives have had very mixed results. Elected municipal councils were first introduced under the colonial rule, and then developed further after independence. During the initial phase of decentralization in the early 1970s, the central government officially recognized the existence of local councils. However, no decisive action was taken to provide rural communities with the means and capacity to establish a true development policy, nor to develop competence in conducting and operating a local administration. In March 1996, the Senegalese government further expanded its commitment to decentralization by legislating local government reform, which transferred several regulatory responsibilities to the local government units (LGUs).

These LGUs consisted of ten regions, forty-three urban subdivisions within the Dakar region, sixty communes representing larger towns and 320 rural communities. With promulgation of the 1996 code, these local jurisdictions obtained the authority to manage their affairs in nine areas, which were land tenure; environment and natural resources; health, population and social affairs; education; youth and sports; culture; urban planning and housing; land development, and development planning.

Later in the same year, local elections brought more than 14,000 local officials to office. But as in many countries undergoing decentralization, the process of reform faced numerous obstacles. It is claimed that the patronage politics made things just worse. Many of the posts of the forty-three urban subdivisions went to party loyalists who had failed to secure more prestigious positions in the national administration. A wave of scandals resulted, involving irregular housing allocations, embezzlement, favoritism and what a former housing minister referred to as a system of grand-scale, organized pillage. Public anger mounted, especially as conditions worsened for many ordinary Senegalese. Between 1992 and 1997, the percentage of urban households below the poverty line rose from 30% to 35%.

This disgruntlement helped Mr. Abdoulaye Wade win the March 2000 presidential election with the backing of a broad opposition coalition. Soon, many local mayors were dismissed as financial audits exposed more of their misdeeds. In July 2000 the new government simply dissolved the heavily indebted Communauté urbaine de Dakar, a super municipal structure that had included the capital and four adjoining municipalities. Since then, responsibility for water services, trash collection and other tasks has devolved to the local councils.

Senegal's new constitution –approved overwhelmingly by voters at the beginning of the year 2001- affirms that elected local government bodies will constitute the institutional framework for citizens' participation in the management of public affairs. Precisely how to do that has been a matter of some debate, however. Both the government of President Wade and the National Assembly, newly elected in late April 2001, are discussing various proposals to reform municipal and rural government.

The experiences on decentralization have varied significantly. In Rufisque-East, part of metropolitan Dakar, the municipal council has been relatively effective, steadily increasing its revenues from local taxes, fees and tariffs, in conjunction with a policy of actively encouraging community organizations to manage local projects. But in the southern town of Kolda, electrical power was cut off in January because the council could not pay its power bills. In Khombole, Dahra and many other municipalities, residents have staged public protests against serious mismanagement, shady real estate deals and corruption.

Before new municipal councils and mayors are elected in November 2001, the central government and legislature will seek further reforms. The overall goals will be to make the councils more transparent and responsive to citizens' concerns, limit the scope for corruption, bolster their revenues and give them greater spending authority. The ultimate aim, states former Minister of Decentralization Khady Fall Diallo, is to stimulate development at the grassroots.

Box 9.4i

Decentralization in Côte d'Ivoire – two different interpretations

The trouble in measuring objectively the advantages and disadvantages of decentralization can be understood from following examples from Côte d'Ivoire. The first example by Agrawal (1999) suggests that decentralization in Côte d'Ivoire is actually nothing more than a specific mode of the internal organization of a unitarian state. The second example by UNDP (1999) claims in contrast that of all the decentralization exercises that have been initiated in Francophone Africa, the most thoroughgoing and, by any measures, the most effective has been that of Côte d'Ivoire.

A critical view: the process has been formal with limited consequences

At the time of independence in 1971, the first president of Côte d'Ivoire, Felix Houphouet-Boigny, spoke of greater participation of the population in the management of local affairs. At this time, Côte d'Ivoire retained a highly centralized administration based on the model of the unitarian French state. In 1974 a public debate emerged on the issue, and several concrete legal steps were taken after 1978 to create municipalities. Laws over the next ten years created new municipalities with similar domains of competence. About 40% of the population, primarily those living in urban areas, are governed by local authorities. The rural population faces a different scenario. Despite a new law in 1995 stipulating the process necessary to create formal rural communities, no such communities have been created by 1996.

The process of decentralization in Côte d'Ivoire can be characterized as top-down, authoritarian and largely formal. Used as a means to reduce the tasks of the central bureaucracy, its essentially administrative character was aided both by the French tradition of centralistic bureaucratic administration and by the authoritarian nature of Houphouet-Boigny's rule. The Ivorian state was described as an administrative-technical agency devoid of structures of representation and participation. Where the central state attempted to involve urban elites, it was to leverage of their in the higher echelons of the party and the administration.

In the wake of the fiscal crisis of the state in the 1980s when the Ivorian economy entered a long-lasting period of severe decline, it became harder for the state to meet the demands of internal and external creditors and of various political constituencies, including local populations. The tentative and faltering steps toward decentralization were attempts to alleviate the burden of central state, but ultimately had little effect since the procedures necessary for municipalities to have significant powers and resources were cumbersome and stringent. Systematically subjected to the central state which interferes in all realms of local competence, possessing few legislative powers, less assistance from the government, and no sources from which revenues can be raised autonomously, municipalities have been hobbled from the very beginning. Local elections in 1996 were manipulated in ways that ensured a landslide victory for the ruling party (154 out of 195 municipalities).

Decentralization in Côte d'Ivoire suffers from the lack of any autonomous political institutions in rural areas where the Prefect exercises an almost absolute control over local affairs. Municipalities in urban areas as well are dominated by central institutions. As a result, despite much talk of decentralization during elections, no significant changes are visible. Nor are there steps toward the creation of any regional political and administrative structures from which office-holders could exercise authority. The fear of losing political control over parts of the country to opposition parties seems to be the major brake on regional development toward some autonomy. For all these reasons, decentralization in Côte d'Ivoire is scarcely more than a specific mode of the internal organization of the unitarian state.

A positive view: decentralization has been a successful political and legal reform

Of all the decentralization exercises that have been initiated in Francophone Africa, the most thoroughgoing and, by any measures, the most effective has been that of Côte d'Ivoire. The initiative began in 1977, when a law was passed in National Assembly confirming the establishment of the two existing "full exercise" communes (Abidjan and Bouaké). Then following the 7th Congress of the country's governing party - the PDCI - in 1980, three major laws dealing with powers and regulations were passed. These laws form the basis of the country's municipal legal frameworks. In 1985, ninety-eight new communes were added to the list of local authorities, for a total of 135, plus the city of Abidjan. The communalization movement was to be extended in 1990 with the opening of a large number of rural communes. Although the groundwork for this initiative was completed, the decision was deferred as a result of economic crisis in the country. Thus, today, Côte d'Ivoire has two levels of decentralization: the commune and the metropolitan levels, with 3,900 elected councilors, 135 mayors, and 423 assistant mayors.

The novelty of decentralization in Côte d'Ivoire lies in the fact that it was introduced without a lot of fanfare. Furthermore, its implementation was not entrusted to a specific structure but rather to a department in the central administration under the control of the ministry of interior. The position of this ministry in the administration hierarchy, enhanced by the personality of its two recent ministers, has managed to transform an institutional framework that was at first perceived as a political handicap, into an advantage. The small local government department (within the ministry of interior) of the late 1970s had become, by 1991, a major department with two important services and six deputy directors.

The decentralization process was supported by the international donor community, particularly USAID, which helped support a training program in financial and technical management, the World Bank, UNDP, and the ILO. In close co-operation and co-ordination, the last three organizations supported a program for capacity development that was focused on management techniques. The program includes an initiative for establishing a funding facility for local governments.

According to most observers, the decentralization exercise in Côte d'Ivoire has on balance been a positive experience. On the one hand, more explicit transfers of power need to be made between the central and local authorities, and more resources need to be given to the communes in the form of personnel and taxation power for them to manage their own affairs. But on the other hand, the critical role of the communes in the daily life of the citizens is becoming increasingly evident. In addition to administrative responsibilities transferred by the central government, other functions exercised by the communes include the maintenance of the civil registry, military bureau, census and public security. Communes are also active in the creation and maintenance of educational infrastructure (both primary and secondary), the maintenance of urban roads, the building of markets, public water taps and latrines, and the removal of household waste. They develop and manage residential and industrial subdivisions. All these services bring satisfaction to the people, who turn increasingly to the communes for their needs.

economic and social activities. These different concepts also overlap considerably. Political, administrative and fiscal decentralization can appear in different forms and combinations across countries, within countries and even within sectors. But all in all, precise definitions are naturally less important than ensuring a comprehensive and functional approach for decentralization (Litvack and Seddon 1999).

Experiences with decentralization are mixed: decentralization does not necessarily promote allocative efficiency or even improve democratization and people's participation. Also, theoretical predictions on decentralization suggest that only certain forms and types of decentralization work. Even so, to debate whether decentralization is good or bad is unproductive and misleading since its impact depends greatly on its design. Yet it is essential to consider the wide range of issues that influence decentralization. The traditional fiscal federalism approach might be a starting point, but the need for a stronger focus on institutions—the rules that influence the behavior of actors at different levels of government and private sector as well as the implementing organizations—is increasingly evident (Litvack et al. 1998, IRIS 1999).

In general, decentralization is neither good nor bad. If designed and implemented well it can move decision making closer to people and improve governance, including also the efficiency of service delivery. However, this design is extremely complicated since it involves political, fiscal and administrative policies and institutions, which individually and interactively affect outcomes. Thus, if decentralization is not designed well, or introduced in certain types of environments, it can have remarkable negative impacts as well. The key challenge in successful decentralization is to balance responsibilities with accountability and resources (World Bank 2002b).

Figure 9.4a

An example decentralization indicator: The share of sub-national revenues of total revenues

Among the several dozens of statistical indicators on decentralization, the share of sub-national revenues of total government revenues is among the most used ones. Basically, the higher the value is, the more decentralized is the financial system of the country. The World Bank (2001b) database contains data for the study region countries indicated below. The cross-country differences are huge but not many clear temporal tendencies can be detected. For comparison, the index values for US, UK and Finland were 42%, 7.6% and 31%, respectively. Most African and SE Asian countries appear highly centralized, being at the same level as the UK. China, India and Pakistan are less centralized.

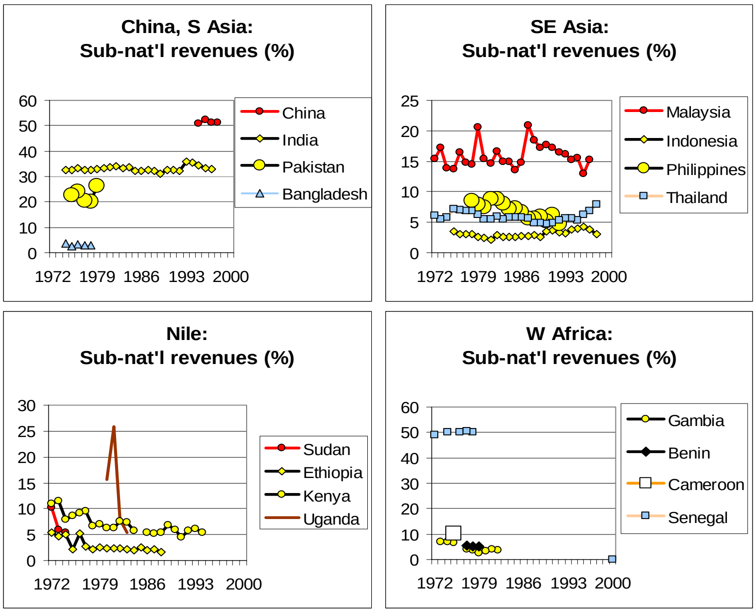


Figure 9.4b

A summary of policies related to spatial distribution of population in the Asian study regions

Most governments are concerned about the spatial distribution of the population in their countries and have implemented policies towards migration of people from rural to urban areas. Source: UN (2001).

China	1	2	3	4
A	~	~	~	~
B			+	+
C			+	+
D			\	\
E			+	.

Pakistan	1	2	3	4
A	+	+	.	.
B		+	.	.
C		.	.	.
D		\	\	\
E		\	\	\

India	1	2	3	4
A	+	~	+	+
B				+
C				+
D	\		\	\
E	\		\	\

Bangladesh	1	2	3	4
A	~	~	+	.
B		.	.	+
C		.	+	+
D		.	.	\
E		.	.	\

Nepal	1	2	3	4
A	+	+	+	.
B		+	+	.
C		.	+	.
D		.	\	
E		.	\	

Myanmar	1	2	3	4
A	~	~	.	.
B				.
C				.
D			.	.
E			.	.

Cambodia	1	2	3	4
A	+	+	+	+
B				
C				
D				
E				

Lao PDR	1	2	3	4
A	+	+	+	+
B				
C				
D				
E				

Vietnam	1	2	3	4
A	+	+	+	~
B			+	
C			+	
D			\	
E			\	

Singapore	1	2	3	4
A	.	.	.	.
B			.	.
C			.	.
D			.	.
E			.	.

Malaysia	1	2	3	4
A	~	~	~	~
B		+	+	+
C		+	+	+
D		\	\	\
E		.	\	\

Thailand	1	2	3	4
A	+	~	+	+
B		.		+
C		.		+
D		\	\	\
E		/	\	\

Philippines	1	2	3	4
A	+	+	+	+
B		+		+
C		+	+	+
D	\	\	\	\
E	\	.	\	\

Indonesia	1	2	3	4
A	+	+	+	+
B			+	+
C			+	+
D			\	\
E			\	\

	Legends	Years of evaluation: 1 = 1976, 2 = 1986, 3 = 1996, 4 = 2001	
	Variable	Possible outcomes	
A	Government's view on spatial distribution	. satisfactory, no intervention, or maintain	
B	Changes in population distribution between regions	Grey shading: missing	+ yes
C	Changes in population distribution between rural and urban places	data	~ minor change desired
D	Government policy towards migration into metropolitan areas		+ major change desired
E	Government policy towards migration from rural areas to other locations	/ raise	\ lower

Figure 9.4c

A summary of policies related to spatial distribution of population in the African study regions

For legends and comment, see Figure 9.4b. Source: UN (2001)

Egypt	1	2	3	4
A	+	+	+	+
B		+	+	+
C		+	+	+
D	\	\	.	
E	.	\	.	

Sudan	1	2	3	4
A	+	+	+	+
B			+	
C			+	
D	\		\	
E	\		\	

Ethiopia	1	2	3	4
A	+	~	+	+
B		.	.	.
C		.	.	.
D	.	.	.	.
E	\	.	.	.

Eritrea	1	2	3	4
A				+
B				
C				
D				
E				

Rwanda	1	2	3	4
A	+	+	+	+
B		.	.	
C		.	.	
D				
E	.	.	.	

Burundi	1	2	3	4
A	~	~	~	~
B		+	.	.
C		.	.	.
D	.		\	\
E	.	\	\	\

Uganda	1	2	3	4
A	~	~	~	~
B		.	.	
C		+	.	
D	\	.	\	
E	\	.	\	

Kenya	1	2	3	4
A	+	+	~	.
B				.
C			+	+
D	.		\	\
E	.		.	.

Tanzania	1	2	3	4
A	+	+	+	.
B		.	.	.
C		+	.	.
D	.	\	\	.
E	.	\	\	.

Mauritania	1	2	3	4
A	+	+	+	+
B		.	.	
C		+	.	
D		.	\	
E		.	.	

Mali	1	2	3	4
A	+	+	+	+
B		.	+	
C		.	+	
D		\	\	
E		\	\	

Burkina Faso	1	2	3	4
A	+	+	+	~
B		+	+	.
C		.	+	+
D	.	.	\	\
E	.	\	\	\

Niger	1	2	3	4
A	+	+	+	.
B			.	.
C			.	.
D	.		.	.
E	.		\	\

Chad	1	2	3	4
A	~	~	~	~
B				
C				
D	.			
E	.			

Senegal	1	2	3	4
A	+	~	+	+
B		.	+	
C		+	+	
D	\	.	\	
E	\	.	\	

Gambia	1	2	3	4
A	~	+	+	+
B		.	+	
C		.	+	
D	\	.	\	
E	\	.	\	

Guinea-Bissau	1	2	3	4
A	+	~	+	+
B		.	.	
C		+	+	
D	\	\	\	
E	.	\	.	

Guinea	1	2	3	4
A	~	~	+	.
B			+	.
C			+	.
D			\	.
E			\	.

Sierra Leone	1	2	3	4
A	~	+	~	~
B		+	.	
C		.	+	
D	.	.	.	
E	.	.	.	

Liberia	1	2	3	4
A	+	~	+	+
B			+	
C			+	
D	.		\	
E	.		\	

Côte d'Ivoire	1	2	3	4
A	+	+	+	+
B		+		
C		+		
D	\	\		
E	\	\		

Ghana	1	2	3	4
A	+	+	~	+
B			+	+
C			+	+
D	\		\	\
E	\		\	\

Togo	1	2	3	4
A	+	+	+	+
B			+	
C			+	
D	.		.	
E	.		\	

Benin	1	2	3	4
A	+	+	+	+
B				
C			+	+
D	.		.	.
E	.		.	.

Nigeria	1	2	3	4
A	+	+	+	+
B				
C				
D				
E	.			

Cameroon	1	2	3	4
A	+	~	+	+
B		.	.	
C		+	.	
D	\	\	\	
E	\	\	.	

CAR	1	2	3	4
A	+	~	~	+
B		.	.	.
C		+	.	.
D	\	\	.	\
E	\	\	\	\

References to Section 9

Adams, A. 1997. *Social Impacts of an African Dam: Equity and Distributional Issues in the Senegal River Valley*. Prepared for Thematic Review I.1: Social Impacts of Large Dams Equity and Distributional Issues. World Commission on Dams (WCD), Cape Town. www.dams.org/docs/kbase/contrib/soc193.pdf (9.6.2006).

Adams, A. 1999. A Grassroots view of Senegal River development agencies: OMVS, SAED. Regional Consultations Africa / Middle East. WCD, Cape Town. www.dams.org/kbase/submissions/showsub.php?rec=soc094 (9.6.2006).

Agrawal, A. 1999. *Decentralization in Nepal*. ICS Press, Oakland.

Africa Recovery 2001. Senegal Experiments with Decentralization. *Africa Recovery* 15(1-2): 33. www.un.org/ecosocdev/geninfo/afrec/vol15no1/151city2.htm (11.5.2006).

Alexandratos, N. 1995. *World Agriculture: Towards 2010. An FAO Study*. Food and Agriculture Organization of the United Nations (FAO)/John Wiley & Sons Ltd, Chichester.

Alexandratos, N. 1998. World Food and Agriculture: the Outlook for the Medium and Longer Term. *Proceedings of the National Academy of Sciences of the United States of America* 96(11): 5908-5914.

ARD 2001. *Senegal: Decentralization and Local Governance*. ARD, Burlington. www.ardinc.com/projects/governance.php (16.5.2006).

Azfar, O., Kähkönen, S. & Meagher, P. 2001. *Conditions for Effective Decentralized Governance: A Synthesis of Research Findings*. IRIS Center, University of Maryland, College Park. www1.worldbank.org/publicsector/decentralization/synthesispaper.pdf (11.5.2006).

Botsford, L.W., Castilla, J.C. & Peterson, C.H. 1997. The management of Fisheries and Marine Ecosystems. *Science* 277(5325): 509-515.

Brummet, R.E. & Williams, M.J. 2000. The evolution of aquaculture in African rural and economic development. *Ecological Economics* 33(2): 193-203.

Burki, S.J., Perry, G.E. & Dillinger, W.D. 1999. *Beyond the Center: Decentralizing the State*. The International Bank for Reconstruction/The World Bank, Washington D.C.

CCC 2000. *NGO statement to the 2000 Consultative Group meeting in Cambodia*. Cooperation Committee for Cambodia (CCC), Phnom Penh. www.camnet.com.kh/ngoforum/ngo_statement_2000/commune_admin.htm (18.11.2001).

CCC 2001. *NGO statement to the 2001 Consultative Group meeting in Cambodia*. Cooperation Committee for Cambodia, Phnom Penh. www.bigpond.com.kh/users/ngoforum/cg2001/commune_admin.htm (18.11.2001).

Chambers, R. 1988. *Managing Canal Irrigation. Practical Analysis from South Asia*. Cambridge University Press, New York.

Colombel, Y. 1998. *L´agriculture dans le monde*. Armand Colin/Masson, Paris.

De Janvry, A. 1981. The Role of Land Reform in Economic Development: Policies and Politics. *American Journal of Agricultural Economics,* 63(2): 384-392.

De Jong, K., Loquai, C. & Soiri, I. 1999. *Decentralization and poverty reduction – exploring the linkages*. IDS Policy Paper 1/99. University of Sussex, Brighton.

De Silva, S.S. 2003. Culture-based fisheries: an underutilized opportunity in aquaculture development. *Aquaculture* 221(1-4): 221-243.

Dixon, C. 1990. *Rural Development in the Third World*. Routledge, New York.

Douglas, M. 1983. The Korean Saemaul Undong: accelerated rural development in an open society. In Lea, D.A.M. & Chaudhri, D.P. (Eds.): *Rural Development and the State*. Methuen, London.

EC 2000. *EC Policy and Approach to Rural Development. Fighting Rural Poverty*. 15 June 2000. DG Development – Rural Development and Food Security, Brussels. http://ec.europa.eu/comm/development/body/theme/rurpol/outputs/fightingruralpoverty/fightingruralpoverty_en.pdf (12.5.2006).

Economist 2001. *An Alarm Call for Latin America's Democrats*. 28 July 2001.

Eicher, C.K. & Staatz, J.M. (eds.). 1988. *Agricultural Development in the Third World*. Johns Hopkins University Press, London.

Engel, K.-H., Frenzel, Th. & Miller, A. 2002. Current and future benefits from the use of GM technology in food production. *Toxicology Letters* 127(1-3): 329-336.

Evenson, R.E. 2000. *Crop Genetic Improvement and Agricultural Production.* Paper presented in the CGIAR Mid-term meeting, 21-26 May 2000, Dresden.

FAO 1995. *Dimensions of need – An atlas of food and agriculture.* Food and Agriculture Organization of the United Nations (FAO), Rome.

FAO 1996. *Feeding the Cities, the Role of Urban Agriculture.* World Food Summit, Rome, 13-17 November 1996. FAO, Rome and United Nations Centre for Human Settlements (UNCHS), Nairobi.

FAO 1997a. *Irrigation potential in Africa: A basin approach.* FAO Land and Water Bulletin 4. FAO, Rome.

FAO 1997b. *FAO progress report*, June 1997. FAO, Rome.

FAO 2000a. *Crops and Drops: making the best use of water for agriculture.* FAO, Rome.

FAO 2000b. *FAOSTAT agriculture database.* FAO, Rome. http://faostat.fao.org/ (12.5.2006).

FAO 2000c. *The state of world fisheries and aquaculture.* FAO, Rome.

FAO 2001. *A History of Decentralization.* CIESIN Online Sourcebook on Decentralization and Local Development. Columbia University, New York. www.ciesin.org/decentralization/English/General/history_fao.html (11.5.2006).

FAO 2002a. *The State of Food Insecurity in the World 2002.* FAO, Rome.

FAO 2002b. *FISHSTAT plus Database (online).* FAO, Rome. www.fao.org/fi/statist/FISOFT/FISHPLUS.asp (11.5.2006).

FAO 2002c. *FAOSTAT Statistical databases (online).* FAO, Rome. http://faostat.fao.org/ (12.5.2006).

FAO 2002d. *World agriculture: towards 2015/2030. Summary report.* FAO, Rome.

Farvacque-Vitkovic, G. 2000. *The Future of African Cities: Challenges and priorities for Future Development*. The World Bank, Washington D.C. www.worldbank.org/afr/findings/english/find162.htm (12.5.2006).

Fischer, G., Shah, M., van Velthuizen, H. & Nachtergaele, F.O. 2001. *Global Agro-ecological Assessment for Agriculture in the 21st Century.* International Institute for Applied Systems Analysis (IIASA) and Food and Agriculture Organization of the United Nations (FAO), Vienna.

Gabriel, T. 1991. *The Human Factor in Rural Development.* Belhaven Press, London/New York.

Gregory, P.J., Ingram, J.S.I., Andersson, R., Betts, R.A., Brovkin, V., Chase, T.N., Grace, P.R., Gray, A.J., Hamilton, N., Hardy, T.B., Howden, S.M., Jenkins, A., Meybeck, M., Olsson, M., Ortiz-Monasterio, I., Palm, C.A., Payn, T.W., Rummukainen, M., Schultze, R.E., Thiem, M., Valentin, C. & Wilkinson, M.J. 2002. Environmental consequences of alternative practices for intensifying crop production. *Agriculture, Ecosystems & Environment* 88(3): 279-290.

Griffin, K. 1974. *The Political Economy of Agrarian Change*. MacMillan, London.

Griffin, K., Khan, A.R. & Ickowitz, A. 2002. Poverty and the Distribution of Land. *Journal of Agrarian Change* 2(3): 279-330.

Guerrero, R. 1999. *The aquatic resources research and development program of the Philippines.* In Gupta, M. & Macawaris-Ele, N. (Eds.): *Priorities in aquatic resources research in the Asia-Pacific region*. ICLARM Conf. Proc. 62. International Center for Living Aquatic Resources Management (ICLARM), Manila.

Hew, C.L & Fletcher, G.L. 2001. The role of aquatic biotechnology in aquaculture. *Aquaculture* 197(1-4): 191-204.

van Hofwegen, P. & Svendsen, M. 2000. *A Vision of Water for Food and Rural Development.* The 2nd World Water Forum, 17-22 March, The Hague.

Hulme, M. 1992. Rainfall changes in Africa: 1931-1960 to 1961-1990. *International Journal of Climatology* 12: 685-699.

Hulme, M., Zhao, Z.-C. & Jiang, T. 1994. Recent and future climate change in East Asia. *International Journal of Climatology* 14(6): 637-658.

Hunter, G. (Ed.) 1978. *Agricultural Development and the Rural Poor*. Overseas Development Institute (ODI), London.

ICARDA 2000. *Desertification, Poverty and Malnutrition Must be Defeated.* International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo. www.icarda.org/News/OldNews/25Ap00.html (11.5.2006).

ICLARM 1999a. *Priorities in aquatic resources research in the Asia-Pacific region.* ICLARM Conf. Proc. 62. International Center for Living Aquatic Resources Management (ICLARM), Manila.

ICLARM 1999b. *Aquatic Resources Research in Developing Countries: Data and Evaluation by Region and Resource System*. ICLARM Working Document 4. ICLARM, Manila.

IFPRI 1996. *Feeding the World, Preventing Poverty, and Protecting the Earth. A 2020 Vision.* International Food Policy Research Institute (IFPRI), Washington D.C.

IPCC (Intergovernmental Panel on Climate Change) 1998. *The Regional Impacts of Climate Change: An Assessment of Vulnerability.* A Special report of IPCC Working Group II. Cambridge University Press, Cambridge.

IRIS 1999. *Decentralization, Governance, and Delivery of Public Services: The Impact of Institutional Arrangements.* IRIS Center, University of Maryland, College Park. http://www1.worldbank.org/publicsector/decentralization/Workplan%2092999%20final.doc (11.5.2006).

IWMI 2000. World water supply and demand in 2025. In Rijsberman, F. (Ed.): *World Water Scenario Analyses.* Earthscan, London.

IWMI 2002. *Pesticide Use and Abuse in Irrigated Areas.* International Water Management Institute (IWMI), Colombo. www.cgiar.org/iwmi/health/pesticide/ (11.5.2006).

James, C. 2001. *Global Status of Commercialized Transgenic Crops: 2001.* ISAAA Briefs No. 24: Preview. International Service for the Acquisition of Agri-biotech Applications (ISAAA), Ithaca.

James, C. 2005. *Executive Summary of Global Status of Commercialized Biotech/GM Crops: 2005.* ISAAA Briefs No. 34. ISAAA, Ithaca.

Jazairy, I., Alamgir, M., Panuccio, T. 1992. *The State of the World Poverty: An Inquiry into its Causes and Consequences.* International Fund for Agricultural Development (IFAD), Rome.

Jiddawi, N.S. & Öhman, M.C. 2002. Marine Fisheries in Tanzania. *Ambio* 31(7-8): 518-527.

Kaczynski, V.M. & Fluharty, D.L. 2002. European policies in West Africa: who benefits from fisheries agreements? *Marine Policy* 26(2): 75-93.

Kropff, M.J., Bouma, J. & Jones, J.W. 2001. Systems approaches for the design of sustainable agro-ecosystems. *Agricultural Systems* 70(2): 369-393.

Lahtela, V. 2002. *Integrated Water Resources Management in West Africa – A Framework for Analysis*. Licentiate Thesis. Helsinki University of Technology, Espoo.

Lahtela, V. 2003. Managing the Senegal River—national and local development dilemma. *International Journal of Water Resources Development* 19(2): 279-293.

Lee-Smith, D., Manundu, M., Lamba, D. & Gathuru, P.K. 1987. *Urban food production and the cooking fuel situation in urban Kenya - National report: results of a 1985 national survey*. Mazingira Institute, Nairobi.

Lewis, D. 1997. Rethinking aquaculture for resource-poor farmers: perspectives from Bangladesh. *Food Policy* 22(6): 533-546.

Litvack, J., Junaid, A. & Bird, R. 1998. *Rethinking Decentralization in Developing Countries*. The World Bank, Washington D.C.

Litvack, J. & Seddon, J. (Eds.) 1999. *Decentralization Briefing Notes.* World Bank Institute Working Papers. The World Bank, Washington D.C. http://siteresources.worldbank.org/WBI/Resources/wbi37142.pdf (12.5.2006).

Liu, J. & Cai, Q. 1998. Integrated aquaculture in Chinese lakes and paddy fields. *Ecological Engineering* 11(1-4): 49-59.

Madamombe, I. 2005. Energy key to Africa's prosperity: Challenges in West Africa's quest for electricity. *Africa Renewal* 18(4): 6.

Meyer, D.M. 1998. *Decentralization – Fantasies, Failings, and Fundamentals.* NDMA Publishers, Ridgefield.

Molden, D., Rijsberman, F., Matsuno, Y. & Amarasinghe, U.A. 2001. *Increasing the productivity of water: A requirement for food and environmental security.* Dialogue Working Paper 1. Dialogue Secretariat, Colombo.

Myrdal, G. 1968. *Asian Drama*. Pantheon, New York.

Nafziger, E.W. 1997. *The Economics of Developing Countries*. 3rd Ed. Prentice-Hall, Upper Saddle River.

Neiland, A.E., Soley, N., Varley, J.B. & Whitmarsh, D.J. 2001. Shrimp aquaculture: economic perspectives for policy development. *Marine Policy* 25(4): 265-279.

Niasse, M., Iza, A., Garane, A. & Varis, O. (Eds.) 2004. *Water Governance in West Africa: Legal and Institutional Aspects*. International Union for the Conservation of the Nature (IUCN), Gland and Cambridge.

Niu, W.-Y. & Harris, W.M. 1996. China: the forecast of its environmental situation in the 21st Century. *Journal of Environmental Management* 47(2): 101-114.

Oerke, E.C., Dehne, H.W., Schönbeck, F. & Weber, A. 1994. *Crop Production and Crop Protection.Estimated Losses in Major Food and Cash Crops.* Elsevier, Amsterdam.

People's Daily 2001. *Cambodia Implements Further Administrative Reform: Senior Official.* 27 March 2001. http://english.people.com.cn/other/archive.html (16.5.2006).

Pickett, J. 1991. *Economic development in Ethiopia: Agriculture, the market and the state*. OECD, Paris.

Pike, J.G. 1995. Some aspects of irrigation system management in India. *Agricultural Water Management* 27(2): 95-104.

PNUD-OMVS 1974. *Programme intégré de développement du bassin du Sénégal*. 12 volumes. Norbert Beyrard, Paris.

Postel, S. 1992. *Last Oasis. Facing Water Scarcity.* W.W. Norton & Company, New York.

Prein, M. 2002. Integration of aquaculture into crop-animal systems in Asia. *Agricultural Systems* 71(1-2): 127-146.

Pretty, J.N., Morison, J.I.L. & Hine, R.E. 2003. Reducing food poverty by increasing agricultural sustainability in developing countries. *Agriculture, Ecosystems & Environment* 95(1): 217-234.

Rees, W.E. 1992. Ecological footprints and appropriated carrying capacity: what urban economics leaves out. *Environment and Urbanization* 4(2): 121-130.

Revenga, C., Brunner, J., Henninger, N., Kassem, K. & Payne, R. 2000. *Pilot Analysis of Global Ecosystems: Freshwater Systems.* World Resources Institute (WRI), Washington D.C.

Rosegrant, M.W., Paisner, M.S., Meijer, S. & Witcover, J. 2001. *2020 Global Food Outlook. Trends, Alternatives, and Choices.* International Food Policy Research Institute (IFPRI), Washington D.C.

Rossi, M. 2001. *Decentralization – initial experiences and expectations of the SDC.* Swiss Agency for Development Cooperation, Bern ./ CIESIN Online Sourcebook on Decentralization and Local Development. Columbia University, New York. www.ciesin.org/decentralization/English/General/SDC_Initial.html (12.5.2006).

Scudder, T. 1988. The African Experience with River Basin Development: Achievements to Date, the Role of Institutions, and Strategies for the Future. Institute for Development Anthropology, Binghampton.

Serageldin, I. 1999. Biotechnology and Food Security in the 21st Century. *Science* 285(5426): 387-389.

Seyoum, E.T., Battese, G.E. & Fleming, E.M. 1998. Technical effciency and productivity of maize producers in eastern Ethiopia: a study of farmers within and outside the Sasakawa-Global 2000 project. *Agricultural Economics* 19(3): 341-348.

Shah, T., Roy, A. D., Qureshi, A. S. & Wang, J. 2003. Sustaining Asia´s Groundwater Boom: An Overview of Issues and Evidence. *Natural Resources Forum* 27(2): 130-141.

Shepherd, A. 1998. *Sustainable Rural Development*. MacMillan Press Ltd., London.

Shiklomanov, L.A. 2000. World water resources and water use: Present assessment and outlook for 2025. In Rijsberman, F. (Ed.): *World water scenario analyses.* Earthscan Publications, London.

Singh, D.K. & Singh, A.K. 2002. Groundwater Situation in India: Problems and Perspective. *Water Resources Development* 18(4): 563-580.

Tilman, D. 1998. The greening of the green revolution. *Nature* 396(6708): 211-212.

Todaro, M. 1997. *Economic Development*. 6th Ed. Longman, London and New York.

Tovar, A., Moreno, C., Mánuel-Vez, M.P. & García-Vargas, M. 2000. Environmental Implications of Intensive Marine Aquaculture in Earthen Ponds. *Marine Pollution Bulletin* 40(11): 981-988.

Treisman, D. 2000. Decentralization and the Quality of Government. International Monetary Fund (IMF), Washington D.C. www.imf.org/external/pubs/ft/seminar/2000/fiscal/treisman.pdf (12.5.2006).

UN 2001. *National Population Policies.* United Nations Bureau of Economic and Social Affairs, New York.

UNCDF 2001. *UNDCF Projects in Senegal.* United Nations Capital Development Fund (UNCDF), New York. www.uncdf.org/projects/countries/sen.html (12.5.2006).

UNCHS (United Nations Centre for Human Settlements) 1996. *An Urbanizing World: Global Report on Human Settlements 1996.* Oxford University Press, Oxford/New York.

UNDP 1999. *Decentralized Governance Monograph: A Global Sampling of Experiences*. United Nations Development Programme (UNDP), New York. http://magnet.undp.org/Docs/dec/monograph/default.htm (12.5.2006).

UNESCAP 2000. *The Empowerment of the Rural Poor through Decentralization in Poverty Alleviation Actions*. United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Bangkok. www.unescap.org/56/e1172e.htm (12.5.2006).

Varis, O. & Fraboulet-Jussila, S. 2002. Water resources management in the lower Senegal River basin—conflicting interests, environmental concerns, and policy options. *International Journal of Water Resources Development* 18(2): 245-260.

Varis, O. & Lahtela, V. 2002. Integrated water resources management dilemma along the Senegal River – Introducing an analytical framework. *International Journal of Water Resources Development* 18(4): 501-521.

Verchot, L., Grace, P., Sanchez, P., Ingram, J., Palm, C., Wassman, R., Fisher, M., Thomas, R., Chandler, F., Bowen, W., Reid, R., Wopereis, M. & Waddington, S. 2001. The Last 50 Years: “The Green Revolution” and Net Greenhouse Gas Emissions. In: *Abstracts of Scientific Papers and Posters Presented at the Global Change Open Science Conference. Challenges of a Changing Earth*. Global Change Open Science Conference, 10-13 July 2001, Amsterdam.

Vitousek, P.M., Aber, J.D., Howarth, R.W., Likens, G.E., Matson, P.A., Schindler, D.W., Schlesinger, W.H. & Tilman, D.G. 1997. Human alteration of the global nitrogen cycle: sources and consequences. *Ecological Applications* 7(3): 737-750.

World Bank 1999. *World Development Indicators 1999 on CD-ROM*. The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2000. *Entering the 21st Century – World Development Report 1999/2000.* The World Bank, Washington D.C. www.worldbank.org/wdr/2000/fullreport.html (12.5.2006).

World Bank 2001a. *World Development Indicators 2001 on CD-ROM*. The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2001b. *Fiscal Decentralization Indicators.* The World Bank Group, Washington D.C. http://www1.worldbank.org/publicsector/decentralization/Indicators.xls (15.5.2006).

World Bank 2002a. *Decentralization Toolkit.* The World Bank, Washington D.C. http://www1.worldbank.org/publicsector/decentralization/toolkit9.doc (12.5.2006).

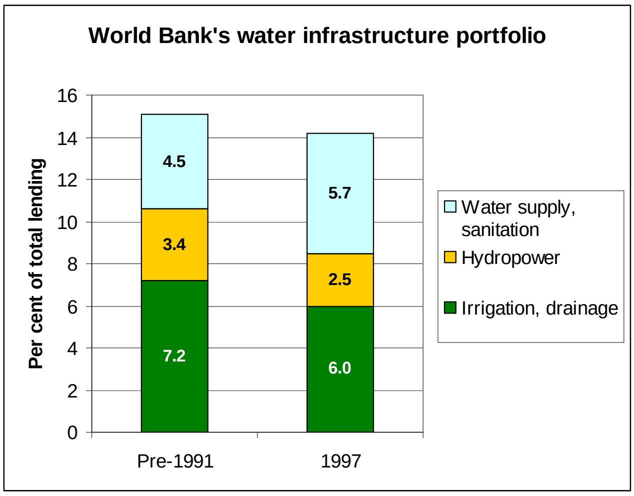
World Bank 2002b. *What is Decentralization?* CIESIN Online Sourcebook on Decentralization and Local Development. Columbia University, New York. www.ciesin.org/decentralization/English/General/Different_forms.html (12.5.2006).

World Bank 2004. *World Development Indicators 2004 on CD-ROM*. The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

10 POLICY TOOLS: WATER

Briscoe (1999) estimates, that the total annual spending of water-related infrastructure in developing countries amounts to US$ 65 billion (almost as much as W Africa's total GNP). Hydropower accounts US$ 15 billion of that, while water supply and sanitation US$ 25 billion, and irrigation and drainage US$ 25 billion. The World Bank's role is massive; its water infrastructure portfolio amounts to US$ 20 billion. This accounts for 15% of all loans of the bank (Figure 10). The volume of annual lending to the water sector is over US$ 3 billion.

Figure 10
Water infrastructure development receives 1/7 of World Bank's total lending
Source: Briscoe (1999).



Hydropower seems to be losing some of its attractiveness among lenders. This is obviously due to the rising concerns of environmental and social impacts of dam construction. The benefits of hydropower, however, should not be forgotten. Hydropower has very low emissions, and in long term, it is a very economic way of producing power.

Irrigation is also less in favor among lenders than before. This is partly caused by the same reasons as with hydropower: irrigation dams, canals, and so forth are not attractive targets for funding. The struggle is hard between the advocates of small-scale irrigation schemes—which is less visible and where modern technologies and private activities are playing an increasing role—and conventional, large-scale schemes, which are chiefly public works. Both are badly needed for increasing the food security in many parts of the world. The focus in the development of them both has already shifted from construction of new irrigation schemes to the worries of water saving, economic issues, and environmental concerns.

Water and sanitation receives gradually augmenting attention and funding. This is important, since the key role of appropriate water supply and sanitation to the well being of humans is unquestionable. Along with the enormous migrations of people from villages to towns and cities, the improvement water and sanitation services won't lose its importance.

10.1 Water storage and hydropower

Olli Varis

Dams are constructed to store water and to produce hydropower. Augmented storage capacity adds to the available water during dry periods, can be helpful in stabilizing water quality, and facilitates better control of floods. Navigation is often improved as well. Hydropower is an energy source with many benefits, such as low emissions, easy controllability and economic operation costs. On the other hand, dams, when blocking river valleys and fill them with water, cause wide-reaching environmental and social problems. The dilemma tends to be that those who benefit are different groups of people than those who lose.

Dams with a feeling

It is hard to imagine any aspect of water resources development, which would evoke as much emotions, public concern, and trouble to policy makers as dam and reservoir construction. Some want to store water, generate electricity, irrigate, or ameliorate living in other ways by constructing dams. Others are against because dams and reservoirs destruct valuable ecosystems, push people away from river valleys where they have dwelled over millennia, and so forth.

The starting point is that water is distributed unequally in time. Natural supply does not coincide with demand. This problem is distinctive in the study region countries, since the regions coincide almost exactly with the monsoon zone (Chapter 4.3), in which rainy seasons bring most of the annual rainfall in a few months, and the rest of the year is much dryer.

The floods of the rainy seasons are devastating in many places, and, on the other side of the coin, the dry seasons often culminate to droughts. Controlling and damping these variations which are harmful in many ways, accorded by the desire to develop hydropower and navigation, are typical arguments for constructing a dam.

Nothing comes for free. The concern of destroying invaluable cultural, human, and ecological assets has raised in the last few decades, and turned the public opinion very much against dam construction in most parts of the world.

Global overview of dam construction

Unfortunately to dam proponents and fortunately to dam opponents, this shift in values has taken place after a good deal of the good dam sites have been exploited in the industrialized countries, but not yet in many parts of the developing world. China, Egypt, India, Pakistan, Thailand, Indonesia, and some other study region countries have already been, however, active dam constructors. In contrary, SE Asia and Sub-Saharan Africa have very few dams in comparison to the rest of the world (Table 10.1).

Table 10.1
China has 46% of world's large dams
Constructed large dams in study region countries (source: WCD 2000).

Nile region (0.07%)	**35**	**China** (46%)	**22,000**
Egypt	6	**S Asia** (9.1%)	**4,366**
Ethiopia	8	Bangladesh	1
Kenya	14	India	4,291
Sudan	4	Nepal	3
Tanzania	2	Pakistan	71
Uganda	1	**SE Asia** (0.8%)	**385**
W Africa (0.2%)	**102**	Cambodia	2
Benin	2	Indonesia	96
Burkina Faso	8	Lao PDR	1
Cameroon	9	Malaysia	59
Côte d'Ivoire	22	Myanmar	5
Ghana	5	Philippines	15
Guinea	2	Thailand	204
Liberia	1	Vietnam	3
Mali	2	**Rest of Asia**	**4,589**
Nigeria	45	(9.6%)	
Senegal	2	***Asia total*** (65.5%)	
Sierra Leone	2	***Africa total*** (2.6%)	
Togo	2	***Rest of world***	**15,046**
Africa, rest (2.3%)	**1,132**	(31.9% of world total)	

China alone has an estimated 46% of all large dams of the world, which is 22,000. China's data, however, varies a lot between different sources. S Asia has

1/11, while SE Asia has only 1/125 of world's dams. Accordingly, it is not a surprise that SE Asia evokes plenty of emotions among conservationists and dam constructors alike. The African study regions have altogether 137 large dams—less than Austria—which is less than 0.3% of world's total figure. Africa has a few more dams than Spain (WCD 2000).

The world peak in dam construction was in the 1970s. The number of commissioned large dams was over 5,000 in a decade. This number has shrunk to slightly over 2,000 till the 1990s (Figure 10.1a).

The trend has had a similar pattern on all continents (WCD 2000). The timings of the peak and the consequent start of the decline differs though. In Europe, N America and Central America, it was in the 1960s, in Asia and S America, in the 1970s, and in Africa and Austral-Asia in the 1980s (Figure 10.1b).

Figure 10.1a
The peak of dam construction was in 1970s
Constructed large dams by decade in the world (source: WCD 2000) The data excludes over 90% of China's big dams.

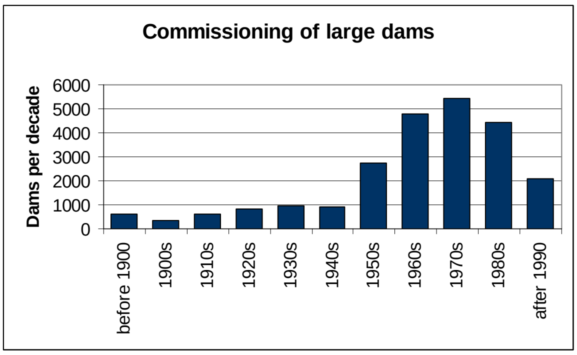
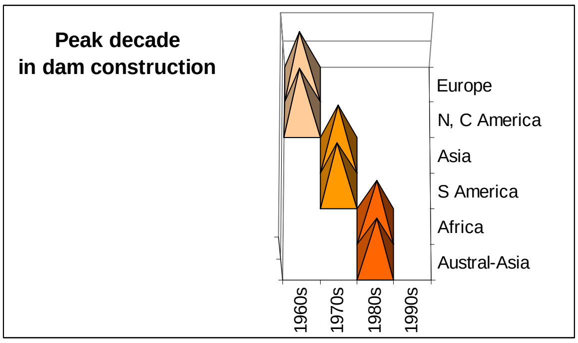


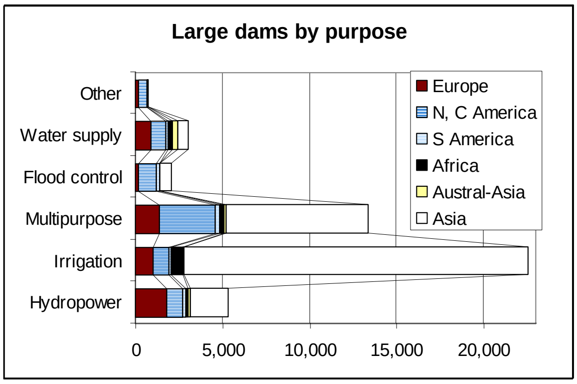
Figure 10.1b
The peak of dam construction by continent
Constructed large dams by decade in each continent (WCD 2000) The data excludes over 90% of China's big dams.



What comes to the purpose of large dams, irrigation has been the far most important, particularly in Asia (Figure 10.1c). Asia's irrigation and multipurpose dams account well above half of the world's high dams. Hydropower is particularly important in Europe.

India holds the pole position in the world in the number of dams under construction. In the different sources avalilable—documented by WCD (2000)—the number ranges between 695 and 960, of which sixteen will be over sixty meters high. China is third with 280 dams under construction, including ninety dams over sixty meters of height. In-between those two giants scores Japan. No other study region countries are on the WCD top twelve chart of dam construction.

Figure 10.1c
Asia has irrigation dams
Large dams by purpose in each continent (source: WCD 2000).



Reservoirs vs. natural retention capacity

The world's total number of reservoirs—big and small together—is close to 1 million (Golubev 1993). Large dams discussed thus far are only less than 5% of this number. The remaining 95% are small reservoirs, including small tanks, micro-storage facilities, and low dams. In addition, many natural lakes are used to store water for various purposes by active regulation of their water table, and aquifers are widely used for water storage. These storage types are less dramatic but equally important providers of water security.

From Figure 2.2c we obtain the following figures by Postel et al. (1996). The accessible river runoff to humans on this planet is 12,500 km^3, and the reservoirs contribute to 3,500 km^3 of this. Dam construction is estimated to add another 1,200 km^3 till the year 2025. The present reservoirs have elevated the secure water supply of the mankind by 28%, and this figure is expected to grow up to 34% by 2025.

The water renewal time of world's rivers has increased dramatically as a consequence of dam and reservoir consumption: from twenty to 100 days (Golubev 1993). The self-purification capacity of

Figure. 10.1d

Aging of river runoff due to impoundment: most important rivers of the study regions

Source: Vörösmarty et al. (1997).

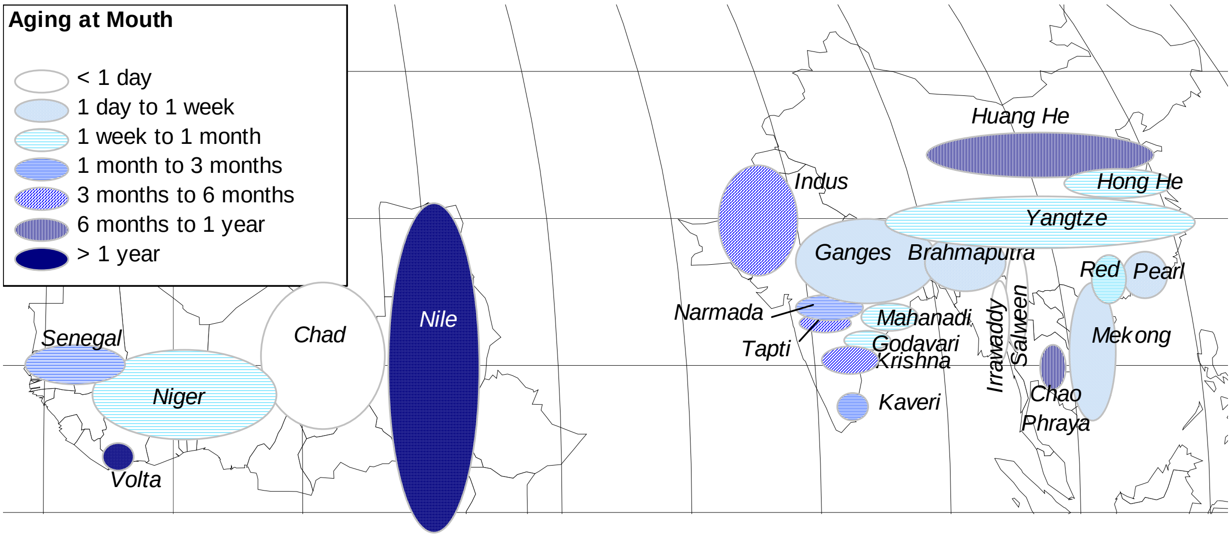
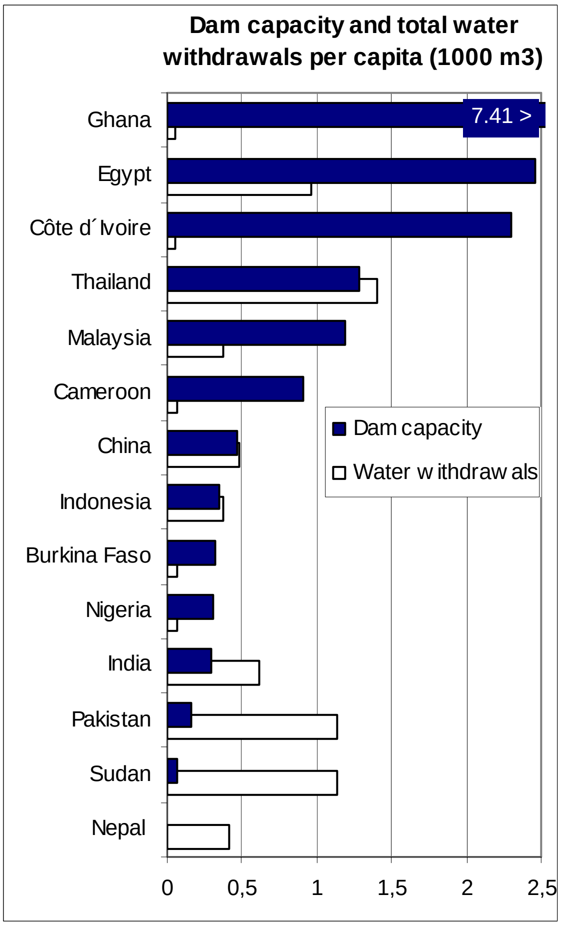


Figure 10.1e

Ghana leads in reservoir volume per capita

Total dam capacity calculated per capita in study region countries. For comparison, the annual freshwater withdrawals per capita are included. The countries with data available by ICOLD (2003) and FAO (2005) are shown.



rivers has decreased, yet more pronounced environmental consequences are due to the profound changes in the river's hydrology and ecology.

The most impacted rivers by dam construction within the study regions are the Nile and the Volta (Figures 10.1d and e). Their water exchange time has gone up by over a year. The Chao Phraya of Thailand and the Huang He of China travel six to twelve months longer to the sea than before. The Nile and the Huang He hardly bring water to the sea, and therefore, the calculations of exchange time are somewhat arbitrary. The Indus, Tapti, and Krishna are delayed with three to six months, and the Senegal, Narmada and Kaveri by one to three months. The other major rivers are less tapped. The low aging rates of African rivers (besides Volta and Nile) is partly due to the low run-off-rainfall ratios, typical to African rivers.

A notable threat to the sustainability of reservoirs is sedimentation. It is estimated, that 1% of the existing storage volume in the world is lost each year (Palmieri 1998). In twenty-five years, 1/4 is thus lost.

Dams for hydropower

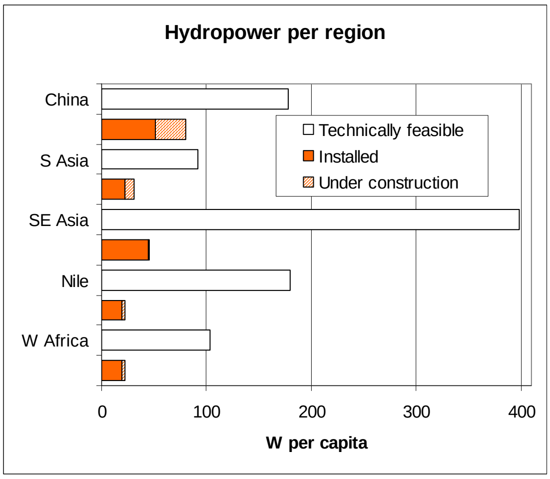
When comparing the hydropower generation potentials in the study regions (Figures 10.1f, g), SE Asia is far richer than the other regions. S Asia and W Africa are poorest in this respect. Therefore, SE Asia's hydropower development is discussed more thoroughly in this Chapter than that of the other regions.

China has a large hydropower potential of 219 GW, almost half of which is already constructed or under construction (Figure 10.1h). This figure is from the

World Atlas (1999). The figures differ, however, surprisingly much between different sources. According to Asian Development bank (ADB 2000): *"The PRC has the largest estimated exploitable power potential in the world: 378.5 GW of which 60.0 GW (15%) had been developed by 1997. The major exploitable potential is in the Yangtze basin (197 GW or 52% of the total) and in the southwest river basins (23%)."*

The major untapped potential is in the Yangtze basin. S Asia's potential is far smaller, 113 GW, and very close to SE Asia's figure. This makes S Asia essentially poorer in hydropower potential than the other regions. W Africa is not far better off, though.

Figure 10.1f
SE Asia has the largest hydro potential
Technically feasible hydropower generation potential, installed capacity, and capacity under construction by region (source: World Atlas 1999).



China's intentions in many of the international basins that originate from the Chinese territory are somewhat obscure these days. Particularly interesting are the rumors of plans for a 50,000 MW hydropower plant to Brahmaputra. A tunnel across the bend that flows around the Namcha Barwa Mountain would allow the construction of this huge plant. The disputed borders of India and China in this region add to the political sensitivity of the issue.

In the Nile Basin, Ethiopia's hydro potential is notable. However, its dam construction is hindered by the Nile Water Treaty, which does not allow Ethiopia to change its stream flows. Ethiopia has historically been excluded from this treaty of British colonial origin, which divides the Nile's waters between Egypt and the Sudan.

SE Asia's power play

Along with the rapid urbanization and industrialization in the region, the contemporary, tolerable water confrontations are expected to grow relatively fast. In addition to Thailand, the most prone countries to water problems are the crowded parts of Indonesia, particularly the island of Java, the Philippines, and Vietnam.

The most important regional issue with respect to insite uses is hydropower production. Along with agricultural intensification and irrigation growth—relying on dam construction—energy demand expands in this urbanizing and industrializing region. In energy production, priority is given to hydropower development (Japan Ministry of Foreign Affairs 1997).

Figure. 10.1g
The most important study countries with respect to technically feasible hydropower potential
China's potential is 219 GW. For comparison, USA's potential is 60 GW, Japan's is 15 GW, and Finland's 2 GW (source: World Atlas 1999).

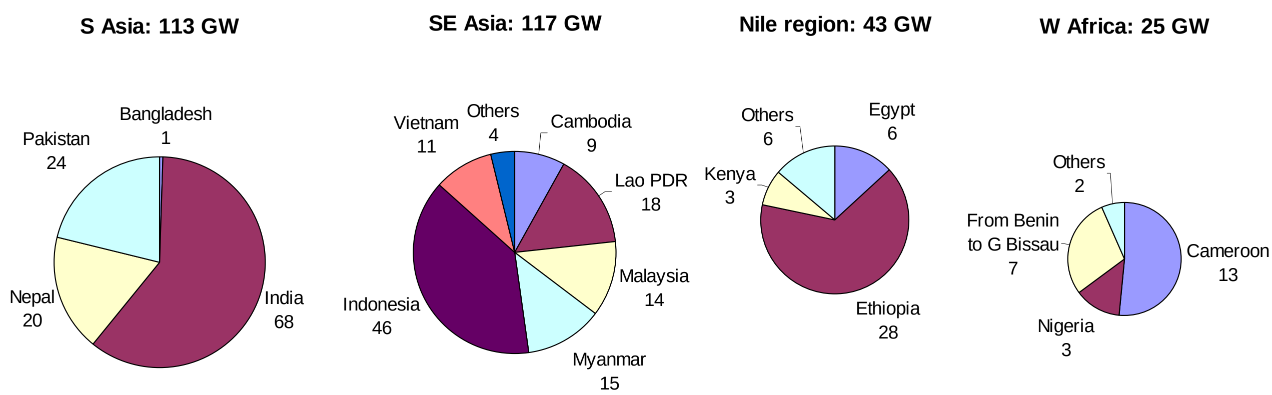
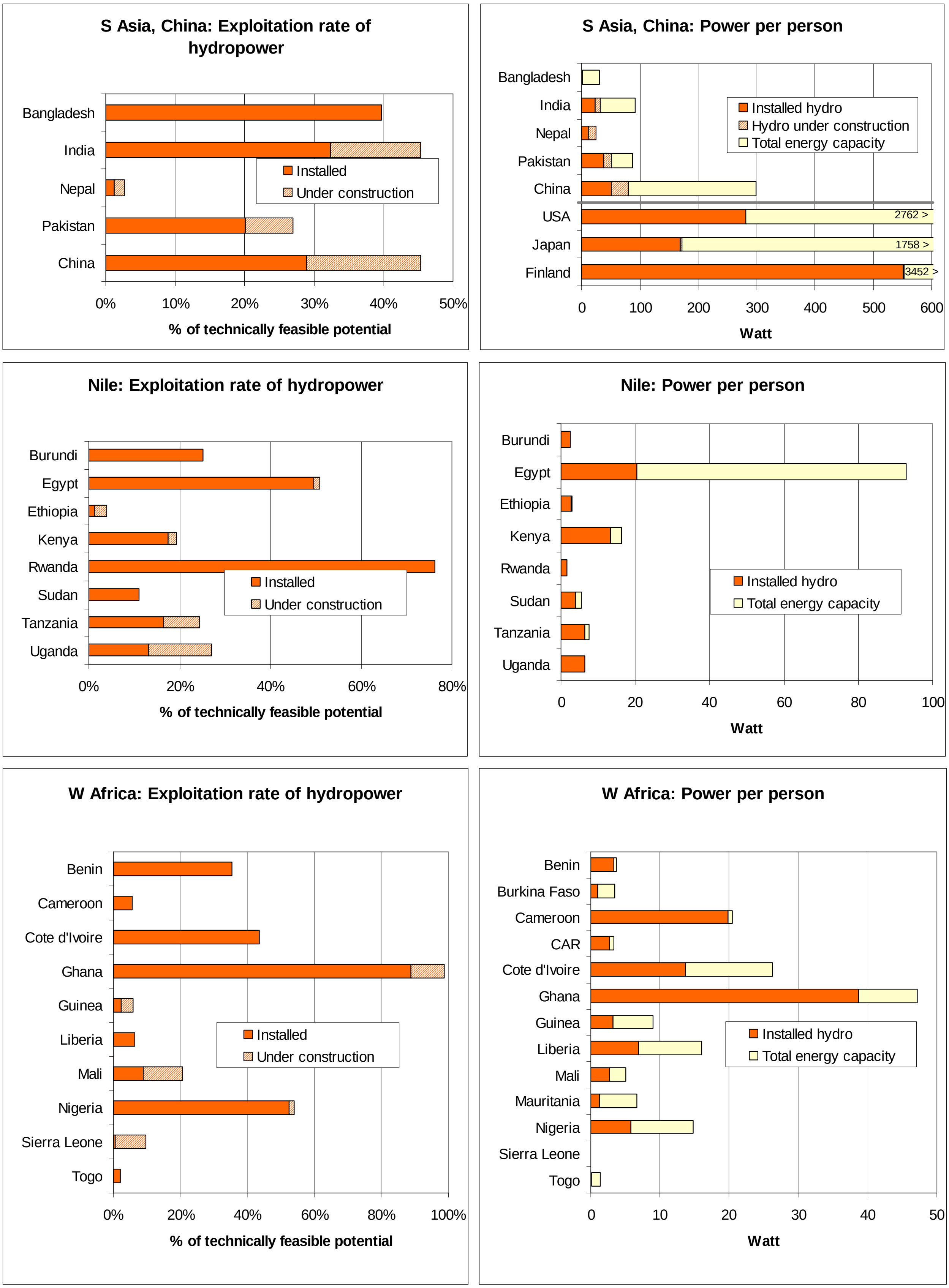


Figure 10.1h

Ghana holds the pole in hydropower

Installed hydropower generation capacity, and capacity under construction in China, S Asia, Nile Region and W Africa. Power generation per capita is shown in the lower diagram (source: World Atlas 1999).



Mekong River serves as a good example of the region in this respect. It is the largest and internationally most complicated river of the region. It houses 60 million people in its basin of 795,000 km^2. It brings annually 500 km^3 of water to the South China Sea. A simple calculation reveals that on average, each person in the basin has over 8,000 m^3 of water per year. Certain emphasis is given to the Mekong basin in the following analyses.

Plans to develop Mekong's hydropower go back for decades. In the late 1950s, the newly established Mekong Commission carried out surveys and studies in the Mekong region, and released a plan of constructing about 100 dams in the basin (Mekong Committee 1970, Lohman 1991). Dams were seen as a universal solution in combating the region's underdevelopment (Lacroze 1998). The model behind this approach was adopted from the famous Tennessee River development scheme.

First wars, political tensions, trade embargos, and then the growing resistance of conservationists and other NGOs have disabled the realization of the plan. At present, only ~1% of the hydropower potential of Mekong's lower reaches have been constructed. This potential is 40,000 MW, which equals the installed hydropower capacity of the Russian Federation.

Three of other major rivers, Irrawaddy, Salween, and Song Hong (Red River) are still less constructed.

The present level of electrification is 4-11% in Indochina, except Thailand, which is over 70% electrified (Figure 10.1i). Obviously, these countries would like to see infrastructure development and better energy supply.

Ironically, the greatest motor behind power development in the Greater Mekong Subregion (Myanmar, Laos, Thailand, Cambodia, Vietnam, and the Yunnan province of PR China) is the well-powered Thailand. This is because its energy potential is very low in comparison to its needs, and its neighbors. Therefore, it looks for neighbors in its power-thirst. The present plans of 2010 include import of 3000 MW from Laos, 3000 MW from China and 1500 MW from Myanmar (Pinkayan 1999). Laos plans to export another 1500 to 2000 MW to Vietnam by 2006.

These plans translate into a tenfold increase of the hydropower production of Lao PDR (Figure 10.1j). However, the power consumption of Laos will grow from the present one 60 W bulb per four people to a bulb per two till 2020. Thailand, in contrary, is expected to consume more electricity in 2020 than Japan or Singapore today. However, much suspicion concerning these growth rates exists.

Figure 10.1i

Low electrification but huge potential

Hydropower production potential, feasible resources, installed capacity, production, total power production, capacity under construction, and electrification rates (sources: Pante 1997, World Atlas 1999, World Bank 1999).

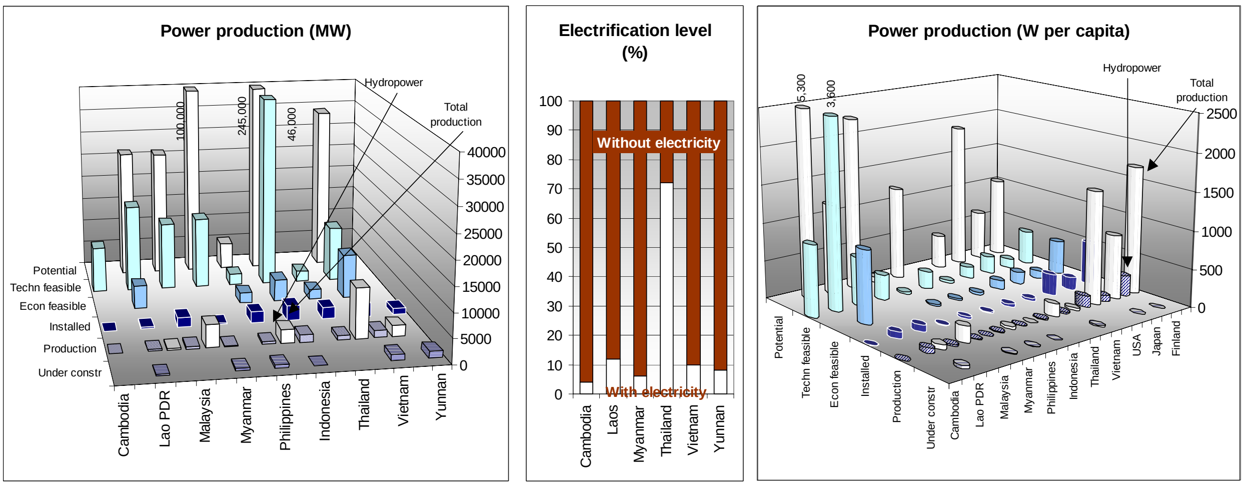
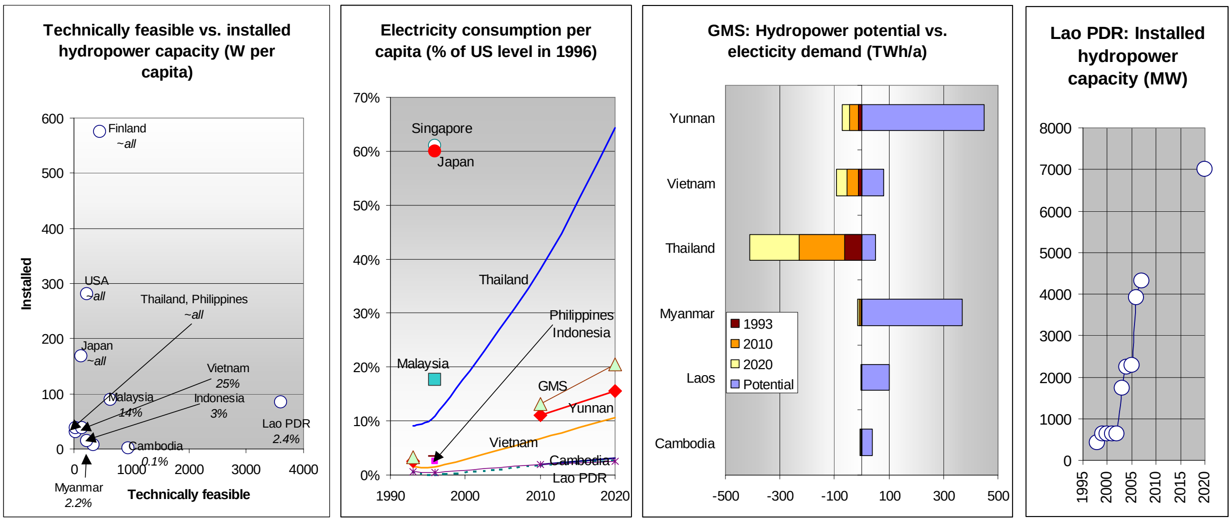


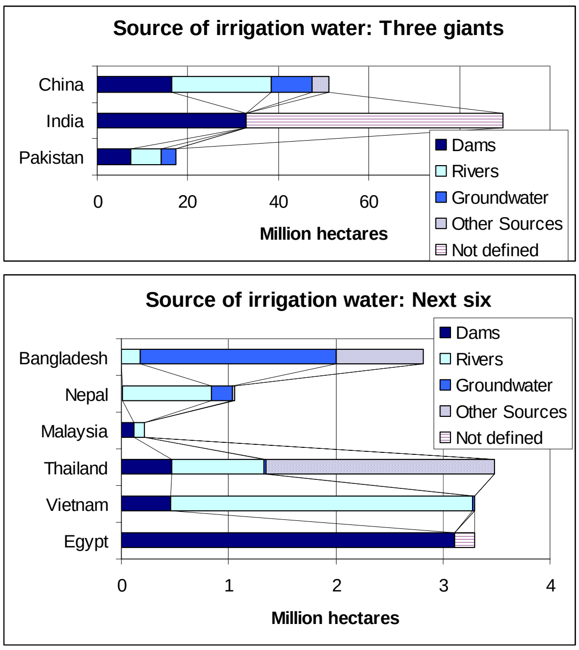
Figure 10.1j
The power play of the Greater Mekong Subregion (GMS)
Thailand has virtually no more hydropower potential, and it invests heavily to power plants in Lao PDR, Yunnan and Myanmar. A great part of the energy produced in the future power stations will be exported to Thailand (sources: Japan Ministry of Foreign Affairs 1997, Pante 1997, World Atlas 1999, World Bank 1999).



Dams for agriculture

It is important to recall from Chapter 9.1 that feeding of growing population on this planet will require the augmentation of 15 to 20% in agricultural water use (van Hofwegen and Svendsen 2000). Much of this will be managed by reservoirs.

Figure 10.1k
Source of irrigation water
Selected, important irrigation countries in the study regions (source: Sanmuganathan 2000).



Today, 20% of world's agricultural land is irrigated, and that area produces 40% of world's agricultural production (Sanmuganathan 2000). The growth of irrigated area has stabilized to the level of 1.3% per year.

Every second large dam has been constructed solely or primarily for the purpose of supplying water for agriculture (WCD 2000). These provide 30 to 40% of all irrigation water. In the study countries, the role of large dams in food production is most important in India, China, Pakistan, Egypt, Vietnam, and Thailand (Figure 10.1k). India's irrigated area is 33% of world's total, while China's and Pakistan's shares are 19% and 6.5%.

Dams for other purposes

Water supply of human settlements, particularly large cities is an important motivation for constructing storage capacity by dams and reservoirs. Globally, about 12% of large dams are primarily for this purpose. In Africa, their share amounts to 20%, whereas in Asia, only to 2% of all large dams (WCD 2000). Reservoirs remain a feasible option for securing water supply for rapidly growing cities for Africa and Asia.

Flood control is one of the major functions of dams. Flood waters are stored in a reservoir, and then utilized in the dry season. This function is particularly important in regions where seasonal variations in runoff are strongest. The study regions—as they lie in the monsoon zone (Chapter 4.3)—are therefore areas with natural proneness to floods and droughts (Box 10.1a).

Box 10.1a

Are floods growing?

News on flood disasters seem to grow more and more frequent and dramatic. Many ask if floods are now bigger than they were before. In many cases they are, but also rivers in which floods have decreased are many. Climatic factors have caused many of these shifts but more important are man-induced changes in watersheds. What has undisputedly occurred is the increase in flood damage. Massive urbanization, particularly in Asia and Africa pushes people to rivers and deltas where they are vulnerable to inundations.

Are there more floods now than before? A simple question but the answer is complicated. Perhaps we should view the situation from back to forth—by starting from the damage that the floods have caused. Their growth is unambiguous and sharp.

After the IFRC (2002) 700 million people were affected by natural disasters during the 1970s. In the 1990s the figure had stepped up close to two billions. The figure keeps growing. The share of floods of these disasters is reasonable—two thirds (Figures 10.1l and m). The property damage has been growing even more rapidly.

Even if an increasing number of individuals are exposed to floods the dead toll goes down. In the 1970s, almost two million people were killed by natural disasters, whereas this number went down to one-third of that in the 1990s. A natural disaster reported to IFRC kills thirteen times the number of people in low human development countries in comparison to what it does in high human development countries.

Figure 10.1l

Floods, droughts and other natural disasters in the world during 1992-2001

Source: IFRC (2002).

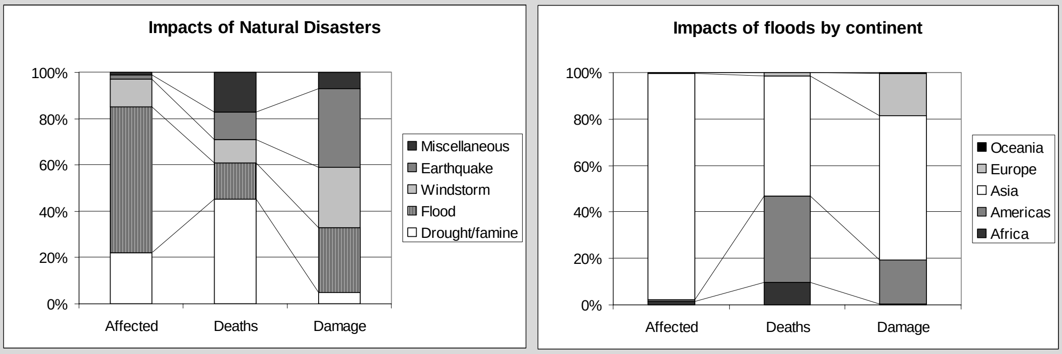
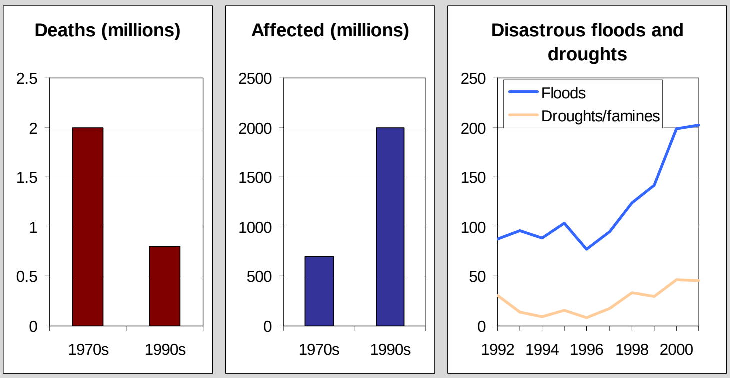


Figure 10.1m

Those impacted and those killed by floods

Left and middle: The number of people affected by floods is soaring but the death toll goes down. Right: The numbers of reported flood and drought disasters are in growth (IFRC 2002).



In the past ten years 3 million people have lost their lives in conflicts and other catastrophes. Conflicts kill three times the number of natural catastrophes. Floods kill around 10,000 humans per year. Droughts are responsible of around triple of this.

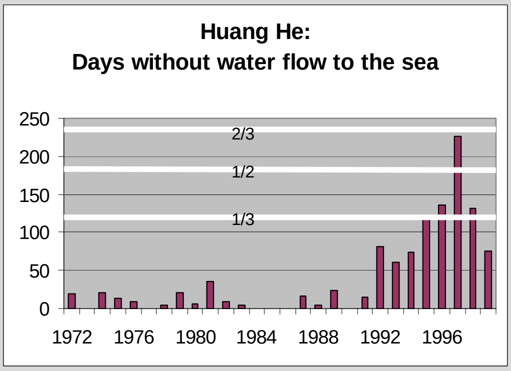
Catastrophic floods have grown. The number of flood catastrophes is towering (Figure 10.1m). This does not mean, however, that the floods would be bigger than before, they just tell that the damages are greater than they used to be. Often the flood damages have grown due to various reasons even though the floods wouldn't have been (Kundzewicz et al. 2001). Particularly in Asia, the massively inundating rivers attract more and more people. Most of the urbanization occurs today along rivers and deltas in Asia and Africa. The informal settlements of cities are particularly vulnerable. Many cities such as Bangkok subside due to overpumping of groundwater and overly heavy constructions.

Some rivers have greater, some smaller floods than before, and some even dry up. In many regions, inundations have grown. However, in perhaps almost equally many regions the floods have become smaller (IPCC 2001). In very dry regions such as Siberia and Northern Canada no remarkable trends have been detected in river flows. In large areas in Northern and eastern Europe as well as in Sub-Arctic Canada and even in California the spring floods seem to be decreasing whereas the river flows seem to grow in other seasons. This is caused by increased temperature—the snow accumulation has been smaller than before. In many parts of the US—such as the Mississippi Basin—the rainfall has grown and subsequently river flows and floods have grown as well.

Perhaps the most dramatic change in river flows has taken in many semi-deserted regions such as the Sahel in Africa and North China Plain; they have witnessed a drastic drop of runoff in their rivers (Figure 10.1n). In contrast, regions that are affected by a monsoon of a month or a few have many rivers that flood far more dramatically than before. Such rivers include Yangtze, Ganges-Brahmaputrra, and many others. Glacier melting has intensified, catchments have lost some of their natural retention capacity of water, and in some cases rains have grown. But, as been said, the people get packed close to these rivers and therefore the vulnerability of floods is the main issue that brings such floods increasingly into headlines.

Figure 10.1n

The Yellow River brings no water into the sea during several months in a year



On the top of climatic factors, various changes in the catchments that affect their water retention capacity, as well as those that have modified the river channel are the key to understanding the contemporary sensitivity of many rivers to flooding. The length of the Elbe has been cut by more than 100 kilometers in the past 150 years as a cause of various constructing activities. The forest cover has decreased sharply, and so has the area of wetlands. Consequently, heavy rains such as those in summer 2002 cause somewhat more inundation than they would have caused a century or more ago.

China's Yangtze is famous for its disastrous floods. The Chinese have collected records from Yangtze's floods over millennia, since the floods have been of primary importance to the country's well-being. Disaster frequency has gone notably up in the few past decades (Figure 5.3f). During the flood catastrophe of 1998, water level was higher than in 1954, although the rains were far heavier in 1954 than they were in 1998 (Yin and Li 2001). The reason to this is in human influence that has changed remarkably the catchment and the river channel:

- The vegetation loss in the upper parts of the catchment and the subsequent growth of erosion. The forest cover went to one half from 1957 to 1986, and erosion doubled. The rate of deforestation is now slower but still significant.
- The volume of the large lakes in the inner delta above Wuhan has shrunk to half. These lakes—the largest of them being Dongting and Poyang—together with the wetlands that have also now almost completely disappeared, used to hold reasonable amounts of flood water.
- Large levees have been constructed over the years along the middle and lower reaches of the river. They protect cities and fields from floods, but at the same time cut strongly the flood retention storage of the river valley. The sediments are no longer spread in fields but they have filled the lakes and block the river channel as well.

There are two ages-old approaches to flood management. Either to control the river flow, or to adapt to the river's rhythm is attempted. This is exactly the situation we are facing now as well.

Hydraulic constructions have been high on the list throughout centuries. The boom in the North was in the second and third quarter of the past Century. In most other parts of the world the rate of construction has also gone down, but a decade or two later than in the North (WCD 2000). The storage volume has been increased for various purposes that benefit from lower floods and higher low flows. Such purposes include irrigation, flood control and hydropower generation. Massive flood levees have also been constructed in innumerable rivers.

Asia is now the undisputed leader on this front. Particularly intensive and massive are the construction activities in S and SE Asia as well as in China. Asia already has 2/3 of the world's large dams, although ICID (2003) claims that the river development potential is only exploited to the level of 30-50%, and should be fully developed in order to successfully face the enormous future challenges of crowded parts of developing Asia. Hydropower, food security, and flood protection all need massive improvement.

Hydraulic constructions are definitely needed, but the focus in flood control and mitigation is shifting instead increasingly to so-called non-structural measures. The following approaches are particularly important (cf. Kundzewicz 2002):

- *Development of flood forecasting and warning systems, communication, and evacuation capability.* Weather forecasts get better all the time. They have improving links to hydrologic models and flood forecasts (Varis et al. 2004). Transboundary co-operation improves in most parts of the world. Also the wide audience gets better informed through TV and Internet. Together with these and other infrastructure developments, the evacuation systems are getting far better than they were only some years, not to talk about decades ago. The water levels of the Mekong, for instance, can be followed on-line through the web pages of the Mekong River Commission (MRC 2006). IFRC (2002) emphasizes the importance of communication and flood forecasts in bringing down the death toll of floods. In Bangladesh, the 1970 cyclone and flood killed half a million people. Today, these or even bigger figures might be true during bad storms and floods but the actual figures are smaller by several orders of magnitude.

- *Watershed management.* Reforestation, erosion control, rehabilitation of wetlands and meanders, and other such activities that increase the water retention capacity of the river basin. Europe's forested area is already increasing, and hydraulic engineering targets more and more on applying ecological principles. In the South, the forests are still disappearing in most areas. The attempts to control erosion and manage catchments are, however, in growth in many developing regions. Preventive care would be the most efficient one but the capabilities of governments are seldom sufficient or the prioritizations are elsewhere to achieve this (See Chapter 10.5).

- *Human resources development as well as insurance and compensation mechanisms.* Big leaps forward have been taken throughout the world by improvements in education, public awareness, emergency readiness and aid, and mechanisms of compensation and insurance. In this respect, the poorest countries and the poorest groupings of people are particularly disadvantaged and special social consideration is very important.

- *Control of habitation of inundated areas.* This alternative is far more difficult in practice than it is on paper. A reference is often made to the 20,000 people who were dislocated from Mississippi's floodplains. This number is, however, minor in comparison to the annual increase of the number of people that are packing to crowded river valleys and deltas which can be approximated to be 50 millions. On the top of that, the poverty problem with informal urban settlements concentrates rapidly in inundated areas.

The benefits of floods should be remembered. When talking about floods people too often forget that the inundations are the uttermost natural issue to the river basin, to which the ecology and traditional settlements have been adapted, and they depend largely on the annual hydrological cycle. Man-made reduction of floods by hydraulic constructions destroys or at least hampers this dependence. Besides to nature, this change can be particularly harmful to populations that live on subsistence farming, fishery, cattle breeding and so forth. Their customary skills and rights, as well as the whole livelihood are set under sledge that very often destroys them, and pushes those populations to real poverty. Equally problematic can be the growth of floods to nature and traditionally living people.

For instance, in the immediate surroundings of the Mekong Basin's largest lake, Tonle Sap, over a million people get their living from fishing and farming in the lake and its huge floodplain. Their average income is as low as US$ 0.4 a day keeping them well below the poverty limit. Now, any change in Mekong's flows and floods affect these people profoundly, and if deforestation, dam construction, or any other activity would change Mekong Basin's hydrology, the impact to these people would be large since they have not much capacity to change their way of living.

Yet, only 2% of Asia's and 1% of Africa's dams are primarily constructed for controlling floods. However, the flood protection function is almost always one of the secondary functions in any large dam, be it constructed for irrigation or hydropower. The world total figure for large dams with the primary function in flood control is as high as 13% (WCD 2000).

A strong tendency these days is to favor dams with multiple purposes. 26% of Asia's and 21% of Africa's dams bear this label.

Dams—good or bad?

It is too easy to criticize dam construction by highlighting only their adverse effects. Equally easy is to pledge the beneficial impacts of dams, and forget all the rest.

A dipole—strongly polarized—discussion has characterized the field over years and years. However, the gap seems to be narrowing, or at least some bridges have been constructed over it recently.

The World Commission on Dams has put forward the most important attempt in this direction by inviting many important proponents and opponent of dam construction to work together (WCD 2000). This attempt has been welcomed by many, on both sides alike. The process was initiated just for this purpose in 1997 by the World Bank and the International Union for the Conservation of the Nature (IUCN).

From the critics side, it is enough to mention that the International Rivers Network (IRN), IUCN and Narmada Bachao Andolan have reacted with positive remarks on the report and its critical appeal.

Some selected comments are collected in Box 10.1b. For this topic, see also the work of Kajander (2001).

Box 10.1b

Reactions against and for the construction of large dams

Selected responses to the report by the WCD on Dams and Development (WCD 2000), which has been considered as an important attempt to bring dam critics and proponents on the same table.

The critical IRN goes: *"The WCD's final report provides ample evidence that large dams have failed to produce as much electricity, provide as much water, or control as much flood damage as their backers claim. In addition, these massive projects regularly suffer huge cost-overruns and time delays. Furthermore, the report shows that:*

- *large dams have forced 40-80 million people from their homes and lands, with impacts including extreme economic hardship, community disintegration, and an increase in mental and physical health problems.*
- *indigenous, tribal, and peasant communities have been particularly hard hit. People living downstream of dams have also suffered from increased disease and the loss of natural resources upon which their livelihoods depended;*
- *large dams cause great environmental damage, including the extinction of many fish and other aquatic species, huge losses of forest, wetland and farmland; and*
- *the benefits of large dams have largely gone to the already well-off while poorer sectors of society have borne the costs.*

Based on these findings, the commission recommends that: *"no dam should be built without the agreement of the affected people; comprehensive and participatory assessments of the needs to be met, and alternatives for meeting these needs should be developed before proceeding with any new project; priority should be given to maximizing the efficiency of existing water and energy systems before building any new projects; periodic participatory reviews should be done for existing dams to assess such issues as dam safety, and possible decommissioning mechanisms should be developed to provide social reparations for those who are suffering the impacts of dams, and to restore damaged ecosystems."*

The WCD partner IUCN arguments by its Director-General Maritta Koch-Wieser: *"The WCD report forms a landmark in the history of the development and operations of dams. It paves the way for a new approach, one that builds on looking at all energy development options, one that recognises people's rights from the outset, one that more truthfully assesses all risks. It also points to the importance of assessing alternatives to irrigation, water storage and hydropower. The report comes at a time when rivers, lakes and wetlands are in peril. Currently 30% of fresh water fish and over 800 other freshwater species are on the brink of extinction. Millions of people are losing their homes, land and livelihoods through natural disasters, floods and droughts, or in connection with the construction of new dams. Among the Commission's findings, I value especially its honest look at the true costs. Whilst recognizing the benefits that dams have made to societies, significant is the assessment that dams have resulted in irreversible loss of species and ecosystems. After this report, we can no longer say, 'We did not know.'"*

An example of dam proponents' views is from C.V.J. Varma, the director of the International Commission on Large Dams (ICOLD): *"We in the ICOLD have completed its initial review of the WCD report Dams and Development: A New Framework for Decision-Making. ICOLD are concerned that your Report will be viewed as anti developmental. Indeed, members of the media are currently making this interpretation. We in the ICOLD instead endorse the comment of Smt. Indira Gandhi, the late Prime Minister of India, who once said that "Poverty is the biggest enemy of environment." A no* *development policy will not alleviate poverty. ICOLD believes that the WCD has made an extremely energetic effort to bring the debate on the pros and cons of dams to a higher level. ICOLD is pleased that our Position Paper on Dams and the Environment fits in so well with the intent of the WCD recommendations. For example:*

- *Sustainable development concepts and principles, including demand side management, improvement of system management and watershed management*
- *Concern for the environment (both natural and social aspects) at all stages and phases of a project, from planning to operation, should be given the same consideration as the technical, economic and financial aspects*
- *The five core values followed by the WCD, equity, efficiency, participatory decision-making, sustainability and accountability*
- *The five critical decision points identified by the WCD as needs assessment, selection of alternatives, project formulation, project implementation and project operation"*

A long list of additional critics and comments was provided by ICOLD in this context.

10.2 Water transfer systems

Olli Varis

Water transfers are used to balance spatial differences in water supply and demand. If a region's water demand exceeds its available water, a logical implication is to try import water from other basins. Large transfers have been realized, but still far larger are planned. The Soviet plans to take water from Siberia to Central Asia were abandoned. The Chinese plan to conduct water from Yangtze to North China in greater volumes than the Nile carries. The Americans want even more water from Canada to California and even to Mexico. A question arises how much more attention should be payed to local solutions to control water demand.

Overview

Water has been transported from a region to another from very ancient times. Gleick (1993) presents a brief chronology of water transfers with some lucent examples. In the old kingdom of Egypt, extensive irrigation canal systems were constructed. In Mesopotamia, Babylon was fed with water by canals, and irrigation was blooming with canalized water from Euphrat and Tigris. The Indus valley has long traditions in water transfers as well. The Romans somewhat later constructed famous aqueducts which still are subject to admiration. The Chinese started to construct the Grand Canal already 2,500 years ago. The canal is still partly in operation.

In the ancient times, already the basic functions of water transfers were almost same as today. Growing cities need water. Agriculture needs water. Canals are used for transporting water to them, along with other transported goods. The Chinese example of the Grand Canal even contains the today's fashionable function of transporting virtual water—which is in this case rice. The water-rich and warm Yangtze Basin was already thousands of years ago used as a rice bowl of the dry North China Plain. Instead of bringing water to the benefit of the northern farmers, rice was transported. It needs only to be recalled that for the production of one ton of rice, 2,000 tons of water is needed.

UNESCO (1999) sees three possible ethical and social functions for inter basin water transfers:

- An enterprise for *trading* water
- A case for *solidarity* between two regions, one that suffers from water shortage and the other that has surplus of water
- A *joint* venture of sharing waters for the benefit of both parties

Whatever the function is, all parties should benefit from the system equitably. Easy to say but in practice not always easy to arrange.

In the 20th century, N Americans were leaders in the water transfer scene (Table 10.2a, Figure 10.2a). Their thirst is by far not at the end, the largest planned system being the North American Water and Power Alliance (NAWAPA). Numbers as high as 300 km^3 of water from Canadian rivers to the Western US and Mexico have been proposed.

Europe and the former USSR have also constructed large transfer systems. The statistics in Table 10.2a are somewhat crude, and certain caution is necessary when interpreting the figures. However, one message is clear. It is the rapid growth of the volume of interbasin water transfers.

A certain bias is also worth taking into consideration in the volume-based statistics. The irrigation canals show well in such statistics, whereas municipal water supply canals, which are a vastly growing domain, are less visible in such statistics.

Water transfer costs and concerns

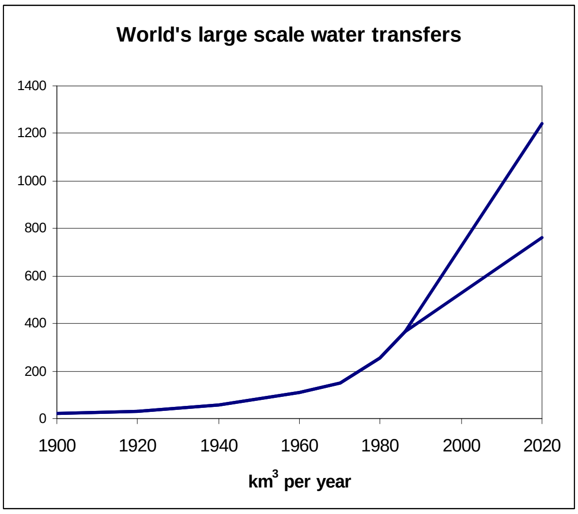
Water transfers must always be seen as one part of the solution among many possibilities. In the first hand, local demand-related solutions should carefully be investigated before importing water from external sources.

A good example is the grandiose approach of the Soviet government to produce cotton in the desert areas of Central Asia. First, the mighty Aral Sea was dried

Table 10.2a
Interbasin water transfers are in growth
Evolution of the volume of water transfers, in km³ per year. Other countries include only Spain, Iraq, Pakistan, Israel, South Africa and Australia (source: Shiklomanov 1999).

	1900	1920	1940	1960	1970	1980	1986	2020
Canada	7	7	10	14	25	90	140	260-300
USA		2	20	26	27	27	30	150-250
Mexico				1	4	4	9	10-15
Former USSR		8	8	10	25	47	60	100-220
Danube countries						2	(5)	15-20
India	15	15	18	18	22	37	50	130-310
China	?	?	?	40	45	50	(10)	?
Others*	?	?	?	?	?	?	60	65-80
Sum (world estimate for 2020)	*22*	*31*	*56*	*109*	*148*	*257*	*364*	*760-1,240*

Figure 10.2a
Water transfers grow almost exponentially
Source: Shiklomanov (1999).

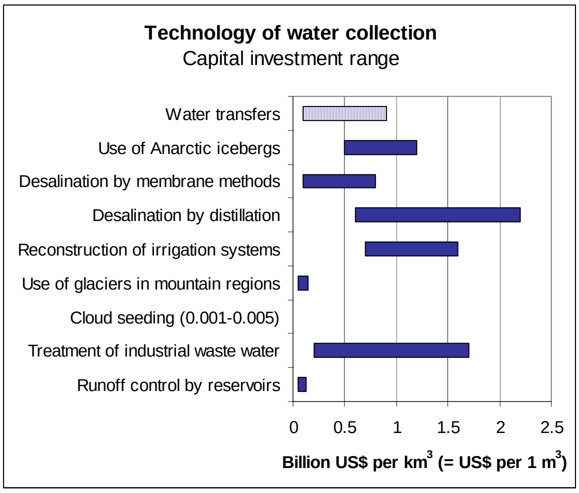


up, and this disaster was planned to be compensated by water transfers from the water-rich Siberian rivers. These plans were cancelled for many reasons, and the region plus the international community are still suffering with solutions to the problem. The colorful history of the Soviet plans and realities is summarized in Box 10.2a.

Water transfers are not always economically very attractive. Costs rise rapidly if pumping is needed. Gleick (1993) demonstrates that the 14 km³ of water to be transferred from the Yangtze Basin to the North China Plain as the 2nd stage of the Eastern canal route (see later) would require over 5 million MWh of energy. This corresponds to 570 MW of energy—a typical electricity production of a commercial nuclear reactor. Given China's aveage energy consumption of 893 kWh per capita in 2001 (World Bank 2004a), this water transfer canal would consume more energy than 7 million Chinese.

Shiklomanov (1999) has made a rough comparison of capital costs of water transfers to selected approaches to water production. It is, however, important to note that these estimates do not include operation costs, such as pumping energy. This feature makes options such as cloud seeding excessively economic.

Figure 10.2b
Water transfer is expensive
Capital investment for the collection of additional water resources (source: Shiklomanov 1999).



China

China's tradition of water transfers and canal construction is respectable. The most famous man-made waterway, the Grand Canal, has over centuries been the third major trading route of the country after Yangtze and Huang He. First parts were dug in the 5th century B.C., and it was the longest canal of the world over centuries. In its best days, it connected Hangzhou and Beijing and totaled 1,800 km.

The 20th century saw an intensification of canal construction in China. The major interbasin water transfer systems—altogether seven with a total length of over 1,300 km—are able to divert over 8 km^3 of water from a basin to another within a year (Table 10.2b). Although their contribution to the total water use in China is only 1.7%, their importance to urban water supply is remarkable. The five systems constructed for that purpose provide 11% of China's domestic water supply.

The plans for water transfers are bold for coming decades. The major project under construction is the Wanjiazhai, which will divert 1.2 km^3 from the Huang He to the Fen River in Shanxi. The project is massive and water must be lifted altogether 600 m, which makes the construction and operation of the system very expensive. Other smaller projects are under way.

Table 10.2b

China's large water transfer systems

Major Water Transfers built in China since 1949 (source: ADB 2000).

Project Name	Main canal (km)	Annual diversion km^3	Province / region	Exporting river/ region	Importing region	Objective	Year of completion
Luan River	286	1.95	North China	Luan River	Beijing-Tianjin-Tangshan	Urban water supply	1984
Huang-Qingdao	262	0.69	Shandong	Huang River	Qingdao	Urban water supply	1990
Qinglong-Qinhuangdao	63	0.17	Hebei	Qinlong River	Qinhuangdao	Urban water supply	1991
Biliu-Dalian	150	0.13	Liaoning	Biliu River	Dalian	Urban water supply	1995
Datong-Qinwangchuan	70	0.44	Gansu	Datong River	Qinwangchuan	Industry	1994
South-North	400	4.10	Jiangsu	Yangtze River	North Jiangsu	Industry & irrigation	1962
Dong-Shenzen	83	0.62	Guangdong	Dong River	Shenzen, Hong Kong	Urban water supply	1965

The plans for the South-to-North Transfer Project are more ambitious than all the existing systems and those under construction (Table 10.2c). To compensate some of the water scarcity in the North China Plain, the total of 53.5 to 71.0 km^3 are planned to be transferred from the Yangtze basin to the north. With the level of 70 km^3 of annual diversions, 30 km^3 would go to the water supply of industry, towns and cities, and the rest to irrigation. Ten million hectares will be irrigated with that water.

To illustrate how huge amounts of water are planned to be abstracted from the Yangtze Basin, one must only recall that the Nile has an annual average flow of 55 km^3 in Aswan.

The first phase of the Eastern route was already constructed in the 1960s and 1970s, and is continuously being extended to the north. A tunnel below the Huang He is already finished. As the Eastern route will be ready, Jiangsu and Shandong will be the major provinces to benefit from this water. Anhui and Hebei benefit as well.

The middle route will get its water from the Danjiangkou reservoir on the Han River. The existing water diversion system for irrigation with a capacity of 1.5 km^3 will be extended. Ultimately, a transfer system from the Three Gorges Dam would be constructed. Provinces to benefit would be Henan, Hebei, Shandong, Beijing, and Tianjin.

The Western route is still at the stage of initial planning. The Yangtze water would be drawn to the upper parts of the Huang He River, from the headwaters of the Dadu River, from the vicinity of the Aba town. The Dadu would, in turn, receive more water from the Yalong and Jinsha, not far upstream from Aba. The former is a major tributary of the Yangtze, and the latter is the Yangtze itself, called differently in this stretch. The Western route would benefit directly the middle parts of the Huang He basin. Indirect benefits would reach the whole basin. There is some controversy between different sources of information concerning the Western route (Biswas et al. 1983, Chen 1994, Liu and Shen 1994, ADB 2000).

There is still controversy whether the Eastern route or the Middle route should be finished first. In many strategic analyses (e.g. Wang 1999), the Eastern route is assumed to be finished by 2010. Everybody seems to agree that the western route will be the last one in the agenda.

In the world history, only the Soviet plans to transfer water from the Siberian rivers to Central Asia and the North American NAWAPA plan exceed the Chinese water transfer plans.

Table 10.2c
China's great water transfer plans
Water to be transferred by the South-to-North Transfer Project (source: ADB 2000)

Route	Stage	Amount: km^3
Eastern	Existing	3.3
	First	6.8
	Second	17.6
	Third	19.0 - 21.0
Middle	Existing	1.5
	Short-term	13.8
	Long-term	20.0 - 30.0
Western	Planned	14.5 - 20.0
Total		53.5 - 71.0

S Asia

This region is constructing and planning extensive water transfers, both within national borders and internationally.

Many extensive water transfer systems are in operation in the Indian peninsula. Parashar (1999) mentions the following four systems as the most important ones:

- The Periyar Project originates from the 19th century. Over 80,000 ha are irrigated with 1.3 km^3 of transferred water.

- The Kurnool-Cudappa Canal is 304 km long, also constructed more than a century ago. It conveys 2.7 km^3 of water to irrigate over 50,000 ha.

- The Tegulu Ganges Project was implemented recently to supply water for the Chennai Metropolitan area in Tamil Nadu. 0.34 km^3 of water are drawn from the Krishna River. Irrigation gains from this system as well.

- Transfers within the Indus valley. A number of large canals and canal networks are in operation in the Indus valley, which chiefly serve irrigation purposes. Of outermost international significance is the Rajasthan canal—known also as the Indira Gandhi Canal—that abstracts water from the Sutley, one of the major tributaries of the Indus, only around 20 km from the border of India and Pakistan, on the Indian side of Punjab. The first part of 649 km of length was finished in 1986. The canal was designed to irrigate 12 million hectares. However, the second phase was suspended due to severe problems of salinization and waterlogging, which affected by 1983 already 10 million ha of irrigated land (Rao 1992).

India's National Water Development Agency plans to construct an extensive canal network across the whole country to transfer water from water-rich basins to the water scarce ones, and also to balance some seasonal shortages in some regions this way. An overview of these plans is presented by Parashar (1999), and some outlines are given here.

The scheme is divided into four major parts.

- *East flowing rivers:* Interlinking of Mahanadi-Godavari-Krishna-Kaveri rivers and building storages at potential sites in these basins. Mahanadi has a certain surplus of water, which is used to balance out deficits in the southern rivers.

- *West flowing rivers:* Interlinking the Narmada and Tapi rivers to the metropolitan area of Mumbai and to the coastal regions to the south. The Narmada river is a key point of this scheme; plans related to distribute its waters from the Sardar Sarovar dam for irrigation in large parts of Gujarat are the starting point. Narmada's and Tapi's water would also be distributed to the city of Mumbai and to the important irrigation areas of coastal Maharashtra, all the way to the Par river (see also Box 2.1a).

- *The Gangetic plain.* Constructing a water grid for Madhya Pradesh and Uttar Pradesh. Plans are divided into two parts. First, those aimed at interlinking the Ken and Chambal Rivers. These are relatively small projects and are not internationally sensitive.

- *Diversion of other west flowing rivers.* A canal system linking the east flowing and west flowing rivers in the southern part of the Indian Peninsula. The most important component is the Pamba-Archanvokil-Vaippar canal, that would divert water from Kerala to the drought-prone areas in southern Tamil Nadu.

These plans aim at providing irrigation to an additional area of 13 million hectares, and hydropower capacity of 4,000 MW. The former is a remarkable number, since India's total irrigated area was 55 million hectares in 2001.

In addition, the Gangetic plain is subjected to extensive construction plans—the so-called Himalayan Component—which are seen as an independent planning entity from the above four ones.

- This plan includes vast canals, one from the Sabarmati River in Gujarat, all the way through Rajasthan, crossing the Yamuna River, and ending to the Sarda River. Five canals are proposed to cross the Gangetic Plain and connecting different tributaries of the Ganges. The Eastern-most canal should connect the Mahandi River to Ganges, and continue to Brahmaputra. Obviously, Bangladesh is concerned about these plans. Nepal as well, since a prerequisite for these canals is the construction of additional storage capacity to the Nepalese side of the Ganges Basin.

This component would provide irrigation to another 22 million hectares, and a grand amount of hydropower, totaling to 30,000 MW. This must be seen in the relation of India's installed hydropower capacity in 1997, which was 22,107 MW (World Atlas 1999).

The time period for implementing these plans is fifty years, and the annual budget requirement is US$ 1.9 billion.

Coming back to the last part of the Himalayan Component, which is the planned canal connecting Brahmaputra and Mahanadi. This plan is a very sensitive topic in the relations between India and Bangladesh (Rahman 1999). The dispute originates from India's unilateral decision to construct the Farakka Dam to the mainstream of the Ganges, just 19 km from the border of Bangladesh. The construction was started in 1960 and went on till 1974. The dam's principal aim was to divert water from Ganges to the metropolitan area of Kolkata along the Hooghly River. The dam's diversion capacity is 1,133 m^3/s which is over 35 km^3 per year.

The dispute reached a partial solution in 1996, when the two countries reached an agreement on the sharing of the river's waters. For details, see Tanzeema and Faisal (2001) and Kajander (2001). It guarantees that during the lowest flows of 1,982 m^3/s, Bangladesh receives half of the river's flow.

India's plans to divert water from Brahmaputra are linked to the desire to increase the low flows of Ganges at Farakka, and continue with water transfers from that location southwards. The planned maximum transfer from the Brahmaputra would be around 100,000 m^3/s, over a distance of 324 km to Farakka.

Bangladesh argues that this scheme "…*would have adverse impacts on the agriculture, navigation, industries, water supply, fisheries, forestry, ecology, and environment in vast areas of Bangladesh. There will be a problem of water logging, in the canal zone, cross drainage by the rivers would be hampered and the flood damages would increase. There will be adverse impact on the hydraulic regime of all the rivers involved and the ecological balance would be disturbed. … The transfer of huge quantity of water will permanently reduce the availability of waters of the Brahmaputra in Bangladesh*" (Rahman 1999).

Rahman continues with the following points:

- loss of 3 million tons of food grain production
- waterlogging of 240,000 ha of highly fertile lands in Northwest Bangladesh
- destruction of many river ports
- serious delocation in river communication, commerce and economy leading to acute unemployment problems
- problems to fisheries and human nutrition
- water quality deterioration and pollution
- disturbance of natural environment
- immense psychological and security problems compounding the problem of social integration

He concludes that "*If all these adverse effects are added together and set to the context of the weak economy and delicate social balance prevailing in today's Bangladesh, it becomes clear that disturbing nature, which would be created by such interbasin transfer of water is something Bangladesh cannot afford.*"

SE Asia

SE Asia is the water-richest among the study regions, and consecutively the water transfer schemes in this region are far less pronounced in water management as they are in the former two regions. Another issue is the heterogeneity—both in political and geographical terms—that contributes to the fact that there are only a few interbasin transfer systems and projects in the whole region.

Thailand—equally thirsty as for power from its neighbors (Chapter 10.1)—is thirsty for water as well. The Chao Phraya basin is by far the water-scarcest region of SE Asia, in terms of its high demand and limited supply.

Water transfer schemes have remained in the discussions of the possible solution of the water shortage problems, particularly for the northern part of the country. The two largest reservoirs of Thailand, Bhumipol and Sirikit have not been fully filled since their construction in the 1960s and 1970s. The Kok-Ing-Nan water diversion project would allow the use of

Mekong's water to full these reservoirs and relieve the water shortage of Northern Thailand. The 8-year project was started in 2000 and will facilitate an annual diversion of 2.2 km^3 of water over canals and tunnels of 117 km of length. Irrigation would gain from this project, and local people are the greatest opponents (Watershed 1998, Kajander 2001).

Some plans also exist for water transfers from the Salween Basin in Myanmar to the Chao Phraya basin, but their stage is very initial at this point (Achakulwisut 1996).

Nile

Egypt has been constructing irrigation and navigation canals since the times of pharaohs. However, the large-scale projects had to wait to the 19th century in the Nile basin. In that century, three important systems were constructed (Abu-Zeid 1983):

- The Nile Delta was networked with canals.

- The Ismailia canal of 128 km was constructed from Cairo to Ismailia, where it bifurcates with one arm reaching Port Said and the other one continuing to Suez. It allows irrigation of large areas of former desert.

- The Ibrahimia Canal was constructed to promote all-year round irrigation in Middle Egypt. In 1900, 29,000 ha were perennially irrigated along its banks, and 175,000 ha were within the reach of basin irrigation. Its branches run hundreds of kilometers from Assint to Al-Fayoum.

In the 20th century, these systems were expanded and other ones were constructed. The most important are the extension of the Ismailia canal, construction of the West Nubaria canal system, and construction of the El Salaam Canal. They allow irrigation of 3.1 million hectares.

Besides the further extension of the existing systems, the two largest schemes along the Nile are (Elarabawy et al. 1998):

- The upper Nile projects. Together with the Sudan, the construction of the Jonglei canal (Box 10.4), the canalization of Bahr El-Ghazal, and canalization of the Sobat-Machar marshes, have been under planning and partial construction over decades. Owing to the civil war in the southern part of the Sudan, these projects have not progressed recently. 18 km^3 of water would be added to the flow of the Nile. According to the Nile Water Treaty, this amount would be divided equally between the Sudan and Egypt.

- The Toshka Project. This large scheme is also known as the Southern Valley Project. A canal system originating from Lake Aswan would conduct 5.0 km^3 of water to a desert depression northwest of the lake. The length of the canal would be 320 km in its first stage, and the second stage would extend it to 800 km. 420,000 ha would be irrigated in total.

None of these projects is genuinely an interbasin project, though.

W Africa

The most important water transfer systems in W Africa are relatively modest in comparison to those in China, S Asia, or the Nile Region. There exist a few systems for irrigation or urban water supply. Since they are not actually large-scale systems comparable to those summarized within the contexts of other regions, only one example is given on those systems. It is the water transfer pipeline from Lac de Guiers to the city of Dakar in Senegal.

The pipeline conducts around 64,000 m^3 water per day to Dakar. A prerequisite for this transfer system has been the construction of the Diama dam at the mouth of the river, and the prevention of the saline water intrusion to the lake during the dry season. This dam has evoked wide criticism (Salem-Murdock 1994, Bosshard 1999), but obviously Dakar's water supply is becoming too important stake for the government to consider any other options than just increasing the volume of water abstracted from the lake. The existing pipeline has been planned to be extended for a capacity of 260,000 m^3 a day, which is 0.1 km^3 per year.

Dakar is located 160 km from the lake and uses the lake directly as a freshwater source. The city had 2 million inhabitants in 1995, 2.5 million in 2000 and the projection to 2015 is 4.1 million. Its share of Senegal's total population will grow from 24 to 30% (Varis and Fraboulet-Jussila 2002).

The water from the Senegal river, from a location very near to the canal that takes river water to Lac de Guiers, will be used to supply water to the city of Nouachott in Mauritania in the near future.

These plans are minor to the ones that have been planned in the region, but never realized. The future will show whether they will be implemented some day.

There have been plans to dig a canal from Lac de Guiers to Dakar, not only for urban purposes, but also to provide water for irrigation in the regions of Louga, Thies, and all the way to the Cap Vert peninsula.

A comprehensive programme to "revitalize" the fossile river valleys south of the Senegal River (e.g. Ministère d'Hydraulique 1987). These ambitious plans include filling a network of around 1,100 km of ancient river beds and canals with the water of the river. The two major abstraction points would be close to towns Bakel and Matam. The water would reach Lac de Guiers, Diourbel, Kaolack, and even the Gambia River basin. Everybody seems to be aware of these plans, but no exact time frames exist for these projects, and it is doubtful whether they are realistic even at the hydrologic standpoint.

Among the major plans in W Africa, the ones to the Lake Chad basin are perhaps the most acute and interesting ones due to their international character (Box 10.2b).

Box 10.2a

The Aral Sea and interregional water transfer plans

Strategic issues

One of the cornerstones of Soviet agricultural policy, and accordingly, to water resources management in the USSR, was the goal of self-sufficiency in both food and cotton. This goal was well reached with cotton, in fact even surplus production for export was achieved. However for many of the major food crops, the country had to rely heavily on imports. The original policy of the USSR was to increase the irrigated agricultural area in order to reach very ambitious production targets for both domestic consumption as well as exports. Voropaev (1976) estimated, that the annual water consumption of the whole country would have needed to grow from 300 km^3 to 2-2.3 times that by 2000 in order to meet some of the targeted goals.

The great problem was the uneven distribution of water within the giant country. Northern regions were rich in water, while the Central Asian republics were excessively dry. Voropaev (1976) estimated that the water shortage in Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) was 100 km^3, yet the precipitation to evaporation ratio in areas around the Aral Sea are as low as 0.12. Despite this, it is interesting to note that local, indigenous communities within the Aral basin had been successfully and quite intensively irrigating the area for thousands of years. It has only been within the last half century that devastating environmental conditions within this region have taken place due to anthropogenic manipulation.

The irrigated area and water consumption started to grow rapidly after 1960 (Figure 10.2c), and has now almost doubled (Golubev 1993). Population has also grown rapidly during the last few decades and is mainly due to natural increases with only a minor contribution from external immigration (UNEP 1993). All the water within the region is based on the two major rivers of the region - the Syrdarya and the Amudarya

Problems of the Aral Sea

The most drastic side-effect of increased irrigation and agricultural production in Soviet Central Asia was clearly the decreased inflow to the world's fourth largest lake, the Aral Sea. The annual water availability within the Aral Basin has been estimated to range between 105 and 127 km^3 (L'vovich and Tsigel'naya 1981). Between 1911-1960, the average water volume reaching the Aral Sea was 56 km^3 (UNEP 1993), but after 1960 historic data reveals the rapid decline (Figure 10.2c). During several years there was actually no discharge at all from the Syrdarya River.

The consequences to the Aral Sea have been severe. Its level, volume and area have decreased drastically during the last three decades, while salinity values have soared (Figure 10.2c). The water quality in the lower reaches of the two rivers is highly enriched with salts and agricultural chemicals, and the water in many locations is unsuitable even for irrigation (Golubev 1993). Yet because it is the only source of water in the region, it must and still is used as a water supply. The consequence is a severe impact on human health, which has been widely observed. Golubev uses the term *environmental catastrophe* to characterize the areas around the Aral Sea.

The earliest solutions to remediate the man-made problems of the Aral Sea were interbasin water transfers. These plans were, however, gradually rejected and local and regional water saving and more efficient use remained the only feasible option to save the sea and the surrounding basin.

Mitigation measures in the Soviet era: Water transfer plans

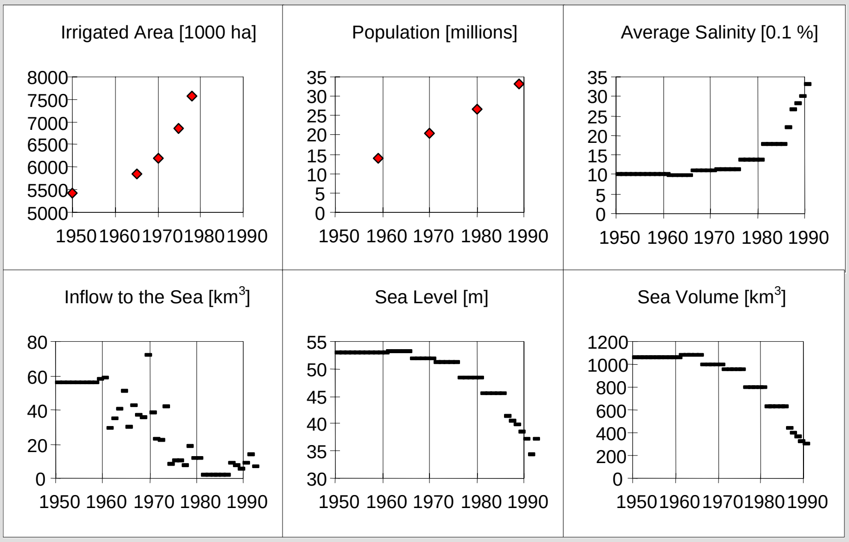
The extensive growth in irrigated area and water use in Central Asia is closely related to the strategic idea of transferring large amounts of water from water-rich areas in northern Europe and Siberia to Central Asia. The idea can be traced back to a Russian engineer Demshenko, who came up with the idea a century ago but whose thoughts were considered too utopistic to be published by the Russian Geographic Society (Rostankowski 1982). The idea was rekindled in the 1930s, and right after the World War II, Davydov presented a plan on connecting the Ob River to the Central Asian rivers and then to the Caspian Sea. It was officially published in 1950 as the Davydov Project (Davydov 1972, Rostankowski 1982).

To overcome the projected water shortage in Central Asia, three types of solutions were proposed. The first plan was simply to save water, while the second was more extensive utilization of regional water resources. Kibalchich and Koronkevich (1983) estimated that with all feasible measures in place (renovation of irrigation systems, paving canals with concrete, increased pesticide use, use of waste waters in irrigation, increased ground water use, construction of new reservoirs), 5 to 12 km^3 of water would be saved per year which was less than the estimated requirement. The third option, to transfer water, appeared unavoidable.

Figure 10.2c

Changes of selected indicators of the Aral Sea and its basin

Data are from UNEP (1993), except inflow 1959-1975 and irrigated area from Rafikov (1983). The UNEP data gives average annual values for 1911–60, five year averaged annual values between 1961–1985, and annual values thereafter.



There was an extensive water transfer experience within the USSR. From the 1930s on, over 3,500 kilometers of transfer canals were constructed, with an annual transfer volume of 50 km^3 (Golubev and Vasiliev 1978). The planned projects would have made a three to four-fold increase to that level (150 to 200 km^3). Voropaev (1976, 1978) and L'vovich (1977) give details of the various plans which can be clustered in four groups:

- *Separate solution for Europe and Asia*. On the European side, 100 km^3 of water would be transferred from various European rivers to the Volga and Dnjepr basins. On the Asian side, 60 km^3 would be transferred from Western Siberia (Ob, Irtysh, Tobol) to Kazakhstan and the Aral Sea basin.

- *Joint solution for Europe and Asia*. The Volga would receive 76 km^3 from Ob, Tom, and Tsulym. Syrdarya and Amudarya would receive 65 km^3 from Volga.

- *The Black Sea – Caspian Sea alternative*. Syrdarya and Amudarya would receive 65 km^3 from Volga, as above. The reduced inflow to the Caspian Sea would be compensated by a canal from the Black Sea, with an annual capacity of 65 km^3.

- *Integrated solution*. An optimal combination of the above alternatives within a 30 to 40 year time frame.

The impacted area would have been around 12 million km^2 (Voropaev 1978), which would have been more than half of the USSR territory, 20 times the French, and more than 140 times the Austrian territory.
The 10th Soviet five-year plan (1976-1980) included an emphasis on the need to develop an extensive scientific co-operation in the planning and impact assessment of large scale projects. During the 11th plan (1981-1985) the preliminary construction works were started to transfer water from some European rivers to Central Asia, while research and planning of water transfers from Asian rivers continued. The 12th five year plan practically stopped the construction works with the option for reconsideration to resume in 1990s.

Mitigation measures in the Post-Soviet era

Due to the break-up of the USSR, the problems of the Aral Sea and its basin have become international. The abatement of the environmental damage has been addressed as a regional problem that will require regional solutions. UNEP (1993) produced an action plan for conservation of the Aral Sea. A summary statement of the report which captures the essence of the difficulties of addressing the current problem (and which we fully agree): *"It is a fundamental mistake to assume that long-term issues of water and land degradation can be effectively addressed without considering the associated problems of population growth and a stagnant economy."*

The report lists a number of actions that are categorized as short-term, mid-term, and long-term actions. The first category includes first-aid type of actions aimed at immediately improving drinking and household water supply and health care, and reducing harmful waste emissions. The second action point consists of technical and economic measures aimed at re-orientating the agricultural practices and structures. The third category includes strategic changes in demography and production structures, with the aim of widening the scope and adding new economic branches, and institutional arrangements.

With the implementation of some simple strategies, it was estimated that 35 to 50 km^3 of water per year could be liberated and allowed to flow to the Aral Sea. This volume is more than five-fold over the estimate by Kibalchich and Koronkevich (1983), referred to above. This could be reached through the reconstruction of inadequate irrigation systems, the reduction of irrigation standards, the removal of low-productivity land from irrigation, the introduction of modern irrigation methods, and the decrease in cultivation of the most water consuming crops.

In 1994, an international fund was set up to save the Aral Sea and its basin. Granted by World Bank and UNEP, four of the five republics in the region agreed to provide 1% of their annual state budgets to the fund (Pearce 1994, Nature 1994). History will prove whether these arrangements will work to stop the catastrophic development which occurred within the Aral Sea basin. The recent World Bank/UNDP/UNEP Plan for dealing with the Aral Sea region defines nineteen specific projects to be performed (World Bank 1994). Additionally, a program to establish the Interstate Council for the Aral Sea (ICAS) has been set up in January, 1994, and the five states of the region have endorsed the ICAS plan (Dinar et al. 1995).

UNEP (1993) action plan seems to undervalue the importance of sound institutional management and monitoring. If the irrigation system is reconstructed, how to guarantee that it will not return to its present condition? Often in the developing world, elaborate infrastructure is built without proper checks and balances in place. The proper monitoring of resources, combined with a well functioning accountability structure will do a lot to create rapid improvement of the situation. It is obvious that the irrigation system needs rehabilitation, that irrigation requirements need to be redefined, and that low-productive lands need to be removed. Yet without strong incentives and proper management these objectives will be difficult to achieve in a sustainable manner, even if large sums of money are directed for the recovery of the Aral Sea basin.

The UNESCO coordinated endeavor to formulate a vision for the basin in the year 2025 as a part of the World Water Vision exercise ended up in a surprisingly positive conclusions. According to the vision, the water resources of the basin are sufficient to provide adequate nutrition for a population that doubles the present level which is 42 millions. In theory, this would be feasible with the over 100 km^3 of water available in the basin. Water supply and sanitation can be improved without excessive costs and reduction of the high infant mortality would follow. Developments in agriculture in terms of careful selection of crops and new technologies would allow the development of a diversified economy which would facilitate sustainable economic growth in the region (UNESCO 2000).

Discussion on the Aral Sea problem

Apparently, a less discussed but somewhat self evident strategic point is the need for the leadership to increase the political power of the many ethnically diverse groups within the region. It is apparent that the past Soviet rulers wanted to stabilize Central Asia by gaining political and technical control. This control never was and continues to be very weak despite the infrastructure investments made. The capitals of the region lie at very strategic places, although quite isolated. The giant Karakum Canal goes to Askhabad, which lies on the border to Iran. Dushambe, close to the Afghanistan border and the main Soviet base during the Afghanistan war, has one of the world's highest dams, the Nurek, which serves a large irrigated area. Frunze was an important military base and Alma Ata borders China. Tashkent, further away from ex-borders and with an abundance of irrigation, was an important regional link and air base. These projects - canals, irrigation networks, industrial complexes, and military outposts- have sought to gain control of the area. They have had a great deal of influence in all respects; greatly impacting both the political structure and the cultural form.
As was mentioned above, the enthusiasm of the Soviet Communist Party towards water transfer plans waned rapidly between 1981 and 1985. Attitudes towards these massive schemes even turned negative, as the global publicity of the projects grew extensively. The new generation of political leaders wanted to distance themselves from the Stalinistic quest for very large, monumental, construction works, and they wanted to stabilize their political power by changing many of the key people within the deteriorating political structure. There was also the need for new symbols that would serve to usher in the new era, but at the same time money and political power became scarce. The impact assessments done by Soviet scientists (e.g., Golubev 1978) showed extensive environmental impacts covering a massive area; even the likelihood of global scale impacts to climate were mentioned. According to Golubev (1993), the cancellation of the project was the first remarkable achievement of the growing environmental movement in the USSR. Yet, some might consider the environmental movement within the region as playing on a marginal role in bringing about the cancellation of the projects.

Box 10.2b

The Lake Chad and interregional water transfer plans

Lake Chad basin is an inland drainage area of 2,355,000 km^2. Its large parts are fully deserted and produce no runoff, and therefore, an area of 967,000 km^2 is usually considered as the "conventional" basin. The basin has been subject to an unfortunately broad range of developments that have driven it from a disaster to another. The population in the basin approaches 30 millions.

In the political level, the main riparian countries—Chad, Niger, Nigeria, Cameroon, Central African Republic and the Sudan—have suffered from economical stagnation and very high population growth rates over decades. Chad had a disastrous civil war in the 1980s, which uprooted a large share of population and destroyed much of the governance system, which has not yet been truly healed (Chapter 8.2, Sananikone 1996).

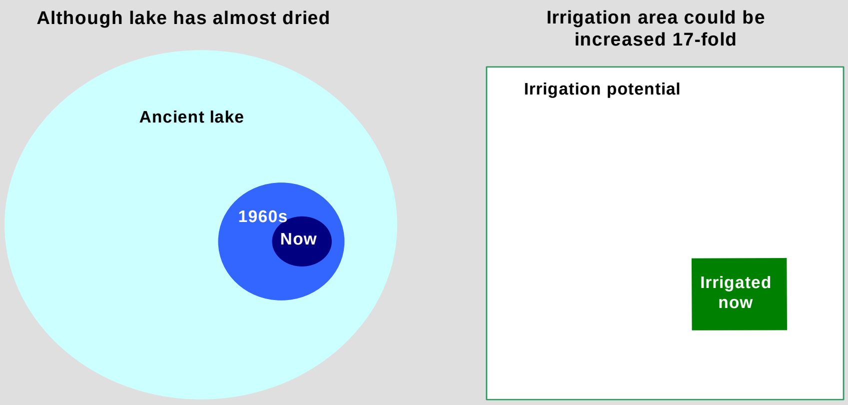
The climate has dried considerably, both in the long term and in the last few decades. In medieval times, the lake may have covered 350,000 km^2 (Jauro 2000), which is not much smaller than the Caspian Sea. By 1960, the lake area had reduced to 25,000 km^2, and at the turn of the Millennium, it has only some 2,000 km^2 of free water surface during dry years. The water level fluctuates considerably due to the seasonal monsoon rains. The lake grows still considerably during the rain seasons in years when rain occurs, up to 28,000 km^2.

The Chari-Logone River system brings about 95% of the annual inflow to the lake. The long-term annual average inflow from that river system—recorded between the years 1930-60—was around 40 km^3. By 1983-84 it had fallen to less than 17km^3, and the exceptionally dry season 1984-85 brought only 6.7 km^3 to the lake. The inflow has averaged around 10 km^3 ever since. Jauro (2000) documents that the annual precipitation isohyets shifted around 180 southwards around 1980. Such changes—although very dramatic to the ecosystems and the humans—are not novel in the basin. Fossil evidence shows that the lake has dried half a dozen times during the last 1,000 years.

Figure 10.2d

What is wrong with irrigation potential calculations?

Climate change has been the major driver for the drying up of Lake Chad, and irrigation has had some impact as well. The basin has a serious water deficit, but still irrigation potential has been estimated seventeen-fold the present level (sources: FAO 1997, Jauro 2000).



This climate change has been attributed as the main source of the declined inflow. Some effect is due to the irrigation of 113,000 ha of agricultural land in the basin, but this effect has been usually considered as minor in comparison to the climatic factors. It is interesting to note, that FAO has estimated, that only 6% of the basin's irrigation potential is used (FAO 1997). For Chad, the percentage is two. This suggests that Chad could augment its irrigated area 50-fold, and the whole basin's irrigation could be extended seventeen times. Given the already existing serious water deficit in the basin, something is badly wrong with these calculations (Figure 10.2d). Although the basin is one of the most problematic regions of the world in terms of food insecurity, these potentials appear dangerously misleading.

The solutions of the problems of the lake are not easy. One option is to transfer water from the surrounding basins of the Congo and Niger Rivers (Jauro 1998). From Congo, annual volumes up to 100 km^3 have been proposed. A navigable canal of 2,400 km has been planned. The lake would be revitalized, and an additional 5 to 7 million ha could be put under intensive irrigation. Well, Africa's total irrigated area is now around 6 million ha. These plans may be attractive and justified to some extent, yet not all pieces fit together again.

Are the irrigation potential calculations and the water transfer plans severely exaggerated? I think they are, given the socioeconomic, political, natural, and human situation in the basin. What are missing are interconnections. All this work is desperately one-sided. This is obviously due to the fact that we experts are desperately too narrow in skills.

10.3 Water supply, sanitation, and wastewater treatment

Olli Varis, László Somlyódy and Tommi Kajander

Water borne and transmitted diseases account for 4/5 of all malady cases and 1/3 of deaths. Western solutions to water supply and sanitation tend to be too expensive to developing countries. Alternatives, often based on traditional approaches, are available, but their implementation is difficult with high population densities.

Solutions in the industrialized world

There is long, diverse history in the construction of water and sanitation systems within industrialized countries; for urban areas in particular. Copenhagen, Denmark in Northern Europe is a good example, because it has the typical features of European development trends within the sanitation and waste water treatment sectors of major urban areas (Box 10.3a, Table 10.3).

The trend is towards further development and improvement of these systems (cf., Niemczynowicz 1993). Treatment processes are developed to remove more and more of the impurities in waste water. In many cities, the sewerage and treatment systems are centrally controlled, with real-time monitoring and computerized control. Sophisticated integration of the system components with external data—such as weather data and analysis—yields increased efficiency and improved treatment results. But such systems require highly skilled labor, large amounts of capital, and steady socio-economic conditions (finance, chemical supplies, etc.; Varis and Somlyódy 1997).

The major problems arise when these requirements are not fulfilled. They may appear risky if proper maintenance is not there (water and pollutant transfer via the entire infrastructure, need for continuous operation, sensitivity to under- and overloads, implementation failure risk is inherent, energy loss, material loss, etc.). Such systems may be sustainable if implemented/operated perfectly, but they have not been realized, and are apparently not realizable in the majority of cities in the world due to economic, political, technological, and institutional reasons (Varis and Somlyódy 1997).

Developing countries in comparison

In many developing countries, sewage systems exist, yet they often date back to colonial times. Therefore, they are typically too small and include no proper end-of-pipe treatment, and are often in a state of disrepair due to improper management. Box 10.3b presents Jakarta, Indonesia as an example. It is, however, not among the cities worst off in urban water infrastructure.

For those with no proper sanitation, realistic solutions should be found. For those with sanitation, improvement is often needed. Improper waste management often causes deterioration of water resources, leading to the need to transfer water from distances. Large portions of housing are illegal with no proper waste water treatment. Water might be in short supply due to seasonal variations, inadequate infrastructure or technical inadequacies within the supply system. Money, political will and power are often lacking.

Box 10.3a

The Copenhagen case

An example of urban water infrastructure in an industrialized country (Varis and Somlyódy 1997 from Hansen and Therkelsen 1977).

The excreta disposal system in Copenhagen in the 18th century was a hole in the ground which was emptied from time to time. Some holes were simply covered when tagged as inadequate and new one was dug as needed. The next step was a privy inside a house, usually under a staircase, which was regularly emptied and often caused severe odor problems. From 1756, ground tanks with brick walls were introduced and became the only allowed system until 1795. Methods for emptying the tanks advanced gradually, and around 1880 vacuum trucks were used. In parallel, various portable, pail latrine systems were developed, where urine and faecals were usually separated.

A sewage system was first proposed in Copenhagen 1853 which consisted of two different lines; one for household waste and stormwater, and the other for toilet sewage. Ironically in 1853, the first cholera outbreak occurred in Copenhagen. Despite the quite evident need to improve sanitation conditions throughout the city, the sewage system proposal was turned down.

The change from the pail system and ground tanks to sewer system and the flush toilet finally arrived during the 1890s. The earlier system failed because it was poorly managed (health related risks) and it was labor intensive. The new system caused less direct nuisance and inconvenience and had fewer hygienic problems. However, the new system was not free of difficulties as it was expensive to construct, especially to areas at great distances. Consumption of the high quality water was considerable which made operating the system quite expensive to run. Also, the sewage discharged from the network caused pollution problems, as there was a several decade utility gap between the sewage system and the purification system in Copenhagen. Eventually, waste water treatment was a complete system, as the transport and purification systems were combined to create a well controlled, semi-closed system.

Table 10.3

Major features of urban water infrastructure in the industrialized world

Varis and Somlyódy (1997)

Water supply	High coverage required, safety is a major concern, a part of living standard, willingness to pay is there. Inherited systems from past decades: no separation (high quality water is used for all the purposes) Limited flexibility: infrastructure is given, a change would need 15-20 years (reconstruction period)
Sewerage	Systems often, and philosophy originate from the 19th Century Public health and water borne / transmitted diseases original driving force Long planning horizon and life time - difficult planning due to uncertainties in future flow estimates Very expensive, investment and money driven (decisive element of the infrastructure) – lobbies Functions: transport of pollutants; originally domestic wastewaters; industrial ones (at a later stage); stormwater; linkage to road construction; an incremental part of city planning; change in its function along time (19th Century - very little industrial wastes, etc.); future changes are also anticipated
Treatment	Central plants dominate Activated sludge mostly and its advanced versions Increasing sophistication (operation etc) Sludge management is often overlooked

Box 10.3b

The Jakarta case

An example of urban water infrastructure in a mega-city in a low-middle-income economy (Varis and Somlyódy 1997).

Indonesia is one of the world's most populated countries. It has a territory of over 1.9 million km^2 for its 200 million inhabitants (the population currently grows at 3 million a year). Yet, around 110 million live on the island of Java which is only 127,000 km^2, making Java one of the most densely populated areas in the world (870 inhabitants per km^2). The biggest of the three Javanese cities is Jakarta, with an official population of 10 million inhabitants, but the actual population is probably higher. The number of seasonal residents and commuters was 1.15 million in 1985. The case study is summarized from the study by United Nations (1989).

More than 20% of the housing in Jakarta is on a temporary basis and 40% is considered semi-permanent. This yields a rough figure of 60% living in settlements called kampungs, which now have a semi-legitimate status. Housing programs divide kampungs into two classes: never-to-be-improved and those to-be-improved categories. Residents of the first category are encouraged to return to their villages, move outside Java, or select some housing area in Jakarta. The to-be-improved category kampungs is improved by introducing basic services such as rubbish collection sites and hydrants. By 1984 the housing improvement programs had reached 3.8 million inhabitants, yet it has been estimated that 50% of the population within these settlements has yet to be served.

The water distribution network of Jakarta was originally built by the Dutch to supply water for 0.5 million inhabitants. Although extended, it cannot cover the whole city area. Due to rapid growth in population and industries, and large scale real estate construction, water demand grows rapidly. Around 14% of the population (generally the most wealthy households) have piped water. Wells are used by more than half, and water vendors by 32% of the population (Serageldin 1994). Highly polluted canals and rivers are used widely as a water source for cooking and washing.

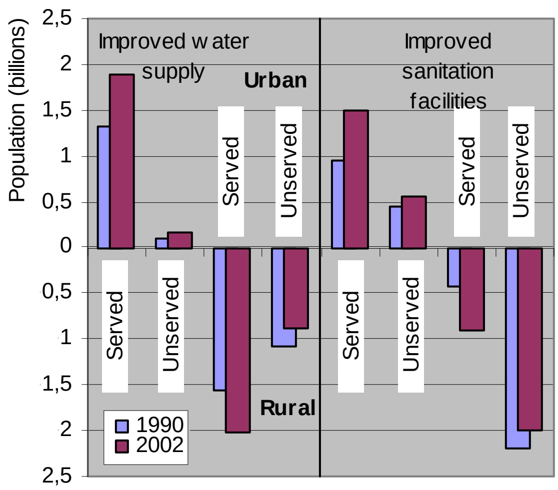
The extension of water supply faces severe problems. Groundwater use has already caused remarkable saltwater intrusion into main aquifers. Surface waters which are utilized are often so polluted that they are considered worse than the water running through sewage treatment systems in many countries. Network leakages are huge. The water supply company is an independent corporation that must make profit, so it focuses extensions of the network to households which can pay. Standpipes on kampungs have received less attention. Where there are standpipes, there are often illegitimate vendors selling water to the poorest urban households at roughly thirteen times the official price.

The city has no sewerage system for the 700,000 m^3 of sewage produced daily. Part of the sewage runs through septic tanks; most of it goes directly to dikes, canals, and rivers. The area is prone to seasonal floods that raise water to the streets. Wide-reaching groundwater pollution has been observed due to poor waste management. As a response, existing drains have been re-directed in some locations to provide a faster passage of the water into the sea. Pilot scale studies for the construction of a sewer system have been made.

Figure 10.3a

The utility gap is growing

Access to improved water supply and sanitation facilities in urban and rural areas in developing countries, 1990 and 2002 (data from WHO and UNICEF 2005).



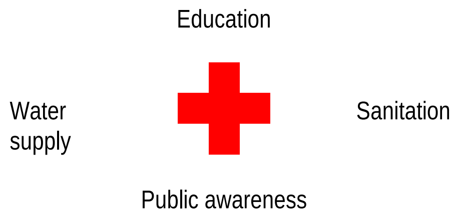
Global experience has shown that the first part of water infrastructure development is the water supply (Figure 10.3a). Sanitation eventually comes along, in one form or another, yet waste water treatment is often greatly delayed. This mismatch (“utiliy gap”) causes an open material flow leading to large-scale water pollution. The delay in industrialized countries has been from years to decades. A question arises; can the formation of this gap be slowed, particularly within big cities, where it is still manageable? In many Third World countries, the urban water infrastructure does not reach the majority of urban dwellers. Another question is how the already existing gap could be closed? In many cities it is huge, and the solution to the problem is not simple but hopefully not impossible. Somewhat astonishingly, the World Bank does not consider this gap a big problem, but rather as a natural evolution path of infrastructure development (Serageldin 1994). In contrary, the WHO sees that the imperatives to public health are proper water supply, sanitation, and public awareness (Figure 10.3b).

Water transfer systems that connect reservoirs, rivers, irrigation systems, cities, and other components of the water infrastructure facilitate improved possibilities for water allocation among different users. This development that can be argued as unavoidable is a potential source of many types of conflicts and problematic development pathways. Few examples among many include increased urban bias, less pressing need to manage water quality (waste, salinization etc.) problems locally, and even international conflicts. All in all, the urban and rural water infrastructures are not as separate entities as they often are considered to be.

Figure 10.3b

Public health and water: imperatives

The utility gap causes public health and pollution problems.



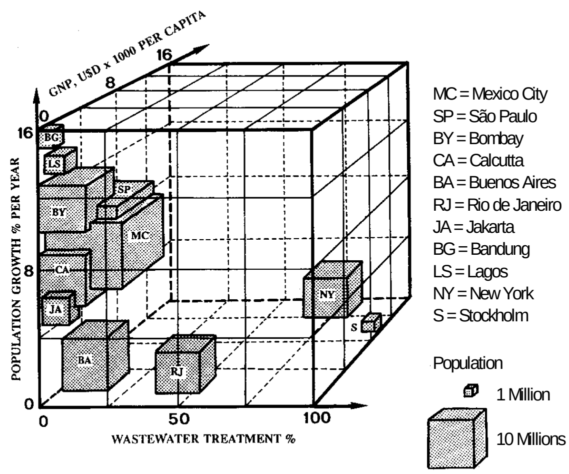
Technical alternatives and affordability

A much argued issue is the type of water technology that should be implemented in developing countries. It should fit the other parts of the infrastructure. Figure 10.3c shows selected cities with respect to the level of wastewater treatment, population growth rate and GNP per capita. Many developing regions do not have the resources for fast development, unlike their counterparts in the industrialized world.

Figure 10.3c

Much is undone in wastewater treatment

Relation between wastewater treatment capacity, GNP and rate of population growth in selected large cities (Niemczynowicz 1993).



The level of investments on environmental protection range globally between 0.5% and 3% of the GNP, being typically higher in countries with higher GNP. In a poor country with GNP per capita around US$ 200 to 400, the spending to environmental protection is bound to be well below US$ 5 a year. Alternative, less capital intensive solutions, which also fit together with available human resources and infrastructure are desperately needed. Many ecological and biological low-input solutions, plus labor-intensive approaches instead of capital and equipment intensive ones enter the discussion (see also Box 4.4).

The literature is rich in alternative solutions to the sanitation problem and several principles for solving the problems illustrated above have been proposed. A short summary is given below, clustered alongside a set of widely used buzzwords (Varis and Somlyódy 1997).

i) *Save Water*. There are many ways to reduce water consumption by increased efficiency, including technical measures such as reducing leakages, economical incentives such as proper pricing, restrictions such as limiting water use for certain purposes, and increased public awareness. Many positive results from developed and developing cities have been reported (e.g. Worldwatch 1993, Chapter 10.4).

ii) *Recycling of organic matter*. In traditional farming systems, manure is returned to fields as organic fertilizer. Composting is widely used. In many traditional integrated aquaculture, livestock and farming systems, especially in Asia, sophisticated and efficient production systems with low emission rates have been sustained for hundreds if not thousands of years (e.g. Edwards 1992, Chan 1993). Although these are primarily rural issues, there are many lessons to be learned from these systems to build cities which can achieve an increased ecological balance. At another level, sludge from waste water treatment plant is relatively widely returned to terrestrial ecosystems.

iii) *Recycling of water*. Various options to industrial and municipal water recycling have been proposed. The industrial production per used unit of water has steadily increased in Japan, being now threefold to the level in 1965. In the developed world, there are many examples; and there are also examples (although fewer in number) from the developing countries (Worldwatch 1993). In municipal water supplies, the use of lower quality water for flush toilets and other uses that require a lower standard have been applied (Chapter 10.4).

iv) *Sanitation without water*. An array of solutions for sanitation through various types of latrines have been found throughout the world (see Hansen and Therkelsen 1977, McGarry 1982, Winblad and Kilama 1985). Water consumption is non-existent or much lower than in flush toilets and the waste can be returned to terrestrial ecosystems, but proper management is required.

v) *Appropriate technologies*. It has widely been emphasized that the technological level chosen should be in balance with the available infrastructure and economic conditions. Technology should allow for proper management and extensions of the installations in accordance with the prevailing conditions and within available human resources. There is a wide range of appropriate technology literature. Examples include water extraction to purification, water distribution to sanitation, and waste water treatment (cf. Eikum and Seabloom 1981, Schiller and Droste 1982, Ho and Matthew 1993, Grau 1996, Mara 1996).

vi) *Solution to pollution is dilution*. This principle unfortunately leads to open mass flows and should be avoided when possible. However, it is used very widely. The pollutant is transported away and/or diluted to a lower concentration. Such systems operate in many ways. One example is the practice in Jakarta: an improvement was due to speeding the passage of waste water into the sea by re-directing open canals.

Niemczynowicz (1993) sees the water pollution abatement process consisting of six principal steps:

i) *Preventive actions.* First, one should try to prevent the formation of pollution at its sources. This applies to industrial processes, to transportation, mining, agriculture, and to many more sources of pollution.

ii) *On-site treatment and reuse close to production*. Wastes (nutrients, minerals, chemicals...) should be recovered and reused as close to the production as possible.

iii) *Off-site treatment and reuse*. If the above is not feasible, recovery can be organized off-site.

iv) *On-site, or off-site concentration and storage*. A temporary solution to residues that cannot be directly re-used.

v) *Treatment at small-scale plants of low technology*. Various biological and ecological systems (terrestrial, wetlands, aquaculture, livestock...) can be effectively used in small-scale plants.

vi) *High technological treatment at the end of pipe.* If the above options are not successful, the approach should follow that of highly developed countries using high technology and capital intensive methods.

Varis and Somlyódy (1997) emphasize the role of the flush toilet, which is more or less self evident issue in industrialized countries. Many points made above would very strongly push the water sector to find alternative solutions to it. Box 10.3a described the urine separation approach when using dry latrines from the 19th century on. Approaches of similar type have been proposed recently as a realistic practice for large urban areas with limited water infrastructure (cf. Beck and Cummings 1996, Larsen and Gujer 1996). It would save water in comparison to the flush toilet, and produce both liquid and solid, natural nutrient-rich matter, that should be used as a fertilizer in food production in order to close the material cycles.

Situation in the study regions

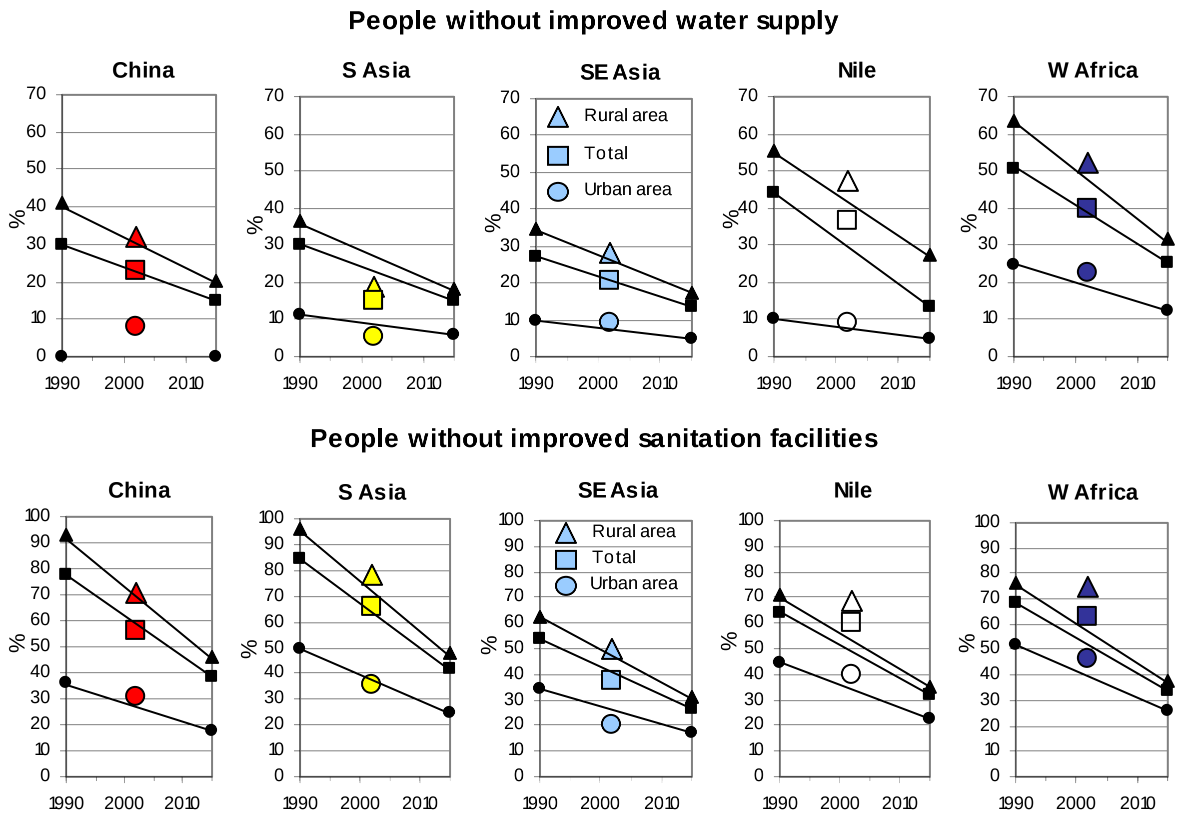
In fall 2000, the United Nations´ 189 member countries adopted the Millennium Development Goals (MDG). The goals were set to tackle with the most important issues in development (see Table 3.1b about the MDGs). The Target 10 of the MDG 7 (ensure environmental sustainability) is to halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation. The target is fundamental as it helps in the achievement of the other MDGs including poverty, hunger, child mortality and disease reduction, universal primary education, gender equality and ensuring environmental sustainability. As in many Millennium Development Goal, the baseline year of Target 10 is 1990.

Are we on track to meet the MDG target 10? The situation in the study regions is illustrated in Figure 10.3d. Although the progress towards Target 10 is assessed as an aggregate figure (total population without improved water supply or sanitation), the charts below illustrates the situation also in rural and urban areas. This is important as the circumstances and challenges are so different between the areas.

Figure 10.3d

Development of water supply and sanitation situation vs. Millennium Development Goals in the study regions

Cambodia, Lao PDR and Malaysia are excluded in the charts of SE Asia due to the lack of data. The Gambia, Guinea-Bissau and Sierra Leone are missing in the charts of W Africa. The charts are compiled from WHO and UNICEF (2005).



Country-specific development in the water and sanitation provision is showed in Figures 10.3e and 10.3f.

The data used in the figures is about improved water supply and sanitation facilities. Often the assessments consider only the type and the use of water supply or sanitation facilities. For example, regularity and quality of the water supply, or cleanliness of sanitation facilites are not taken into account (UN-HABITAT 2003, UN Millennium Project 2005). Due to the inaccuracy of the data, estimates of the coverage of water supply and sanitation vary a lot (Varis 2006). In the following, the situation is analyzed by study regions. The data is from WHO and UNICEF (2005).

In China, the water supply and sanitation development has been good and the country is on track with target 10. This is understandable in the rural area as its population has decreased by 40 million between 1990 and 2002. The situation is worse in cities which face a daunting urbanization challenge. Cities are growing at an annual rate of 3.8%. The water supply and sanitation sector has not kept pace with the growth. Although the number of people served by safe water supply increased by an outstanding 141 million, the urban water supply coverage has fallen from 100% in 1990 to 92% in 2002. However, urban sanitation coverage increased.

Dramatic improvements have been taken in water supply and sanitation situation in S Asia. It is the only study region where the proportion of people without sustainable access to safe drinking water is already halved. The total water supply coverage has increased to 85% meaning that S Asia is holding the first position among the study regions (Figure 10.3d). The early achievement of the MDG target 10 in terms of water supply is reality thanks to India. The imbalance between the development of urban and rural areas has fairly decreased in water supply but is still very big in sanitation.

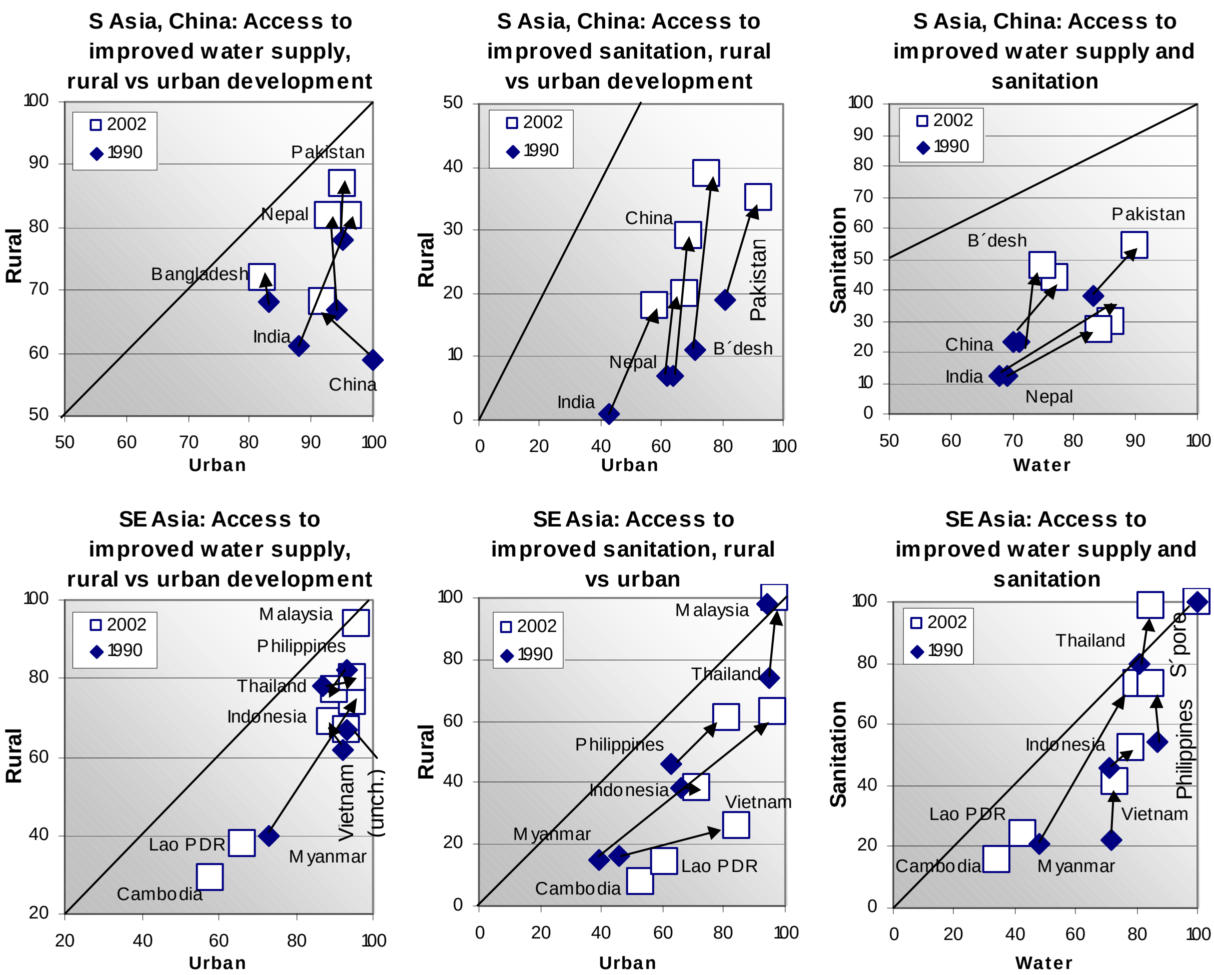
When investigating the S Asian countries separately the picture becomes different. In Nepal, the urban water supply coverage has decreased to 93%. No wonder; among the Asian study countries Nepal is the poorest but struggles with the highest urbanization rate. Between 1990 and 2002 the urban population has more than doubled equaling to an annual growth of 6.8%. The urban water supply coverage has also decreased in Bangladesh and stayed unchanged in Pakistan. Rural water supply situation has improved in every country in S Asia.

Sanitation coverage has improved all over the subcontinent but is still very low. In 1990, nearly every single people (96%) in rural area, and half of the urban population were without basic sanitation. In 2002 the figures were 78% and 36%, respectively. In terms of the MDG Target 10 about sanitation S Asia is on track in urban areas but lagging behind in the rural areas. Among the study regions, S Asia is holding the last position in terms of total sanitation coverage.

Figure 10.3e

Development of water and sanitation situation in the Asian study countries

Notice the different scales. Data sets for Cambodia, Lao PDR, and Malaysia are incomplete. Data: WHO and UNICEF (2005)



When considering its first place in total water supply coverage, the “utility gap” (see above) is huge.

In SE Asia, the development of water and sanitation situation is different compared to China and S Asia. Total access to improved water supply has increased slowly from 73% to 80% while access to improved sanitation has jumped from 46% to 62%. Total sanitation coverage is clearly higher in SE Asia than in any other study regions (10.3d). Utility gap has decreased very rapidly.

SE Asia is on track with MDG target 10 except for urban water supply which is lagging behind. The development has been reverse in Philippines where rural and urban water supply coverage has decreased by 5% and 3% to 77% and 90%, respectively. In Indonesia, the access to improved water supply in urban areas has also decreased from 92% to 89% between 1990 and 2002. Unfortunately data for Cambodia and Lao PDR for year 1990 is lacking. However their water supply coverages in urban areas in 2002 were 58% and 66%, respectively. In rural areas the access to improved water supply was just 29% in Cambodia and 38% in Laos. These two countries are well behind among the other Asian study countries. Water supply access in Cambodia is even below the African rates with the exception of Ethiopia.

As mentioned above, the progress in sanitation sector has been rapid. In urban areas SE Asia has almost reached MDG target 10. Access to improved sanitation facilities has increased in every country. In Vietnam the development has a strong focus on urban areas. Despite the number of city dwellers has increased by 52% to 20 million, the sanitation coverage has increased from 46% to 84% between 1990 and 2002! In rural areas the figures were 16% and 26%. Consequently the development has been strongly urban biased.

Myanmar is a case in its own. Its development in water supply and sanitation sector is beyond compare in the world. The total access to safe water supply has increased from 48% in 1990 to 80% in 2002. The progress in the sanitation sector has been even stronger. Between 1990 and 2002, the total sanitation coverage has exploded from 21% to 73%. One might think that the data is burnished by the military government.

Nile region is not on track with the target 10. It is behind the water supply and sanitation goals in both, rural and urban areas. The priority seems to have been in urban water supply. Coverage has exceeded 90% in cities, which is comparable to the level of China, S Asia and SE Asia. However, in rural areas the situation is badly behind the Asian study regions. Nearly half of the rural people were without access to improved water supply in 2002.

Although the situation is pretty good in urban areas no progress has been taken since 1990. It is due to three countries in the Nile region, namely Kenya, Sudan, and Burundi, where access to water has decreased (Figure 10.3f). In Sudan the urban water supply coverage has decreased most from 85% in 1990 to 78% in 2002. It is explicable as the country´s urban population has doubled since 1990 and is now Nile region´s second largest (12.5 million) after Egypt. In addition the political instability in Sudan has surely had its own effects. Although the areal imbalance or urban bias in the development of water supply in the Nile region has slightly decreased thanks to rural development, it is still very large.

Access to improved sanitation is low and has increased slowly. Total sanitation coverage arose from 36% to 40% between 1990 and 2002. The increase is due to good progress in Egypt which improved the access to sanitation from 54% to 68%.

Out of the study regions, W Africa has the lowest water supply coverage being 60.3%. In rural areas the figure is less than 50%. In cities the situation is better. Three quarters of urban dwellers are living with improved water supply. This is however very low compared to the urban water supply coverage figures exceeding 90% in the other study regions (Figure 10.3d). Although W Africa is not on track with the Target 10, progress towards the goal has taken place.

Despite the poor water supply situation in W Africa, the total water supply coverage has increased in every country. The progress has been most significant in Central African Republic which increased its water supply coverage from 48% in 1990 to 75% in 2002. The development has been favorable in Ghana and Côte d´Ivoire as well. Also Mauritania´s increase in total water supply coverage has been big although its development in rural areas has strongly been inverse. This is confusing as Mauritania is the only study country in Africa where the rural population has decreased between 1990 and 2002.

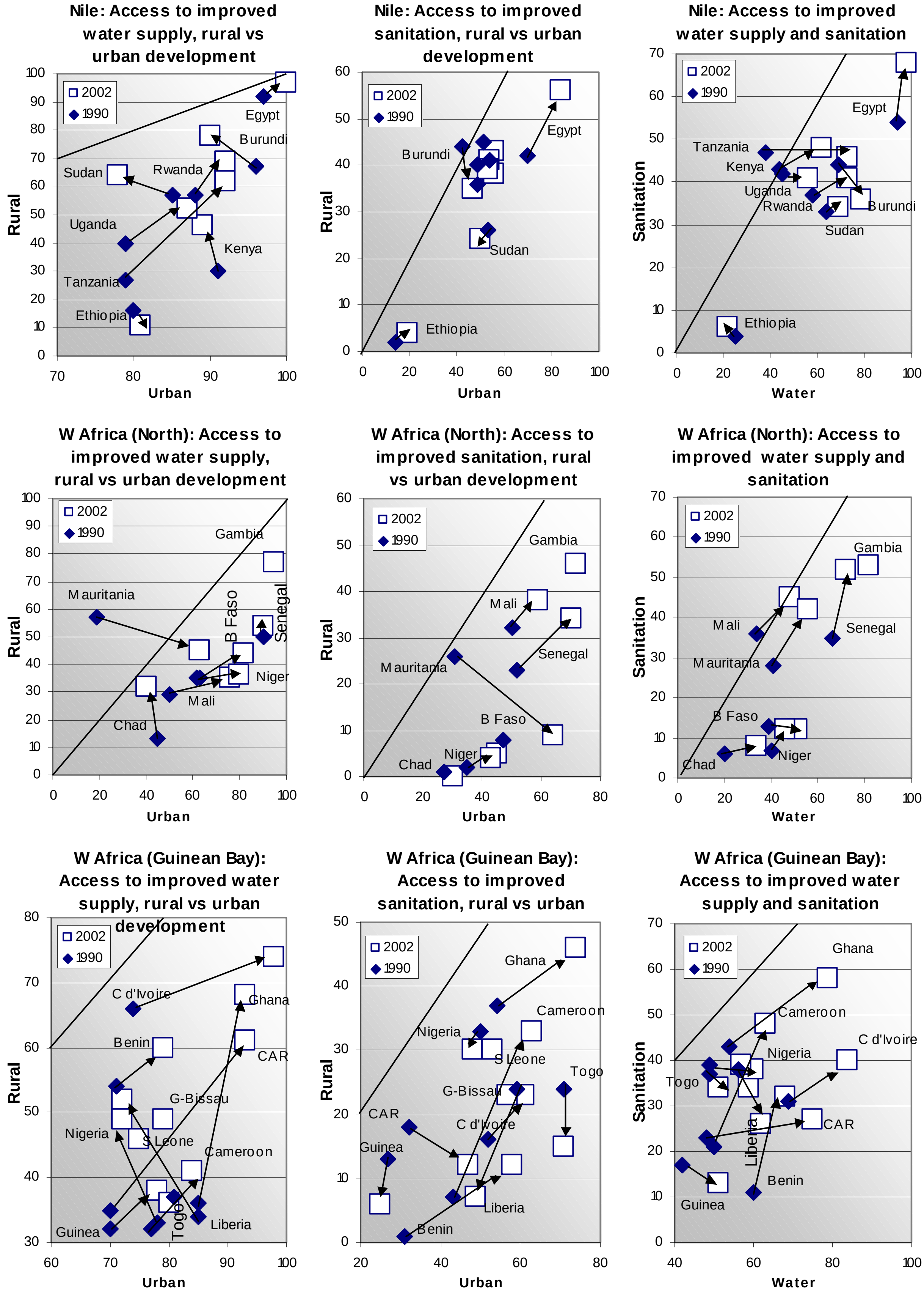
In urban areas the water supply coverage has decreased in Chad, Liberia, Nigeria, and Togo. In Liberia the reduction has been largest; from 85% in 1990 to 72% in 2002. On the other hand its rural water supply development has been strong. Nigeria is another example where development in rural water supply has been good while cities have suffered from decreasing service levels (Figure 10.3f).

In 1990, the share of population without improved sanitation facilities was 68%. In 2002, the figure was

Figure 10.3f

Development of water and sanitation situation in the African study countries

Notice the different scales. Data sets for Gambia, Guinea-Bissau and Sierra Leone are incomplete. Data: WHO and UNICEF (2005).



63%. Out of the study regions, W Africa holds the last position in urban sanitation coverage which was just slightly above 50%. Although the overall situation is worse in S Asia, progress in the W African sanitation sector has been very slow. The development has been slower only in the Nile Region.

Despite the slow progress in the development of the sanitation sector of W Africa, there are some countries which have performed well. Cameroon has put significant efforts in sanitation. The sanitation coverage was just 21% in 1990 while in 2002 nearly every other had improved sanitation facilities. In Benin the development has been rapid as well. Just one tenth of the population had sanitation in 1990. In 2002, sanitation facilities reached every third inhabitant.

Out of the eighteen W African study countries five experienced inverse development. The situation was worst in Liberia where the total sanitation coverage decreased from 38% in 1990 to 26% in 2002. In rural areas the decrease was even bigger; from 24% to 7%. The utility gap has increased significantly when considering that the water supply coverage in the rural areas increased from 34% in 1990 to 52% in 2002.

Summary

Water supply, sanitation and wastewater treatment are fundamental to life. However, economic, political, technological, and institutional reasons determine the state of water supply and sanitation facilities. Consequently the water supply and sanitation situation differ considerably around the globe.

Industrialized countries rely often on centrally controlled sewerage and treatment systems, with real-time monitoring and computerized control. Highly skilled labor, significant amounts of capital and stable socio-economic conditions are available. In the Third World the situation is different. Lack of wastewater treatment and waste management further deteriorate the available water resources. Water and sewerage systems are often in a state of disrepair. The greatly needed investments and political will are missing.

In water infrastructure, water supply is developed first. This can be seen from the global figures. 1.1 billion people lack access to improved water supply while 2.6 billion people are still without basic sanitation facilities. Due to financial difficulties wastewater treatment is often neglected although sanitation facilities are constructed. The utility gap causes an open material material flow which causes large-scale degradation of water resources.

Many options exist to tackle with the wastewater induced water pollution if wastewater treatment is not possible. Means include i.a. water saving, recycling of organic matter, recycling of water, sanitation without water, appropriate technologies and dilution.

What comes to the water supply and sanitation situation in the study regions Africa is behind Asia. Nile Region and W Africa are also the regions which will not achieve the Millennium Development Goal about water supply and sanitation if current progress continues. On the contrary China, S Asia and SE Asia are on track to meet both water supply and sanitation targets.

Situation in the water supply and sanitation development is better in urban areas than in rural areas. The imbalance between the development of rural and urban water infrastructure is big. The already outstanding urbanization challenge will be even harder to solve if rural development to decrease rural-push is neglected.

10.4 Intensification of water use

Tommi Kajander

Water demand is increasing along with the population growth and industrialization. Contemporaneously water resources are depleting and deteriorating. The development of additional large volumes of water is no longer possible or cost-effective. In this context intensification of water use will have a crucial role in fulfilling the ever-increasing water demand.

Overview

The number of people subjected to water scarcity is in rapid growth. Major problems in water availability are to be expected in i.a. N Africa, China, and S Asia (see Chapter 2.4). In Egypt, China, India and Pakistan the situation will be critical as the water use will exceed the utilizable water resources (Figure 6.1h, Chapter 6.1). National water availability averages are however misleading as the water resources are unevenly distributed and often badly polluted. Water scarcity is more common than statistics may imply and considerable efforts to derive additional water supplies take widely place.

The development of additional large volumes of water is more and more expensive and often impossible. Focus has moved to the efficiency measures of water use. It is increasingly common that intensification of water use is the only way to fulfill the ever-increasing water demand. Efficiency of water use is a rural and urban concern. It is a concern in agricultural, industrial and municipal sectors.

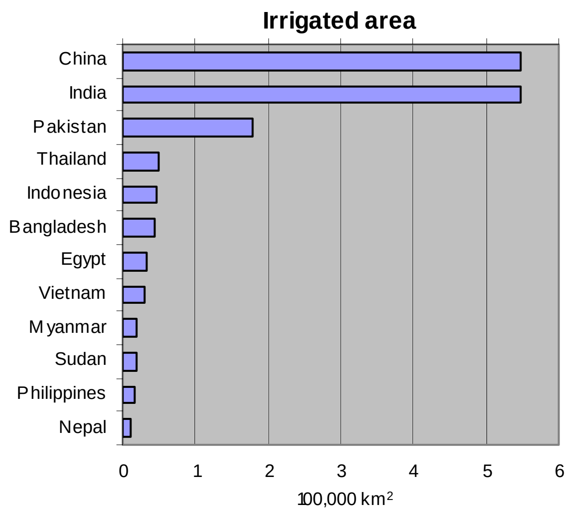
Water use can be intensified in many ways including i.a. technological, regulatory, monetary, educational and managerial means. In this chapter the topic is discussed by sectors focusing on irrigation, which uses by far the greatest bulk of water. Furthermore water pricing and wastewater reuse are discussed.

Intensification of irrigation

Globally, with a share of 69%, agriculture is by far the most water-consuming sector. In the study regions the water withdrawals for irrigation exceed commonly 80% of the total water use and 90% in several countries like Mali, Mauritania, and Sudan (Figure 10.4b). However, intensification of irrigation is often necessary as the share of water allocated to agriculture is decreasing when the water use in industrial and domestic sectors is getting priority. Fortunately there exists a great potential for water savings in agriculture. The average irrigation efficiency in developing countries is just 43% (FAO 2000).

As can be seen from the Figures 10.4a and 10.4c India, China and Pakistan have the largest irrigated areas among the study region countries. These three countries and Egypt will also face their limits in water consumption, which will exceed the utilizable water resources at the latest by 2025 (see Figure 6.1h). In Pakistan the situation is already critical. More water is used than is sustainably utilizable. It is clear that the most massive and dramatic efforts in the intensification of irrigation have to take place in the four above-mentioned countries.

Figure 10.4a
Study countries with largest irrigated areas
S Asia relies extensively on irrigation while the crops in W Africa are mostly rain-fed (source: World Bank 2004a).



SE Asian countries are well represented among the countries with the largest irrigated areas. Agricultural water withdrawals are significant but so are the available water resources. Rice is the dominating crop. The major strategies for increasing the effective use of irrigation water in rice irrigation systems are introduced later in this chapter.

Figure 10.4b

Agriculture dominates in water consumption

Water use statistics by sectors and related to Gross Domestic Product in study region countries (source: FAO 2005 and World Bank 2004a).

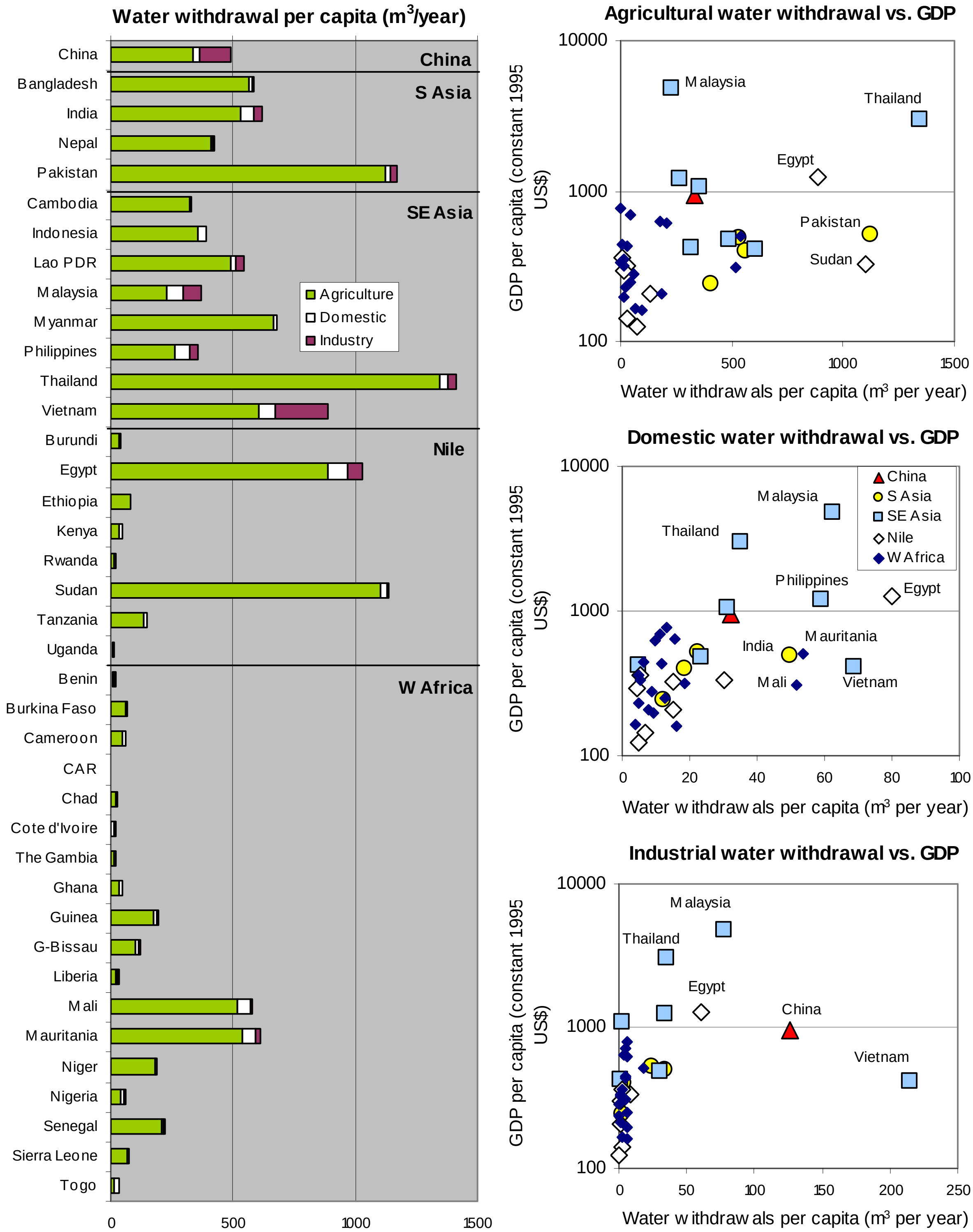
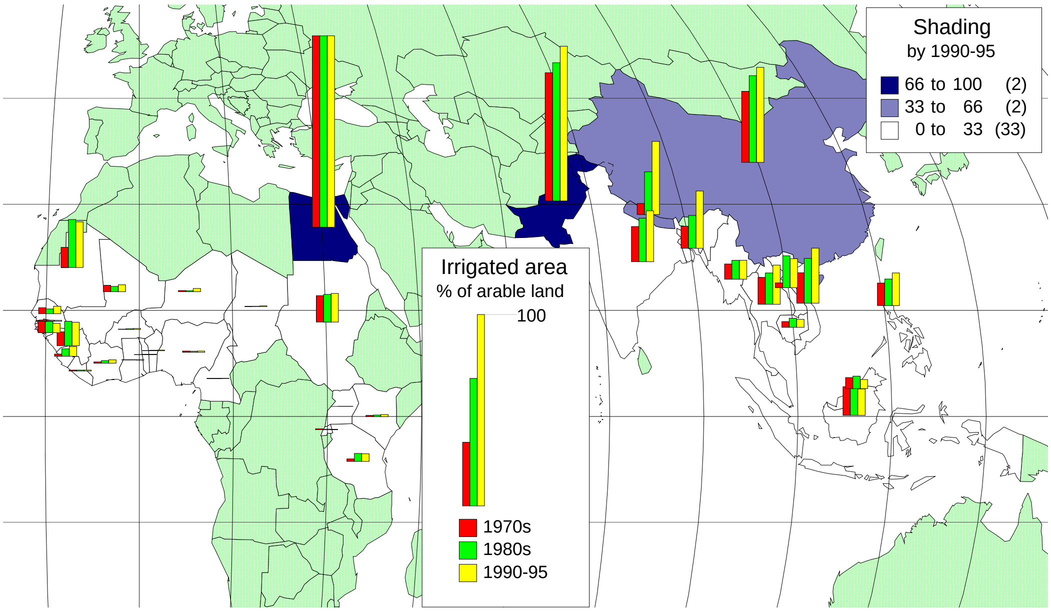


Figure 10.4c

Irrigated area

Egypt and Pakistan have a bigger share of irrigated area than the others. Source: World Bank (1997).



The world's most common irrigation technique is surface irrigation in which the crop area is entirely or partly flooded by water conducted in channels. Due to the evaporation and seepage losses surface irrigation is also the most water consuming irrigation technique.

When examining the major reasons for water losses in the top-four countries (Table 10.4a) it can be seen that seepage losses prevail. Evaporation and over-irrigation are considered as principal reasons for water losses as well.

Referring to above, the following six keys to improving irrigation efficiency seem to be well in place (FAO 2000):

- Lining of canals or using closed conduits to reduce seepage losses.
- To avoid irrigation during the mid-day and prefer under-canopy sprinkling (instead of overhead sprinkling) to reduce evaporation.
- To avoid over irrigation.

Table 10.4a

Principal reasons for water losses and the most suitable irrigation practices in China, Egypt, India, and Pakistan

Largest water losses in irrigation are due to the seepage and evaporation from the irrigation canals. Furrow irrigation and improved surface irrigation schemes are prioritized and followed by modern irrigation techniques (Source: ICID 1997).

	Principal reasons for water losses at farm level	**Most suitable irrigation practices (in order of priority)**
China	Losses from field ditches, lower uniformity and efficiency due to micro topography, improper scheduling and management	Small border or short furrow, improved design and management of surface irrigation with land levelling and sprinkler or micro irrigation
Egypt	Flood irrigation practices, neglect of night irrigation, unofficial cultivation of rice, lack of knowledge and insufficient farmers participation	Improved distribution and main canals, expansion of telemetry system and land levelling, and light irrigation
India	Seepage losses, over irrigation, high evaporation losses	n/a
Pakistan	Seepage through canals, water courses and fields, high evaporation, uncontrolled water supply to fields	Furrow irrigation, sprinkler, drip (for orchards in Quetta valley)

- To control weeds on inter-row strips and keep them dry.
- To plant and harvest at optimal times.
- To avoid crop distress by irrigating frequently with the right amount of water.

However it should be noted that often the percolating irrigation water is not wasted as it recharges groundwater aquifers and can be used somewhere else as a water supply. Water saved in an uncontrolled stream may have a lower real value than water stored in an aquifer. Therefore planning for water saving measures should take place on a basin-wide scale.

As illustrated in Table 10.4a there are also several principal reasons for water losses in irrigation which are not of technical background. These include uncontrolled water supply to fields in Pakistan, lack of knowledge and insufficient farmers participation in Egypt and improper scheduling and management in China. Hence managerial and institutional measures do have considerable scope for increasing efficiency in agricultural water consumption (Table 10.4b).

Table 10.4b
Managerial and institutional options for improving irrigation water productivity
Sources: Vickers (1999), Wallace and Batchelor (1997) in Postel (2000).

Managerial	• Better irrigation scheduling • Improving canal operations for timely deliveries • Applying water when most crucial to the yield • Water-conserving tillage and field preparation methods • Better maintenance of canals and equipment • Recycling drainage and tail water
Institutional	• Establishing water user organizations for better involvement of farmers and collection of fees • Reducing irrigation subsidies and/or introducing conservation-oriented pricing • Establishing legal framework for efficient and equitable water markets • Fostering rural infrastructure for private-sector dissemination of efficient technologies • Better training and extension efforts

Both dimensions, managerial and institutional, are closely interlinked. The establishing of Water Users' Associations (WUAs) and the devolving of irrigation management responsibility to them is believed to increase water-user participation in decision making, enable the collection of fees from farmers and increase the efficiency of operation and maintenance. Consequently government subsidies to irrigation decline. As a result cost recovery, agricultural productivity and water use efficiency should increase.

Studies concerning WUAs are numerous but rarely detailed and comprehensive. The results are mixed but show that equity and service areas have generally increased (Philippines and Vietnam in some cases, India, Lao PDR and Nepal). Increases in water-use efficiencies have likewise been reported (Smith and Jalal 2000). Although the eagerness to apply WUA approach has faded among many irrigation experts due to the mixed results, some still considers it crucial. According to Vidal et al. (2001) public incentives, irrigation management transfer to users and involvement of the private sector to relate crop marketing to water savings are necessary for successful water conservation and improved water use efficiency.

Introduction of modern irrigation techniques including sprinkler and drip irrigation has enabled considerable water savings in irrigation. Both methods minimize the evaporation and seepage losses by rationing the water in small doses to the individual plants. Studies have shown that drip irrigation can reduce water use by 30 to 70% while crop yields have raised by 20 to 90%. Suitable crops for drip irrigation are cotton, sugarcane and most vegetable and fruit crops (Postel et al. 2001).

Drip irrigation technique with its high capital cost ranging between US$1,500 and US$2,500 per hectare has been suitable for high-value crops such as vegetables and fruits with medium to large field areas only. However the vast majority of the world's farmers live in developing countries, are poor ,and cultivate plots smaller than two hectares being unable to afford drip systems. Fortunately low-cost drip irrigation systems which cost US$ 250 per hectare have been developed (Polak et al. 1997). These systems have already been purchased by 13,000 small farmers in India, Nepal, and Sri Lanka and water savings of approximately 50% have been reported (Postel et al. 2001)

Area irrigated by drip irrigation has increased by at least 75% since 1991 and today covers more than 2.8 million ha or 1.1% of the global irrigated area. Drip irrigation is still playing a minor role in the study regions where the share of drip-irrigated area is counted in per milles. The potential is however big. It is estimated that in India the drip potential is 100,000 km^2 or 20% of the irrigated land area being mainly located in the water-short states of Madhya Pradesh, Gujarat, Rajasthan, Maharashtra, Andhra Pradesh, and Tamil Nadu (Indian National Committee 1994). Out of the potential an area of 2,600 km^2 was drip irrigated in 2000 (ICID 2002). The potential in China is estimated to be approximately 100,000 km^2 out of which an area of 2,670 km^2 was under drip irrigation in 1998.

In terms of water savings drip systems can alleviate significantly water shortages. Kärkkäinen (2001) has estimated that at least 28.8 km^3 of water could be saved in the North China Plain alone by applying drip irrigation in vegetable and cotton production.

In terms of water-savings modernized surface irrigation schemes can be comparable with the modern irrigation techniques. This is due to the capability of farmers to adopt more easily to the modernized surface irrigation which is closer to traditional practices (Vidal et al. 2001).

The most water-consuming crop is Rice. In Asia where 90% of the world´s rice is cultivated half of the total irrigation water is used for rice cultivation. In SE Asia and W Africa where the main irrigated crop is rice, major part of the total water withdrawals is used for rice production. As rice cultivation differs considerably from the farming of other crops modern irrigation techniques are not applicable. However considerable water savings can be put into practice.

According to Guerra et al. (1998) the five major strategies for increasing the effective use of irrigation water in rice irrigation systems can be stated as follows:

1. Changing the crop and irrigation schedule to use rainfall more efficiently
2. Water distribution strategies.
3. Water recycling and the conjunctive use of groundwater.
4. Rehabilitation and modernization.
5. Strengthening managerial capacity and farmer cooperation.

It can be noticed that water saving strategies in rice cultivation are principally similar to those applied in traditional irrigation.

Wastewater reuse and recycling

Wastewater, if properly treated, can be used as a water source for several purposes including inter alia irrigation, aquaculture, groundwater recharge, industrial uses such as cooling, washing and boiler supply, recreation and environmental uses. In addition to the water saving aspect, wastewater reuse prevents environmental pollution and recycles nutrients. Due to the obvious and significant benefits wastewater reuse offer, it is becoming an integral part of integrated water resources management programs.

Several extremely water scarce countries, mainly located in the Arabian Peninsula and Middle East, rely on wastewater reuse. Israel, which reused 285 million m^3 of wastewater being equivalent to 18% of the total water supply, has the highest percentage of wastewater effluents reused in the world (Shelef 2001). Although wastewater reclamation is most commonly practiced in water short countries, which can afford advanced treatment facilities, such as Saudi-Arabia and Kuwait it is also widely found in low and middle-income countries. The following section describes wastewater reuse in the study regions and demonstrates that low cost treatment facilities for safe sewage reclamation in the developing world exist.

Reclamation of wastewater has long been practiced in China. Ponds have been used in rural areas over 2000 years to treat and utilize sewage. At present there are more than 100,000 ponds in China, which are mainly used for fish farming, duck or geese farming and growing of aquatic plants (Wang et al. 2001).

Urban pond systems integrating food production and wastewater treatment have evolved in China since the 1970s. These systems require large surface areas but are easy to operate, energy efficient and low in capital, operation and maintenance costs. In consequence pond systems have proved to be a good solution to alleviate the severe water shortages and pollution in poor regions where non-arable and uninhabited land areas are available.

Construction of advanced wastewater treatment facilities for reuse has proved to be economic as well. The first full-scale wastewater reuse project including a wastewater treatment plant was carried out in the Shanxi province in northern China in the beginning of the 1990s (Peng et al. 1995). The benefits of the project were obvious. Wastewater reuse resolved the water shortage in the Huifeng industrial area with an annual net gain of US$67,000. In addition environmental pollution was significantly reduced.

Egypt has a strong confidence in wastewater reclamation as an additional water resource in the future. It is calculated that 43% of the extensions of 24 km^3 of water required in the water supply side by 2030 will be met by drainage and sewage reclamation (see Box 10.4). Effective and beneficial low cost treatment system of domestic waste combined with wastewater reuse for aquaculture and irrigation has been developed in Suez, Egypt. The low- cost waste stabilization pond system enables efficient fish farming reach-

Box 10.4

Water politics and saving options in the Nile Basin

Source: Varis (2000)

The Blue Nile is by far the largest tributary in terms of water flow. Its share of the water that reaches Aswan in Egypt is 64%. The other two main branches that originate from Ethiopian Highlands, Atbara and Sobat, bring 21% of the water, whereas the contribution of the longest arm, the White Nile (upstream of Malakal, the Sudan), is only 15% (Hurst et al. 1959).

There are propositions from that direction, that it would be more efficient to grow grain in Ethiopia than in Egypt, since this would save huge amounts of water due to lower evaporation losses (cf. Woube 1994). The losses that could, in theory, be controlled by hydraulic constructions, amount to 6 km^3 (Allam et al., 1999). This option, evidently, faces strong opposition in Egypt. More modestly, the historic *droit acquis* of Egypt to the Nile's waters has been questioned many times. Since 'the time immemorial' Egypt has considered itself as 'a gift of the Nile' and sees that it has a historical 'priority of appropriation' of the river's waters that all upstream nations must honor (Tadesse 1998). Ethiopia sees clearly itself as the greatest provider of this 'gift' to Egypt. This situation does not only draw from the ancient times, but also from the colonial history of the 19^{th} and 20^{th} Centuries (El-Atawy 1996), as well as from the complicated peace process in the Middle East that has provided Egypt a special situation among the Nile basin nations.

The White Nile loses 96% of its rainfall water before the river reaches Khartoum. The huge evaporation losses at Bahr El-Ghazal and other regions upstream of Malakal in the southern Sudan could be reduced by bringing the construction of the Jonglei canal into end. INBA (1996) and Allam et al. (1999) present a figure as high as 51 km^3 a year as a volume of evaporation losses that could be controlled in the White Nile. This figure sums up the whole controllable potential in the regions of Kioga Lake, Bahr El-Jebel, and the Sudd Area (including Jonglei and Bahr El-Gazal). Abu-Zeid and Rady (1992) present a figure of 18 km^3 a year, which can realistically be added to the Nile flow by such projects. According to Stoner (1990), only the phase I of the Jonglei canal is expected to be completed before 2025. This would add the water flow to the High Aswan Dam by 2 km^3 a year (Elarabawy et al. 1998).

Knowing the aversion of multilateral financing organizations to fund these canal projects (given their vast environmental consequences) as well as political realities, it is questionable, whether the next decades will see much more intensive water use along the White Nile.

Egypt is likely to be an exception in many respects including the efficiency issue. It is striving for efficiency in its water use, and is expected to make further progress in this field. Its current—already high—water use efficiency can further be enhanced to a notable extent. Elarabawy et al. (1998) have calculated, that Egypt's present water use of 56 km^3 a year could be elevated up to 80 km^3 by the year 2030. This is required to facilitate the realization of the South Valley (Toshka canal) Project, which would allow the reclamation of 2,100 km^2 of desert to agricultural use, by abstracting 5 km^3 a year from Lake Aswan. The extensions required in the supply side (from 56 to 80 km^3) can be sustained by increased water use efficiency plus groundwater mining in the Egyptian territory. Irrigation improvement would save 5, reuse of drainage and sewage water 10.4, catching rainfall and flash floods 1, and ground water use 7.5 km^3 per year till 2030. Most meaningful implications to agriculture will be the strong reduction of the area of water-demanding crops, particularly rice and sugar cane (Magloff 1999).

Egypt's ambition for rural development through water investments is not only for producing more food and other crops. It is obviously also for providing employment for the rural population. Otherwise, the urban areas, the delta in particular, would be subjected to much higher immigration pressure than at present.

Besides controlling quantitative water losses, the water pollution control grows gradually in importance within the Nile basin. Although the Nile is not among the world's most polluted rivers (UNEP1995), it has severe local pollution problems, which culminate to the delta's poor water quality. Water pollution control has been acknowledged by the policy makers in Egypt, but the situation in the whole basin scale is towards worse. Better pollution control is a necessity in coming years in this water stressed basin.

ing an annual fish production of 5-7 tons per ha. Furthermore the effluent conformed to the WHO standards is used to grow trees and cultivate i.e. barley, maize and beets (Easa et al. 1995, Shereif et al. 1995).

As mentioned above wastewater aquaculture has long traditions in China but has long been practiced in S Asia and SE Asia too. For example in Vietnam, wastewater has been used for centuries for agriculture and aquaculture. At present the activities contribute significantly to the country's food production. E.g. in Hanoi well over half of the total fish production of 6,500 tons per year relies on wastewater-fed fish culture mainly concentrated in the suburban areas of the city (Vy 2001). Among the countries in the study regions commercially viable wastewater fish farming is also found in China and India.

Although the reclamation of treated wastewater is still fairly exceptional in the third world due to the low treatment capacity, the use of untreated wastewater for irrigation is common. Raw wastewater is broadly used in water-short areas as a water supply. Due to the rich nutrient content many small farmers rely on wastewater also in areas where water availability is not a problem. Major concerns related to wastewater irrigation are the adverse impacts on health and the possible groundwater and soil pollution by nitrates and heavy metals, respectively (IWMI 2002).

Mexico used 3.2 km^3 of wastewater to irrigate 2,570 km^2 of land in 1995 and is among the leading countries in terms of wastewater use in irrigation. Impacts to the groundwater quality have been studied in Mezquital Valley where the world’s largest and oldest wastewater irrigation project is located. Potassium, TDS, calcium, boron concentrations and the number of total coliforms exceeded the recommended values in at least half of the wells. In over 25% of the wells hardness, sulfates, nitrates and faecal coliforms exceeded the drinking water quality criteria (BGS 1995). Although water quality in the shallow aquifer is deteriorated, in the deep wells it still meets the Mexican drinking water standards if disinfected (Jimenez et al. 2000).

WHO (1989) has set guidelines for the quality of wastewater used for irrigation to minimize health hazards. These guidelines are however often neglected. Feenstra et al. (2000) have studied the health risks of irrigation with untreated wastewater in Punjab, Pakistan. The study showed that the prevalence of diarrheal diseases and hookworm infections was very high in the farmer communities exposed to wastewater. Their prevalence in the farmers’ children was also higher than in the control population. In cases where wastewater treatment is not feasible protective measures including e.g. information on hygiene behavior should be disseminated.

Water saving in municipalities

Water use is often inefficient in the cities of developing countries. Water supply systems are worn out and leakages may cause water losses of several dozen percents. In addition the price of water is still generally very low. The potential for water conservation in municipalities is thus considerable.

The percentage of unaccounted-for water (water lost through leaks or illegal connections) is generally high in many urban areas. According to a study carried out by ADB (1997) it is in average 35% in large Asian cities being as high as 65% in Hanoi and 61% in Phnom Penh. In African cities the situation is even worse. The average level of unaccounted-for water in urban water supply systems is about 50% (World Commission on Water 2000).

Reducing the amount of unaccounted-for water is crucial to increase water use efficiency. There are several ways to do it including the removal of public taps, intensifying metering of production and consumption, repair of leaks and elimination of illegal connections. Hueb (1999) emphasize the importance of institutional, managerial and operational adjustments in reducing the unaccounted-for water; major reasons for the inefficient operation of water supply systems being the lack of effective management and the lack of clearly defined objectives and policies.

According to Hinrichsen et al. (1998) more than 1/3 of the water wasted in cities could be saved by fixing the leaking community standpipes and household connections and tightening of the joints in the water pipes. It is estimated that 45.4 million m^3 of fresh water could be saved in Jakarta by fixing the leaking distribution pipes.

By using water conserving equipment in households and installing water meters, water savings can be achieved. For example in Tianjin City in northern China the municipal water use per capita has remained relatively low (128 liters per day) and unchanged since 1984 although the GDP of the city has grown tenfold between 1978 and 1996 (Bai and Imura 2001). For comparison domestic water consumption of 257 l per d and 217 l per d have been determined in Delhi and Bangkok, respectively (Asian Development Bank 1997). The high water use implicates i.a. low tariffs and the lack of metering.

In Mexico City annual water savings of nearly 28 million m^3 were achieved by replacing 350,000 conventional toilets with less water-consuming models. To encourage the installation of new water saving devices water tariffs were increased. In addition raising awareness of the citizens about the importance of water saving took place by educating children and spreading the word in radio and television (Postel 1992).

Raising of awareness may play an important role in water saving campaigns as in the case of Mexico City. Psychosocial interventions may significantly reduce municipal water consumption. German Advisory Council on Global Change (1999) has assembled from various studies the following factors which have led to reduced water consumption:

- a perceived social norm of saving water,
- low-cost installation of water-saving fittings
- a rise in water prices,
- communicating the situation as a commons dilemma (long-term benefit of saving water for all

people; effectiveness of personal water-saving behavior),

- a combination of information campaigns and a personal duty to help save water,
- a combination of consumption feedback and generation of cognitive dissonance, and
- water-saving programs involving a combination of educational (e.g. information, appeals, consumption feedback) and regulative elements (e.g. temporary consumption restrictions).

Still another way to improve municipal water use efficiency at national level is to set national standards for water using devices including inter alia shower heads, toilet flushes and washing machines.

Saving water in the industrial sector

Significant water savings are possible in the industrial sector by increasing the water recycling ratios. This is possible as just a fraction of the water is consumed. The largest part is used for cooling and processing and finally released back to the environment.

Pollution control laws have played a great role in the intensification of water use in the industrial sector in developed countries. Among with the strict wastewater quality standards industries have found that the most effective and economical way to meet the standards is to recycle and reuse water (Postel 1992). According to Dunglas (1998) the most effective way to promote water recycling in industries is progressive taxation of effluents.

Examples of successful water savings are numerous. Japan more than tripled its industrial water productivity (industrial output per m^3 of water input) from US$ 21 in 1965 to US$ 77 in 1989. In Sweden the pulp and paper industry quadrupled its water productivity between the early 60s and late 70s. United States has had glorious water conservation programs as well. IBM in San Jose reduced its water use from 420,000 m^3 per year to 1/10 of that amount; the payback period on investment being just 3.6 months (Postel 1992).

In developing countries the situation is different. Incentives for efficient water use are rarely given. Water and wastewater charges are low and pollution control regulations are marginally enforced. Untreated wastewater is commonly discharged into rivers. On the other hand industrial water use still represents just a minor fraction of the total water use in the Third World. Industrialization is however rapid and the water use in industries is expected to rise significantly meaning increasing pressure on water conservation.

Encouraging examples of increased water use efficiency in industry can be found in the developing world too. In Tianjin, the largest industrial center in northern China, intensification of industrial water use has been vigorous. Annually 36 million m^3 of fresh water is saved by using seawater for cooling in power industry (Bai and Imura 2001). This is equivalent to an annual water use of 770,000 citizens. Water recycling ratio has increased from 40% to 74% in ten years. The present ratio is the highest in China, being comparable to the Japanese level. One reason for the high recycling ratio in Tianjin is the quota system applied for the water use. Enterprises which exceed the given quota in water use are required to pay the water rate in two to ten times.

Water pricing saves water

According to the Dublin Principles water has an economic value in all its competing uses and should be recognized as an economic good. In practice this means that water should have a price to achieve efficient and sustainable use of water. World water commission agrees with the Dublin principle by recommending that the full cost of water services should be recovered from users. Rogers et al. (2002) list the effects of water price policy out of which several are interconnected to the intensification of water use. Among with water pricing conservation of water becomes affordable, economic incentives are provided to reduce water losses and managerial efficiency improves.

Although intensifying water use, high water tariffs are criticized because these are said to discriminate poor people. Poorest of the poor can not pay for water. However low water price has negative effects on water supply systems by inducing poor service, low coverage and inadequate supply. The most adversely affected people are often the poor with no access to water supply system. They have to spend 5-15% of their income on water bought from vendors (Ahmad 2000).

As concluded by Rogers et al. (2002) water pricing improves in many cases the distributional equity of water supply for the poor. In addition there are tariff structures, such as the Increasing Block Tariff systems (IBTs), which are suitable for providing water at low-rates for poor if necessary.

In agriculture the water pricing is more problematic. The full cost of water can not be charged from farmers as the total economic value per m^3 of water is orders less than in the domestic and industrial sector.

Rogers et al. (1998) have calculated the total economic values of water (sum of net value of crop output and values of return flow, water in non-irrigated uses and other societal objectives) and total economic costs of water in Subernarekha Basin, India. The total economic value was 9.7 cents per m^3 and the total economic cost was 65 cents per m^3. The water tariff paid by farmers was just 0.1 cents per m^3. It is clear that in these kind of situations government has to subsidy farmers considerably.

Irrigation water tariffs are commonly very low in the third world countries. Additionally, especially in S Asia, it is common to charge a flat rate according to the irrigated land area and crops cultivated. The price does not depend on the volume of water consumed promoting wasteful use of water. Volumetric pricing of water is thus advisable but unfortunately often too demanding to implement in large canal irrigation schemes.

Rational water pricing results in more sustainable operation and maintenance of water systems. In this context users should pay at least the operation and maintenance costs. The reality is however different. For example in India and Pakistan irrigation operation and maintenance cost recovery is just 20 to 30% meaning that the state remains heavily involved in operating irrigation systems (Dinar and Subramanian 1998).

There is potential for increasing water prices in agriculture. In Haryana, India, farmers are known to spend 20% of the net value of output from crops for a timely and reliable groundwater supply indicating high willingness to pay (Rogers et al. 1998). Typically water charges amount to just 2-5% of the harvest’s value in India (Postel 1992).

Before a water pricing reform could effectively take place certain institutional conditions are needed. These include an independent water pricing agency and regulatory institution, clearly defined water rights, financially autonomous agencies to supply water and management transfer to water users´ associations or private sector (Saleth 2001). The institutional changes are not easy. In addition all this need the full support of government which is not axiomatic in the often institutionally weak developing countries.

Summary

It is clear that intensification of water use is gaining more and more importance as the water demand is continuously rising. Meanwhile water withdrawals are approaching their limits and water quality is deteriorating. As the water scarcity will increase more efficient water use is a sine qua non. Fortunately potential for water savings exists.

Globally irrigation’s share of water use is 70%. Large surface irrigation schemes with high water losses dominate indicating large potential for water savings. Intensification of irrigation is achieved by modernizing existing schemes and intensifying operation and maintenance by devolving management responsibilities to water users. Application of modern irrigation techniques such as drip irrigation saves significantly water but is uncommon in developing countries. In India and China the potential for drip irrigation is estimated to be approximately 20% of the irrigated area.

Just a small part of water withdrawals is actually consumed. In the industrial and municipal sectors 80-98% of the water withdrawn return to the environment (Babillot and Lourd 1998). This amount, if properly treated, is in theory utilizable e.g. for irrigation, aquaculture and industrial uses. Low-cost wastewater treatment facilities which meet the effluent standards set for wastewater reuse exist. The pond systems requiring large surfaces are practicable in areas where additional land is available (e.g. Egypt, NW China). In China advanced treatment facilities have proved to be cost-effective solution for water shortages as well.

Water use in municipalities is generally inefficient in developing countries. Unaccounted-for water in Asia and Africa, is 35% and 50%, respectively. Intensification of water use in cities can take place by repair of water distribution systems, water pricing, and institutional, managerial and operational adjustments. Water can be saved by raising public awareness as well.

Industrial water use is just a fraction of total water use in developing countries. However among with the industrialization the industrial water use will significantly increase. Developed countries have demonstrated how considerable industrial water savings can be by increasing recycling ratios. China, as a developing country, has improved significantly its industrial water use efficiency during the last decade. Efficient ways to intensify water use in industries are i.a. pollution control laws, progressive taxation of effluents and quotas.

Water pricing encourages conservation of water in all sectors and leads to more efficient water use. Water tariffs are however low in developing countries promoting wasteful use of water. Potential for rising water charges is considerable but realization of water pricing reform in practice is difficult. The required institutional changes will perhaps be the greatest challenges.

10.5 Watershed management

Tommi Kajander

Watershed degradation belongs to the most serious environmental problems in many parts of the Third World. Economic, social and ecological consequences hinder the efforts towards sustainable development. As a response Watershed Management is becoming increasingly important. The concept has developed during the past decades and is nowadays widely applied. It has preserved nature, brought economic benefits and reversed many adverse cycles of environmental degradation and poverty. Still big challenges and constraints in watershed management exist.

Introduction

In developing countries, watershed degradation is becoming an increasingly common phenomena due to natural but especially anthropogenic causes. Poor people which often rely on subsistence agriculture and fisheries are directly dependent on the watershed´s natural resource base for food, fuel, and fiber. The link between the state of the watershed and human welfare is strong. On the other hand people living downstream – often urban dwellers or commercial farmers – depend on the availability and quality of water originating in the upper parts of the watersheds.

Watersheds offer goods and services such as water, food and wood. Utilization of these natural resources contributes to watershed problems which affect adversely people´s livelihoods. The vicious cycle arises. Undesirable side-effects, among them erosion, decline in agricultural productivity, run-off pollution, and reduction in biodiversity and water availability occur and touches both: upstream and downstream people.

Watershed management (WSM) is a concept for tackling the watershed problems and their causes. It is indispensable in protecting/rehabilitating the goods and services offered by the watersheds. Application of watershed management is thus important in societal, economical and environmental terms.

This chapter starts by discussing watershed problems and their reasons and consequences in the developing world. Overview of watershed management concepts, issues and constraints follows after which application of the approach in the study regions is discussed.

Watershed problems: causes and consequences

Watershed or catchment is defined as the total area above a given point on a watercourse that contributes water to its flow. It is thus obvious that changes in the characteristics – biophysical and socioeconomical – of the watershed affect water quality, water flow and biotic resources. This in turn has direct impact on the livelihood of billions of poor rural people which are dependent on the natural resources of the watersheds as well as economic sectors at larger scale.

Watersheds in the study regions are undergoing rapid changes. Ever increasing population and widespread poverty pose continuous stress to river catchments. As discussed in chapter 6.2 land degradation is common in Africa and Asia ranging from desertification to water erosion and soil fertility decline. Major causes to land degradation are deforestation in Asia and overgrazing in Africa. In many places farming practices such as shifting cultivation contribute significantly to watershed degradation as well.

According to Magrath and Doolette (1990) the major watershed problems in Asia are:

- Loss of agricultural production due to erosion
- Deforestation
- Population and poverty
- Downstream sedimentation
- Flooding
- Dry season stream flows

From the above list it can be noticed that soil erosion, often driven by forest clearance, seems to be one of the major concerns in watershed problems. This is especially true in the upper watershed areas which have commonly steep slopes. Erosion increases downstream sedimentation and flooding as the river beds rise and water conductivity in the channels reduces.

Sedimentation is a serious problem in terms of its harmful impacts on water infrastructure. Lifespan of dams and irrigation systems are in cases considerably shortened. For example the expected life of Nizam Sugar reservoir in India occurred to be just 6% of its designed life due to unexpectedly high sedimentation rates (Brown and Wolf 1984).

In addition to sedimentation induced problems, erosion degrades soil quality in natural, agricultural, and forest ecosystems. This reduces the productivity of the land which affects agricultural production and finally the livelihoods of farmers. Reduced productivity of land diminishes also the diversity of plants, animals, and microbes. Consequently the entire ecosystems are threatened (Pimentel et al 1995).

Besides erosion, watershed degradation has extensive hydrological impacts. In a comprehensive review Bruijnzeel (2004) scrutinizes the hydrological functions of tropical forests. Along with the forest biomass removed, the total annual water yield in the watershed increases.

It is a common statement that deforestation decreases low flows. However the issue is not so straightforward, as in many cases the key factor determining peak and low flows is the rainfall infiltration capacity of the soil. If the surface disturbance (compaction of topsoil, disappearance of soil faunal activity, increases in impervious surface area) is limited dry season flows commonly increase. Thus e.g. applied logging practices count a lot. However land degradation and reduced infiltration opportunities often follow land clearance. Consequently peak flows increase and low flows decrease (Bruijnzeel 2004).

One less discussed annual problem in the degraded watersheds are landslides. These claim hundreds of lives each year. The phenomena is common in the denuded steep slopes with low-stability soil types and high intensity rainfalls. Landslides and their prevention by watershed management is discussed in Marui (1988).

Watershed management: concepts, issues and constraints

MRC and GTZ (2002) defines watershed management as following:

"Watershed management is the co-ordinated multi-stakeholder management of land, water and other resources within a watershed, with the objectives of: conserving or rehabilitating resources and environment; ensuring biodiversity; minimising land degradation, achieving specified and agreed land and water management targets and promoting social and economic development."

The definition does not really differ from the definition of Integrated Water Resources Management (see e.g. GWP 2000). However WSM has a stronger environmental and ecological focus. It aims to secure/rehabilitate the goods and services offered by watersheds and deals commonly with forest and land resources. IWRM aims primarily to efficient and equitable development and management of water resources to promote economic and social development without compromising the sustainability of ecosystems. Watershed management should definitely be an integral part of IWRM.

The concept of watershed management dates back to the 19th century when European countries started to control the debris and floods in the mountain streams and drainage basins. The approach expanded to developing countries during the colonial period (Brooks and Eckman 2000). From the 1960s to 1980s focus in watershed management was commonly on the restoration of degraded water and land systems. Aim to protect water infrastructure investments was often driving the watershed management activities. As will be later discussed this tendency is still dominating in many parts of the study regions.

Watersheds are complex to manage. Multiple number of stakeholders are using the water upstream and downstream for many purposes while environment is requiring its own share. While the reasons behind watershed degradation are many-folded, these are often anthropogenic in nature. The importance of human dimension in watershed management was realized in the 1970s when integrated approaches were developed (Sheng 2001). The aim moved to sustaining natural resources with an emphasis on human resources and their environment. Focus has turned to the root causes of watershed degradation instead of just curing the problems.

Catchment management is commonly motivated by the following main issues (Swallow et al. 2001):

- On-site land productivity and the welfare of the people relying on that land
- Annual water yield flowing into the reservoirs used for hydropower, irrigation and municipal water supply
- Peak flow of water and the implications for floods in the lowland areas
- Dry season stream flows that are directly used from the river for people, animals or industries
- Appearance and safety of water in lowland areas
- Sedimentation of lowlands, reservoirs and lakes

As can be seen from the objectives listed above, most of the benefits achieved from watershed management goes to the downstream people. This leads us to one of the major challenges in watershed management programs. How to get upstream people involved in activities when the benefits go mostly elsewhere? Solutions include e.g. the use of incentives which can be direct or indirect (FAO 1989). On the other hand integrated watershed management aiming simultaneously to poverty reduction, balance the distribution of benefits.

The diversity in scales and factors influencing watershed management (table 10.5a) tells about the complexity and multidisciplinary nature of watershed management. Nowadays, the so much highlighted integrated approaches seem to be well in place.

Table 10.5a
Factors influencing watershed resources use and management at different scales
Source: (Thapa 2001).

Scale	Factors
Household	Labor force, landholdings, land tenure, education, non-farm employment, training, interaction
Watershed	Altitude, slope, soil, climate, extension, credit, institutions, indigenous knowledge, social structure, accessibility
Regional	Transportation network, market centers, flow of goods and services, planning system
National and international	Laws and policies: market prices, property rights, benefits sharing, planning system

Factors above explain the variety of possibilities in watershed management activities. Although consensus about the necessity of integrated watershed management is strong, its implementation in practice is extremely challenging. Successful projects are lacking in the developing world.

According to Perez and Tschinkel (2003) most of the watershed management projects implemented during the past twenty-five years have tried to combine two goals: resource conservation and poverty alleviation. However neither of these goals have been satisfactorily achieved. Activities have commonly focused on the poorest segments of the watersheds. Efforts have often been put on farmers´plots instead of focusing to the whole catchment. Thapa (2001) states that changes from the traditional top-down watershed management projects towards participatory and integrated approaches has been cosmetic and ineffective. Tendency has still been towards vegetative and structural measures while institutional structures have remained in disarray. Also lot of improvements in participatory planning process is needed.

To have effective watershed management it is critical to use conservation criteria to define the target area and population. In addition the most locally appropriate poverty reduction activities have to be defined. Perez and Tschinkel (2003) emphasize also the scale of interventions. Well-focused actions in one part of the watershed can have significant impacts on the whole watershed. Inclusion of all stakeholders and the application of participatory approaches in watershed management is indispensable in terms of sustainability (Johnson et al. 2001). Dombeck et al. (1998) highlight the balance among the diversity of interests; a shared vision or collective goal for conserving or restoring healthy ecosystems, and a commitment to use the best available science, as the critical principles for successful community-based projects.

In this chapter it is out of scope to review the numerous practices to watershed management. Instead some general principles are discussed. Means of watershed management include i.a., soil and water conservation, and land-use control. The basic restorational measures can be divided in three classes: vegetation measures (planting forest, cash trees, etc.), engineering measures (terracing, small storage works, checking dams, bank protection works, etc.), and tillage measures (contour farming, rotation cropping, development of agroforestry, etc.) (Lixian 2002).

For further information about vegetative and soil treatment measures in watershed management see Schiechti (1985). Conservation in arid and semi-arid zones is discussed in e.g. Kunkle and Thames (1976). For WSM in developed world see e.g. Naiman (1992).

Overview of the major watersheds in the study regions

Major watersheds of the study regions and some of their characteristics are listed in table 10.5b. Differences between the areas can be found.

Among the major basins largest share of eroded area (27%) is found in the Yangtze basin, China. Similar problems are found in the Yellow River catchment out of which 20% is eroded. Population densities in these rivers are relatively high while protected areas cover only 1.3% of the Yellow River basin and 1.7% in the Yantze Basin.

South Asian major watersheds stand out from the rest by high population densities. Ganges basin provides domicile to 401 people per km^2. Eroded area exceeds 10% in all the watersheds with the exception of the Indus River.

Southeast Asia is blessed with humid tropical climate. Its major watersheds have no arid area. Irrawaddy and Mekong basins have lost less than 70% of their origi-

Table 10.5b
Some characteristics of the major watersheds in the study regions
Source: IUCN et al. (2003), Kajander (2001) and the references within, Revenga et al. (1998) and FAO (1997).

Basin	Surface area (km^2)	Mean annual discharge (km^3)	Loss of original forest cover (%)	Eroded area (%)	Arid area (%)	Protected areas (%)	Population density (people/km^2)
China							
Yangtze	1,722,193	951	84.9	27	0	1.7	214
Yellow River	944,970	66	78	20	38	1.3	156
South Asia							
Brahmaputra	651,335	598	73.3	11	0	3.7	182
Ganges	1,016,124	525	84.5	10	26	5.6	401
Godavari (India)	319,810	111	76.9	15	43	3.5	202
Indus	1,081,718	178	90.1	4	63	4.4	165
Krishna (India)	226,037	78	80.2	20	41	4.2	265
Southeast Asia							
Chao Praya	178,785	30	77.3	24	0	11.7	119
Irrawaddy	413,710	410	60.9	9	0	0.6	79
Mekong	805,604	475	69.2	21	0	5.4	71
Salween	271,914	157	72.3	4	0	2.2	22
Red River	170,888	137	80	23	0	3.8	191
West Africa							
Senegal River	419,575	20	99.9	1	82	5.7	10
Lake Chad	2,497,738	0.5	99.9	2	83	10.2	11
Niger River	2,261,741	177	95.9	10	65	4.9	31
Volta River	407,093	38	96.6	19	60	7.7	43
Nile	3,254,853	80	91.2	5	67	4.5	46

nal forest cover which is exceptional among the selected river basins. Erosion is a major problem in the watersheds of Chao Praya, Mekong, and Red River where eroded area exceeds 20%. Thailand has protected 11.7 % of the Chao Praya watershed which is more than in any other river basin.

In the African regions practically all of the original forest cover is lost. On the other hand all the watersheds are mostly arid in nature. The percentage of the arid area varies from 60% in the Volta River basin to 83% in the Lake Chad basin. This can be also seen from the low annual discharges (compared to basin area). Consequently the forest cover has already originally been limited. The prevailing aridity makes the watersheds particularly vulnerable to desertification.

In the African watersheds population densities are relatively low and basin areas exceptionally large. Erosion seems not to be a major problem except in the Niger and Volta watersheds where the portion of eroded area has reached 10% and 19%, respectively. In the Nile Basin most of the eroded area is found in the steep slopes of Ethiopia which struggles with extreme land degradation problems (Hagos et al. 1999).

Watershed management in the study regions

China

China is experiencing the most serious water and wind erosion in the world. Eroded area covers an area of 3.67 million km^2 or 38 % of the country´s total area. Approximately half of this area is affected by wind erosion while the other half suffers from water erosion (Chinese Ministry of Water Resources 2003).

In all reason, the People´s Republic of China is putting a lot of effort to tackle with the top environmental problem. Watershed management dates back to the early 1950s and is nowadays an important part of environmental conservation in the country. Activities has been taken at all scales from farm level to national policy level.

Watershed management is included in the national economy and social development plan telling about the integration of the concept. Many laws, policies, and regulations concerning natural resources conservation have been formulated. These include e.g. the Water and Soil Conservation Law, the Forest Law, and the Water Resources Law. Clear national objectives for watershed management and means to achieve these have also been determined. Government approved the first National Program for

Water and Soil Conservation Planning in 1993 followed by the National Plan of Ecological Environment Rehabilitation in 1998 (Chinese Ministry of Water Resources 2003).

Although national laws and plans have been developed some areas are selected as key control areas requiring more effort on soil and water erosion control. Key control areas include i.a. Shaanxi and Inner Mongolia in the middle reaches of Yellow River (see Box 10.5a below), upper reaches of Yangtze River, Three Gorges reservoir area, and the sandstorm zone north of the Great Wall.

Box 10.5a

Soil and water conservation on Loess Plateau of China

Source: Xiubin et al. (2003), Ziqiang et al. (2002) and Chinese Ministry of Water Resources (2003).

Loess Plateau situated in the middle reaches of the Yellow River experiences one of the most serious soil erosion in the world. It covers an area of more than 600,000 km^2 and is inhabited by 82 million people (the figures for the whole Yellow River Basin are 795,000 km^2 and 110 million). Most of the Loess Plateau´s population are poor farmers which have been struggling with low yields. Loess Plateau contributes 58% to Yellow River´s annual runoff (68.8 km^3) but nearly all of the sediment load. Sedimentation consequent to erosion has led to i.a. frequent basin-wide droughts, flood disasters and reservoir siltation in the lower reaches of Yellow River. High sediment concentration of the water impedes its use to irrigation and industrial activities as well.

In response to the socio-economic problems and severe soil erosion in the Loess Plateau, soil-water conservation strategy of watershed management has been carried out since the late 1970s. Structural and vegetative measures were widely applied. Earth dams were constructed and trees or grass planted. In addition farming practices were intensified by improving tillage technology and irrigation. The activities got further boost in 1994 when the World Bank financed the water and soil conservation project with a sum of US$ 150 million. This was followed by another equal loan in 1999. The project combined closely water and soil erosion control and the improvement of peasants´ livelihoods.

The massive soil-water conservation program has had significant impacts on the grain yields and soil erosion. Food self-sufficiency has been achieved as the grain production has tripled to 3150 kg/ha since the times before the conservation efforts. Out of the erosion area 24% has been controlled. Consequently sediment concentration in the Yellow River has decreased by 25%. On the other hand deep soil water has depleted, runoff in the Yellow River has decreased and consequently ecological problems have occurred. Forest and cropland plantations are increasingly suffering from water stress. According to Xiubin et al. (2003) this might well be due to the soil-water conservation measures. In the present situation government is forced to change land use priorities. Ecosystem restoration is outstripping food security.

Watershed management activities at small scale have also been promoted. Since 1992, small watersheds have been treated with household-responsibility contracts. The constraining effects of lacking land tenure have been removed by reform measures including auction of the use right, land leasing, and shareholding cooperation.

Such profound watershed management activities have had significant impacts on the environment and socioeconomy. The erosion controlled area has reached 859,000 km^2 including i.a. building of basic farmland (133,000 km^2) and planting of soil and water conservation forest (433,330 km^2). Consequently 25 km^3 of water and 1.5 billion tons of soil is saved (Lixian 2002). The income of farmers has increased.

South Asia

South Asia is very vulnerable to watershed problems as the population densities in the river basins are often extreme, poverty is widespread, and the water resources are very unevenly distributed due to monsoon climate. In addition the world´s largest massif – the Himalayas – covers the upper watersheds of the major rivers. The slopes of the mountain range are undergoing rapid environmental degradation as the pressure on natural resources is considerable. Soil degradation is a very real problem in the Himalayan slopes. Rates of soil erosion and land slides have increased and consequent soil losses and nutrition depletion occurred. The yearly destructive floods in S Asia are a common phenomena and commonly attributed to watershed degradation. Challenges in watershed management are tremendous on the subcontinent.

As a response large scale activities has taken place. According to Nishat (2001) catchment management activities in the Ganges-Brahmaputra-Meghna region include macro-scale forest management to rehabilitate the badly deforested Himalayan slopes. This is suppose to reduce the significant flooding problems occurring downstream.

Extensive land degradation in the mountainous kingdom of Nepal is characterized by deforestation, mass wasting, erosion, flooding and water logging. Main reasons behind the degradation are marginalized agriculture, livestock grazing, and fuel wood and timber cutting activities (Balla et al. 2002).

Watershed problems have reached a status of national concern. The department of Soil Conservation and Watershed Management was established already in 1974. Community forestry and watershed management have been recognized in the five-year plan of Nepal as programs supporting poverty alleviation. Thapa (2001) highlights the multitude of institutions dealing with watershed management. These vary from line agencies at national and provincial levels to donor agencies. Institutions act often in isolation to each other and without coordination. This consumes the scarce resources and decreases the efficacy of the projects.

What ever the national efforts and institutional challenges are, hill farmers of Nepal have long practiced indigenous watershed management systems. These encompass terracing (30% of the country´s arable land is terraced), control of shifting cultivation, relay and mixed cropping, grazing in forests and open grounds, and retaining trees on upland terraces (Balla et al. 2002).

In Pakistan watershed management is focused on erosion control. No wander as 76% of the nation´s land area is affected by wind and water erosion. Pakistan Water Sector Strategy (Ministry of Water and Power 2002) highlights the siltation problems of major reservoirs and irrigation systems. Catchment management has been undertaken since the early 1970s encompassing i.a. reforestation and construction of silt traps. Despite considerable reforestation efforts (1.2 million ha since 1970s) forested area has decreased. About 88% of the loss of forest is due to wood cut for fuel. Consideration of human and social dimensions in watershed management is fundamental to its sustainability.

Watershed projects in India, although dating back to 1970s, got a big boost in the late 1990s. With an annual budget exceeding US$450 million, watershed development has become a focal point in rural development. Large-scale technocratic top-down approaches dominated in the 80s while more recently the focus has moved towards greater local participation. Also acceptance of local technologies has increased. Consequently watershed projects have achieved better performance in natural resources conservation and agricultural productivity (Kerr 2002). Still widely successful projects are a rarity.

Mohile (2005) highlights the major drawbacks in the Indian watershed management:

- There are very few instances where watershed management is integrated in the overall development plans

- Storing of the non-effective part of rainfall in field ponds (rainwater harvesting in irrigated fields) is not practiced

- Success stories have been considered as separate alternatives instead of a complementing component of a master plan

- Reduction of sediment load (improving reservoir efficacy) has been overemphasised while soil & water conservation aspects have been underemphasized. Controversies about financing has resulted in impediment of watershed management and reservoir projects.

One common problem in Indian watershed management projects is the uneven distribution of benefits. Due to conservation of common lands, landless people loose the access to vital forestry resources which makes their living even harder. Meanwhile the benefits go to landholders of large areas downstream. In such cases indirect benefits for the poor including e.g. peripheral activities or increased agricultural employment are needed (Kerr 2002).

Southeast Asia

As discussed in the context of loss of ecosystems and biodiversity (Chapter 6.5), SE Asia is by far the leading macro region in the world in terms of deforestation. It lost 6.7% of its forest cover in just five years (1990-1995). Deforestation is clearly the main issue in the region´s watershed problems.

In the policies dealing with the management of upland areas, watershed protection is the major objective in most of the SE Asian countries. In northern Thailand, Indonesia, and the Philippines, primary focus in watershed management has been on sustaining water quality and quantity by maintaining the forest and tree cover in the upper watershed areas (Swallow et al. 2001).

Watershed protection is commonly carried out by conserving valuable areas in terms of their hydrological functions and biodiversity. In 1993, Lao PDR established National Biodiversity Conservation Areas covering no fewer than 13% of the country. However, adequate financial resources for proper management of the areas is lacking (Badenoch 1999). A common problem in all of the Lower Mekong Basin countries is the weak enforcement of protected area management (ARCADIS Euroconsult 1999). See Box 10.5b below.

Box 10.5b

Watershed management in the Lower Mekong Basin (LMB): challenges and strategies

Source: ARCADIS Euroconsult (1999), Kristensen (2001), MRC and GTZ (2002) and MRC (2003).

Although the Mekong River is considered relatively unexploited, large part of its watershed is deteriorated. The degradation is a considerable problem as the LMB´s riparian nations: Cambodia, Laos, Thailand, and Vietnam depend to a great extent on the natural resources of the river basin. 17% of the Lower Mekong Basin´s population live in the forests and are directly dependent on the forests (ARCADIS Euroconsult 1999). Neither should we forgot the majority of the people dependent on the basin´s fisheries and paddy fields which rely on the availability and quality of water resources. Activities in the upper watersheds affect water quality and quantity downstream and might consequently disturb whole economic sectors.

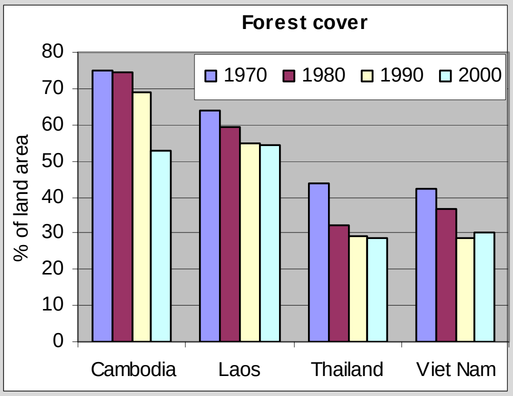
Loss of forest resources in term of quantity and quality, seems to be the main watershed problem in the LMB. Nearly fifth or 18% of the basins surface area of 619,000 km^2 is degraded (ARCADIS Euroconsult 1999). Between 1993 and 1997 LMB lost two percent of its forest cover (MRC 2003) most of which was found in the upland areas. Also the composition and structure of forests has degraded. Watershed degradation is most serious in Laos where mainly shifting cultivation has degraded 81,000 km^2 or one third of the country´s territory. The past political instability and unrest has taken toll of the Cambodian forest cover. Also driven by loggings, deforestation rates in Cambodia have been highest among the LMB countries during the past two decades (Figure 10.5). Although Thailand banned logging in 1989 and forest clearings slowed down, deforestation still takes place in the Thai parts of the Mekong Basin. Reasons include conversion of forest land to agricultural land, shifting cultivation areas converted to permanent cropping, forest fires, over-grazing, mining and logging. Wood demand in Thailand is a major driving force of loggings in Cambodia and Laos. Large-scale reforestation programs in Vietnam have bored fruit. Vietnam is the only country in the basin which has gained forest cover during the past decade. However, nearly 90% of the reforested area is composed of mono-culture plantations which significantly decreases biodiversity (MRC 2003).

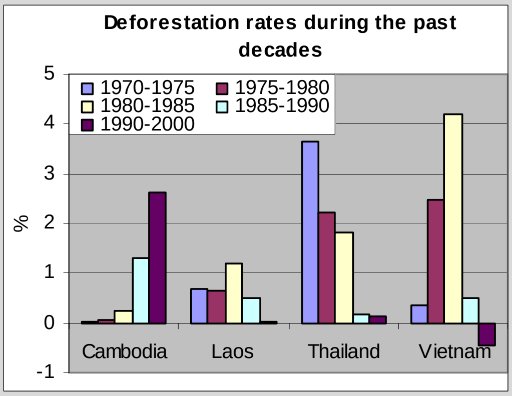
Figure 10.5

Forest cover and deforestation rates in the Lower Mekong Basin countries during the past decades

Cambodia is the only country where deforestation rates have still been growing

Source: FAOStat 2004, Data for year 2000 from World Bank 2003





According to MRC and GTZ (2002) watershed degradation has lead to serious environmental and socio-economic problems in the LMB. These include loss of ecosystems and consequent reduction in supply of timber and non-timber forest products, increased erosion, and decreased water regulation capacity. Also declined spiritual, cultural and recreational values are attributed to watershed degradation. It is often the ethnic minorities who suffer as these mostly inhabit the upland watersheds.

All of the LMB countries have responded to watershed problems at some level. However, any of the governments has formulated an explicit policy or strategy on watershed management with the exception of Cambodia who issued a Royal Decree on watershed management in 1998. Still many laws are very relevant to watershed management varying from environmental protection and water resources laws to land and forest laws. Unfortunately this complicates effective implementation of WSM as the number of regulations and institutions involved in watershed management activities is often very high. Each of the countries has also a number of projects concerning watershed management. These encompasses small NGO projects as well as larger donor driven watershed management projects. For further information on WSM in the Lower Mekong Basin see MRC and GTZ (2002).

MRC and GTZ (2002) identifies eight key constraints on the successful implementation of watershed management in the LMB. These are:

- The significant number of line agencies and stakeholders involved in the WSM implies i.a. high co-ordination needs and joint responsibilities. The common sectoral set-up and thinking constrain the integration.
- Present national guidelines and planning procedures in the LMB countries follow administrative boundaries instead of physiographical boundaries.
- Institutions involved in WSM are understaffed and lack expertise.
- Regardless of policies, the local people should make the ultimate decisions about the use of watershed´s natural resources. Generally this is not recognized well enough.
- Constraints on local participation. These include e.g. mistrust of local authorities, lack of village-level social cohesion in war-affected areas, and traditions of top-down land allocation and adjudication.
- Weak enforcement of regulations due to inter alia limited local management capabilities. Problems with conflicting regulations.
- Problems occurring in the land tenure and allocation systems. These include insufficient ownership security of smallholders, traditional land-use rights and land-use allocation processes conflicting with government land zoning.
- Weak enforcement has lead to overexploitation of forest resources by legal and illegal loggers. Destructive log transportation and logging practices further increases the watershed degradation.

Although the biggest player in the region – the Mekong River Commission (MRC) – does not have a separate watershed management programme it has developed a catchment management approach to Mekong Basin at the tributary level. The whole basin is divided into subdivisions a.k.a catchment areas. The use of the natural resources of the catchments is tried to be optimized by considering all the sectors (agriculture, forestry, fisheries, environment, local services, socio-economic and cultural characteristics of the communities) and their interconnections (Kristensen 2001). Consequently the interlinkages between the activities at the catchment and the rest of the Mekong Basin are studied. The catchment management approach is applied in MRCs programs such as the Agriculture, Irrigation and Forestry Program. Methodology of the commission´s core programs including the Water Utilization Program, the Basin Development Plan, and the Environment Program rely on the catchment management approach.

In many SE Asian countries vast tracts of land have been declared for the states. Consequently millions of farmers experience lack of tenure security. Conflicts between smallholder farmers and state have arisen and lead even in intentionally lit forest fires. In such circumstances no incentives exist to invest in land husbandry and investment. It is a common statement (and often the case) that watershed protection is hindered by insecure land tenure. However, Neef (2001) reports about opposite cases in Vietnam and northern Thailand where uncertain land rights have driven tree planting and introduction of erosion control measures.

The island state of the Philippines is tackling its most serious environmental problem (erosion and sedimentation) with forestry oriented watershed management activities and legal arrangements. Deforestation and unsustainable farming practices contribute to the annual US$2.4 billion hydropower losses and US$300 million on-site and off-site damages attributed to soil erosion and sedimentation.

African Regions

According to NBI et al. (2001) watershed management in the Nile basin is one-sided. Land degradation is commonly tackled with conventional methods including mulching, manuring, low tillage, contour based cultivation and agroforestry. Sustainable results are rarely achieved if the practical constraints are not dealt with (which is often the case). These encompass shortage of cash and labor; use of wood, dung and mulching materials as fuel; and problems of overgrazing.

On the way towards integrated watershed management more effort in increasing agricultural production is needed. To further increase the crop yields which are commonly very low in the basin (see chapter 9.1) i.a. rainwater harvesting, efficient irrigation, increased water holding capacity through soil improvement, and crop choices should be promoted (NBI et al. 2001).

Large scale reforestation has taken place in the Nile basin but with limited success. Consequently governments have started to give more responsibility to local communities and governments in forest management. However the incentive frameworks to support community forestry are still immature. Protection of selected areas as a measure of watershed management is not very effective. Conservation areas – out of which many are already degraded – are under continuous pressure by encroachment by farming, logging, and other activities. The importance of community participation in the conservation activities can not be underestimated.

In West Africa the more humid river basins including Niger and Volta suffer from erosion while the more arid river basin are blamed by desertification (Table 10.5b). Although land degradation problems in W Africa are said to be very serious Mazzucato et al. (2001) did not find evidence that soil fertility had declined in Burkina Faso.

According to World Bank (2004b) one of the reasons behind the considerable natural resources degradation in West Africa is the lack of adequate land and water management policy frameworks. In the Niger River Basin inappropriate agricultural land management practices are causing extensive land and water degradation. These include i.a. bush clearing, overgrazing, fertility loss, poor drainage systems and utilization of zones close to the river.

Literature concerning watershed management in West Africa is scarce. However, soil and water conservation which can be considered as watershed management is widely studied and discussed (e.g. Aina et al. 1991, Zougmoré et al. 2004). Increasing land productivity is commonly a main objective in WRM in Sahel. Efforts have been put in the control of desertification as well. For example European Commission (among other donors) committed 143 million euros to desertification projects in West Africa between 1990 and 1995 (EC 1997).

Falloux and Mukendi (1988) identified five crucial policy areas which need interventions in terms of better resource management and desertification control in the Sahelian and Sudanian zones of West Africa. Policy interventions are needed in land tenure systems, water management, household energy use, production systems and migration issues.

Summary

Watershed degradation is very common in the study regions. Inter alia deforestation, agricultural practices and over-grazing has lead to water and wind erosion, soil fertility decline, declined biodiversity, decreased water availability, increased flooding problems and so on. Consequences might touch all the economic sectors downstream while the livelihoods of people living in the upper watershed areas is adversely affected.

Response to the watershed problems is Watershed Management which aims to conserve or rehabilitate watersheds resources and environment while promoting social and economic development. The concept has evolved towards integrated approaches meaning i.a. the inclusion of human dimension (social development, poverty reduction, etc.) and the numerous stakeholders and institutions. It is realized that sustainability requires interventions in the root causes of watershed problems.

China is tackling its tremendous water and wind erosion problems with extensive WSM programs and policies. These have also turned into action. Erosion controlled area has reached 859,000 km^2 while 25 km^3 of water and 1.5 billion tons of soil have been annually saved. Meanwhile yields have considerably increased.

In South Asia focus on WSM has traditionally been on erosion control. Siltation of reservoirs and irrigation systems is a serious problem with economic losses in India, Pakistan and Nepal. Consequently watershed management projects are commonly narrowly focused.

Along with the highest deforestation rates loss of forest cover is the main watershed problem in Southeast Asia. Consequently reforestation programs and conservation of upper watershed area has taken place. Conflicts between state and people relying on the resources of upper watersheds have occurred.

The African regions are mainly arid indicating high vulnerability to desertification and soil fertility decline. Also the lack of adequate land and water management policy frameworks nourishes the natural resources degradation in West Africa. It is no wander that WSM activities include commonly soil and water conservation measures with the aim to increase the low yields. Desertification control by vegetative measures is taking place as well.

Although the watershed problems among the study regions vary, common problems and challenges in Integrated Watershed Management exist. Successful integrated projects are still a rarity. Inter alia land tenure questions, efficient application of participatory approaches, inclusion and co-ordination between the numerous institutions and stakeholders are commonly major challenges in WSM in the Third World.

References to Section 10

Abu-Zeid, M.A. 1983. The River Nile: main water transfer projects in Egypt and impacts on Egyptian agriculture. In: Biswas, A.K., Dakang, Z., Nickum, J.E. & Liu, C. (Eds.): *Long-Distance Water Transfer—A Chinese Case Study and International Experiences.* United Nations University Press, Tokyo / Tycooly, Dublin.

Abu-Zeid, M.A. & Rady, M.A. 1992. Water resources management and policies in Egypt. In:.Le Moigne, G., Barghouti, S., Feder, G., Garbus, L. & Xie, M. (Eds.): *Country Experiences with Water Resources Management. Economic, Institutional, Technological and Environmental Issues.* World Bank Technical Paper No. 175. The World Bank, Washington, D.C.

Achakulwisut, A. 1996. *Changing Course: A Study on Water Shortage in Thailand and Interbasin Water Transfer From the Salween Basin.* University of Oregon, Eugene.

ADB 1997. *Second Water Utilities Data Book.* Asian Development Bank (ADB), Manila.

ADB 2000. *Strategic Options for the Water Sector: PRC.* Hydrosult, SOGREAH and IWHR, Beijing for Asian Development Bank, Manila.

Ahmad, M. 2000. Water pricing and markets in the Near East: policy issues and options. *Water Policy* 2(3): 229-242.

Aina, P.O., Lal, R. & Roose, E.J. 1991. Tillage methods and soil and water conservation in West Africa. *Soil & Tillage Research* 20(2-4): 165-186.

Allam, G.I., El-Gamal, F.S. & El-Kady, M.M. 1999. Milestones for Nile stakeholders future cooperation. In: *Proceedings, 7th Nile 2002 Conference,* Cairo, Egypt, March 15-19, 1999.

ARCADIS Euroconsult 1999. *Strategy Study on the Development of the Watershed Management/ Forestry Sector in the Lower Mekong Basin. Watershed Management and Forestry Strategy and Action Plan for the Mekong River Commission*. Final Report. ARCADIS Euroconsult, Arnhem.

Babillot, P. & Le Lourd, P. 1998. Y-a-t-il un marché de l´eau? In: Margat, J. & Tiercelin, J. (Eds.): *L´eau en questions: Enjeu du XXI^{e} siècle*. Romillat, Paris.

Badenoch, N. 1999. *Watershed Management and Development in Lao PDR: a Synthesis of Policy Issues.* World Resources Institute (WRI), Chiang Mai.

Bai, X. & Imura, H. 2001. Towards sustainable urban water resource management: a case study in Tianjin, China. *Sustainable Development* 9(1): 24-35.

Balla, M.K.., Upadyaya, C.P. & Bajracharya, R.M. 2002. Soil and forest degradation in Nepal. In: *Forest and Soil Degradation in the Himalayan region: State of the Art*. Department of Soil and Water Sciences, Agricultural University of Norway, Ås.

Beck, M.B. & Cummings, R.G. 1996. Wastewater infrastructure: Challenges for the sustainable city in the new millennium. *Habitat International* 20(3): 405-420.

BGS 1995. *Impact of wastewater reuse on groundwater in the Mezquital Valley, Hidalgo state, Mexico.* Phase I report, February 1995. BGS Technical Report WD/95/24. British Geological Survey (BGS), Keyworth.

Biswas, A.K., Dakang, Z., Nickum, J.E. & Liu, C. 1983. Long-Distance Water Transfer—A Chinese Case Study and International Experiences. United Nations University Press, Tokyo / Tycooly, Dublin.

Blasco, P. 2000. Narmada, un barrage contre l'oubli. *Globe-Mémoires* 3: 26-29.

Bosshard, P. 1999. *An act of economic and environmental nonsense. A case study on the Manantali dam project (Mali, Mauritania, Senegal).* Berne Declaration, Zürich/International Rivers Network (IRN), Berkeley.

Briscoe, J. 1999. The financing of hydropower, irrigation and water supply infrastructure in developing countries. *Water Resources Development* 15(4): 459-491.

Brooks, K.N. & Eckman, K. 2000. Global Perspective of Watershed Management. In Ffolliott, Peter F.; Baker, Jr., Malchus B.; Edminster, C.B., Dillon, M.C., Mora, K.L. (Eds.): *Land stewardship in the 21st century: The contributions of watershed management; March 13-16, 2000; Tucson, AZ. Proc. RMRS-P-13.* U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins.

Brown, L.R. & Wolf, E.C. 1984. *Soil Erosion: Quiet Crisis in the World Economy*. Worldwatch Institute Paper 60. Worldwatch Institute, Washington, D.C.

Bruijnzeel, A.K. 2004. Hydrological functions of tropical forests: not seeing the soil for the trees? *Agriculture, Ecosystems and Environment* 104(1): 185-228.

Chan, G.L. 1993. Aquaculture, ecological engineering: lessons from China. *Ambio* 22(7): 491-494.

Chen, C. 1994. Major characteristics and problems of the South-to-North Water-Transfer Project. *Chinese Environment and Development* 5(2): 20-41. (appeared originally in *Chinese in Water Conservancy Planning* 1/1993: 26-32).

Chinese Ministry of Water Resources 2003. *Country Report of the People´s Republic of China.* World Water Council (WWC), Marseille.

Davydov, M.M. 1972. The Ob will enter the Caspian: the Yenisei-Ob-Caspian water connection and the energy problem. *Soviet Geography* 13: 603-617.

Dinar, A., Seidl, P., Olem, H., Jorden, V., Duda, A. & Johnson, R. 1995. *Restoring and Protecting the World's Lakes and Reservoirs.* World Bank Technical Paper 289. World Bank, Washington D.C.

Dinar, A. & Subramanian, A. 1998. Policy implications from water pricing experiences in various countries. *Water Policy* 1(2): 239-250.

Dombeck, M.P., Wood, C.A. & Williams, J.E. 1998. Focus Restoring Watersheds, Rebuilding Communities. *American Forests* 103(4): 26.

Dunglas, J. 1998. La technique peut-elle tout résoudre? In: Margat, J. & Tiercelin, J. (Eds.): *L´eau en questions: Enjeu du XXI[e] siècle*. Romillat, Paris.

Easa, M.E., Shereif, M.M, Shaaban, A.I. & Mancy, K.H. 1995. Public health implications of wastewater reuse for fish production. *Water Science and Technology* 32(11): 145-152.

EC 1997. *Addressing Desertification. A review of EC policies, programmes, financial instruments and projects.* European Communities, Luxembourg.

Edwards, P. 1992. *Reuse of Human Wastes in Aquaculture: a Technical Review*. United Nations Development Programme (UNDP)/World Bank, Washington DC.

Eikum, A.S. & Seabloom, R.W. (Eds.) 1981. *Alternative Wastewater Treatment.* Reidel, Dordrecht.

Elarabawy, M., Attia, B. & Tosswell, P. 1998. Water resources in Egypt: Strategies for the next century. *Journal of Water Resources Planning and Management* 124(6): 310-319.

El-Atawy, M.-H. 1996. *Nilopolitics: a hydrological regime 1870-1990.* The American University in Cairo Press, Cairo.

Falloux, F. & Mukendi, A. (Eds.) 1988. *Desertification Control and Renewable Resource Management in the Sahelian and Sudanian Zones of West Africa.* World Bank Technical Paper No. 70. World Bank, Washington, D.C.

FAO 1989. Incentives for community involvement in conservation programmes. FAO Conservation Guide 12. Food and Agriculture Organization of the United Nations (FAO), Rome.

FAO 1995. *Irrigation in Africa in figures - L'irrigation en Afrique en chiffres.* Water Report 7. FAO, Rome. www.fao.org/docrep/V8260B/V8260B00.htm (16.5.2006).

FAO 1997. *Irrigation Potential in Africa: A Basin Approach.* FAO Land and Water Bulletin 4. FAO, Rome. www.fao.org/docrep/W4347E/W4347E00.htm (16.5.2006).

FAO 2000. *Crops and Drops: making the best use of water for agriculture.* FAO, Rome.

FAO 2005. *Aquastat online database – FAO´s Information System on Water in Agriculture and Rural Development.* FAO, Rome. www.fao.org/waicent/faoinfo/agricult/agl/aglw/aquastat/main/index.stm (16.5.2006).

Feenstra, S., Hussain, R. & van der Hoek, W. 2000. *Health risks of irrigation with untreated urban wastewater in the southern Punjab, Pakistan.* Institute of Public Health/International Water Management Institute (IWMI), Lahore.

German Advisory Council on Global Change 1999. *World in Transition: Ways towards Sustainable Management of Freshwater Resources*. Annual Report 1997. Springer-Verlag, Berlin.

Gleick, P. 1993. Water and Energy. In: Gleick, P. (Ed.): *Water In Crisis: A Guide to the World's Freshwater Resources*. Oxford University Press, New York.

Golubev, G. 1978. Environmental issues of large interregional water transfer projects. In: Golubev, G. & Biswas, A.K. (Eds.): *Interregional Water Transfers: Problems and Prospects*. Pergamon, Oxford.

Golubev, G. 1993. Sustainable water development: implications for the future. *Water Resources Development* 9(2): 127-154.

Golubev, G. & Vasiliev, O. 1978. Interregional water transfers as an interdisciplinary problem. In: Golubev, G. & Biswas, A.K. (Eds.): *Interregional Water Transfers: Problems and Prospects*. Pergamon, Oxford.

Grau, P. 1996. Low cost wastewater treatment. *Water Science and Technology* 33(8): 39-46.

Guerra, L.C., Bhuiyan, S.I., Tuong, T.P & Barker, R. 1998. *Producing more rice with less water*. SWIM Paper 5. International Water Management Institute (IWMI), Colombo.

GWP 2000. Integrated Water Resources Management. Technical Advisory Committee Background Paper No 4. Global Water Partnership (GWP), Stockholm.

Hagos, F., Pender, J. & Gebreselassie, N. 1999. *Land Degradation in the Highlands of Tigray and Strategies for Sustainable Land Management.* Socioeconomic and Policy Research Working Paper No. 25. International Livestock Research Institute (ILRI), Addis Ababa.

Hansen, J.A. & Therkelsen, H. 1977. *Alternative Sanitary Waste Removal Systems for Low-Income Urban Areas in Developing Countries.* Polyteknisk Forlag, Lyngby.

Hinrichsen, D., Robey, B. & Upadhyay, U.D. 1998. *Solutions for a Water-Short World.* Population Reports, Series M, No. 14. Johns Hopkins School of Public Health, Baltimore. www.infoforhealth.org/pr/m14edsum.shtml (17.5.2006).

Ho, G. & Matthew, K. (Eds.) 1993. *Appropriate Waste Management Technologies*. Pergamon, Oxford.

van Hofwegen, P. & Svendsen, M. 2000. *A Vision of Water for Food and Rural Development.* The 2nd World Water Forum, 17-22 March, The Hague.

Hueb, J.A. 1999. Advantages of leakage control and the reduction of unaccounted-for water. In: *Proceedings of the International Symposium on Efficient Water Use in Urban Areas – Innovative Ways of Finding Water for Cities.* Kobe, Japan, June 8-10.

Hurst, H.E., Black, R.P. & Simaika, Y.M. 1959. *The Nile Basin, Vol. IX: The Hydrology of the Blue Nile and Atbara and the Main Nile to Aswan, with some reference to the projects*. Nile Control Dept. Paper 12. Government Printing Office, Cairo.

ICID 1997. *The Watsave Scenario.* International Commission on Irrigation and Drainage (ICID), New Delhi. www.icid.org/ws_pdf.html (17.5.2006).

ICID 2002. *Sprinkler and Micro-Irrigated Areas in Some ICID Member Countries.* ICID, New Delhi. www.icid.org/sprinkler.html (16.5.2006).

ICID 2003. *ICID Database.* ICID, Delhi. www.icid.org (22.5.2006).

ICOLD 2003. *World Register of Dams 2003.* International Commission on Large Dams (ICOLD), Paris.

IFRC 2002. *World Disasters Report 2002.* International Federation of Red Cross and Red Crescent Societies (IFRC), Geneva. www.ifrc.org/publicat/wdr2002 (3.5.2006).

INBA 1996. Water scarcity in the Nile basin. *International Nile Basin Association Bulletin* 2(1): 47-55.

Indian National Committee on Irrigation and Drainage 1994. *Drip Irrigation in India.* Indian National Committee on Irrigation and Drainage, New Delhi. Cited in Postel et al. 2001.

IPCC 2001. *Climate Change 2001: Impacts, Adaption and Vulnerability.* Intergovernmental Panel on Climate Change (IPCC), Geneva. www.ipcc.ch (3.5.2006).

IUCN, IWMI, Rasmar Convention Bureau & WRI 2003. *Water Resources eAtlas.* The World Conservation Union (IUCN), International Water Management Institute (IWMI), Ramsar Convention Bureau, and World Resources Institute (WRI), Washington, D.C. www.iucn.org/themes/wani/eatlas/html/index.html (19.5.2006).

IWMI 2002. *Reuse of Wastewater for Agriculture.* International Water Management Institute (IWMI), Colombo. www.cgiar.org/iwmi/health/wastew/index.htm (16.5.2006).

Japan Ministry of Foreign Affairs 1997. Strategies for development of the Greater Mekong Area. In: Stensholt, B. (Ed.): *Developing the Mekong Subregion*. Monash Asia Institute, Clayton.

Jauro, A.B. 1998. *Lake Chad Commission (LCBC) Perspectives*. International Conference “Water and Sustainable Development”, 19-21 March 1998, Paris. Office Internationale de l’Eau, Paris. http://ruisseau.oieau.fr/ciedd/ang/frames/doctravfr.htm (22.5.2006).

Jauro, A.B. 2000. *The Lake Chad Basin Regional Vision for 2025: A vision for Integrated River Basin Management.* Lake Chad Basin Commission, N’Djamena.

Jiménez, B., Chavez, A., Barrios, J.E. & Pérez, R. 2000. Impact and potential of reused water in the Mezquital Valley. *Water* 21 (June 2000): 34-36.

Johnson, N., Ravnborg, H.M., Westermann, O. & Probst, K. 2001. User participation in watershed management and research. *Water Policy* 3(6): 507-520.

Kajander, T. 2001. *Water Resources, Large Dams and Hydropower in Asia.* Helsinki University of Technology, Water Resources Laboratory, Espoo. www.water.tkk.fi/wr/tutkimus/glob/publications/Kajander/alku_v.html (17.5.2006).

Kärkkäinen, T. 2001. Tihkukastelu säästää vettä. *Vesitalous* 2/2001: 40-45.

Kerr, J. 2002. Watershed Development, Environmental Services and Poverty Alleviation in India. *World Development* 30(8): 1387-1400.

Kibalchich, O.A. & Koronkevich, N.I. 1983. Some of the results and tasks of the geographic investigations on the water-transfer project. *Soviet Geography* 18: 724-727.

Kristensen, J. 2001. Food Security and Development in the Lower Mekong River Basin. Paper presented at the *Asia and Pacific Forum on Poverty: Reforming Policies and Institutions for Poverty Reduction,* 5-9 February 2001, Manila.

Kundzewicz, Z., Budhakooncharoen, S., Bronstert, A., Hoff, H., Lettenmaier, D., Menzel, L. & Schultze, R. 2001. *Floods and Droughts: Coping with Variability and Climate Change.* Thematic Background Paper, International Conference on Freshwater, 3-7 December, Bonn. www.water-2001.de/ (3.5.2006).

Kundzewicz, Z. 2002. Non-structural flood protection and sustainability. *Water International* 27(1): 3-13.

Kunkle, S.H. & Thames, J.L. (Eds.) 1976. *Conservation in arid and semi-arid zones.* FAO Conservation Guide 3. Food and Agriculture Organization of the United Nations (FAO), Rome.

Lacroze, L. (Ed.) 1998. *L'aménagement du Mékong 1957-1997*. L'Harmattan, Paris.

Larsen, T. & Gujer, W. 1996. Separate management of antropogenic nutrient solutions. *Water Science and Technology* 34 (3-4): 87-94.

Liu, C. & Shen, D. 1994. The most vital strategy: an overview of areal reallocation of China's water resources. *Chinese Environment and Development* 5(2): 3-19.

Lixian, W. 2002. Theory and Practice of Watershed Management in China. In Juren, J., Lianxiang, W., Deyi, W., Xiaoning, T. & Jing, N. (Eds.): *Proceedings of the 12th ISCO Conference. Volume IV.* 26-31 May 2002, Beijing.

Lohmann, L. 1991. Engineers move in on the Mekong. *New Scientist* 131(1777): 44-48.

L'vovich, M.I. 1977. Geographical aspects of a territorial redistribution of water resources in the USSR. *Soviet Geography* 18: 557-574.

L'vovich, M.I. & Tsigel'naya, I.D. 1981. The potential long-term runoff in the mountains of the Aral Sea drainage basin. *Soviet Geography* 21: 471-483.

Magloff, L. 1999. Turning point on the Nile. *Egypt Today*, November: 76-82.

Magrath, W.B. & Doolette, J.B. 1990. Strategic Issues in Watershed Development. In Doolette, J.B. & Magrath, W.B. (Eds.): *Watershed Management in Asia: Strategies and Technologies.* World Bank Technical Paper Number 127. The World Bank, Washington D.C.

Mara, D 1996. *Low-Cost Urban Sanitation.* Wiley, Chichester.

Marui, H. 1988. *FAO watershed management field manual. Landslide prevention measures.* FAO Conservation Guide 13/4. Food and Agriculture Organization of the United Nations (FAO), Rome.

Mazzucato, V., Niemeijer, D., Stroosnijder, L. & Röling, N. 2001. *Social Networks and the Dynamics of Soil and Water Conservation in the Sahel.* Gatekeeper Series no. 101. International Institute for Environment and Development (IIED), London.

McGarry, M.W. 1982. Low-cost alternatives to sewerage. In: Schiller, E.J. & Droste, R.L. (Eds.): *Water Supply and Sanitation in Developing Countries.* Ann Arbor Science, Ann Arbor.

Mekong Committee 1970. *Plan indicatif du bassin inférieur du Mékong.* Mekong River Committee, Bangkok.

Ministère d'Hydraulique 1987. Présentation cartographique de la stratégie de mise en oeuvre. *Programme de Revitalisation des Vallées Fossiles.* Ministère d'Hydraulique, République du Sénégal, Dakar.

Ministry of Water and Power 2002. Pakistan Water Sector Strategy. Vol. 5. National Water Sector Profile. Ministry of Water and Power, Islamabad. www.waterinfo.net.pk/pwss/vol5main.htm (16.6.2004).

Mohile, A.D. 2005. Integration in Bits and Parts: IWRM in India. In Varis, O. & Biswas, A.K. (Eds.): *Integrated Water Resources Management in South and Southeast Asia.* Oxford University Press, New Delhi.

MRC 2003. *State of the Basin Report: 2003. Executive Summary*. Mekong River Commission (MRC), Phnom Penh.

MRC & GTZ 2002. *Watershed Management in the Lower Mekong Basin. A Component of the Agriculture, Irrigation and Forestry Programme of the Mekong River Commission.* Volume 1: Main Report. Mekong River Commission and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Fohren-Linden/Mougins/Eschborn.

MRC 2006. *River Monitoring.* Mekong River Commission, Vientiane. http://ffw.mrcmekong.org/ (3.5.2006).

Naiman (Ed.) 1992. *Watershed Management: Balancing Sustainability and Environmental Change*. Springer-Verlag, New York.

Nature 1994. Asian republics agree on joint rescue plan to save the Aral Sea. *Nature* 367(3640): 206.

NBI, GEF, UNDP & World Bank 2001. *Nile River Basin: Transboundary Environmental Analysis.* Nile Basin Initiative (NBI), Global Environmental Facility (GEF), United Nations Development Programme (UNDP) and World Bank, Washington, D.C.

Neef, A. 2001. Land Tenure and Soil Conservation Practices – Evidence from West Africa and Southeast Asia. In Stott, D.E., Mohtar, R.H. & Steinhardt, G.C. (Eds.): *Sustaining the Global Farm – Selected papers from the 10th Inernational Soil Conservation Organization Meeting, May 24-29, 1999, West Lafayette, IN.* International Soil Conservation Organization (ISCO) in cooperation with United States Department of Agriculture (USDA) and Pursue University, West Lafayette.

Niemczynowicz, J. 1993. New aspects of sewerage and water technology. *Ambio* 22(7): 449-455.

Nishat, A. 2001. Development and management of water resources in Bangladesh: Post-1996 treaty opportunities. In Biswas, A.K. & Uitto, J.I. (Eds.): *Sustainable Development of the Ganges-Brahmaputra-Meghna Basins.* United Nations University Press, Tokyo.

Oyang, Z. & Wang, R. 2000. Water environmental problems and ecological options in China. In: *China Water Vision: Meeting the Water Challenge in Rapid Transition.* The Second World Water Forum, The Hague, 17-22 March.

Palmieri, A. 1998. Reservoir sedimentation and the sustainability of dams. *World Bank Water Week Conference*, 15 December, Annapolis, the U.S.A.

Pante, F. 1997. Energy sector in Vietnam, Cambodia and Laos. In: Stensholt, B. (Ed.): *Developing the Mekong Subregion*. Monash Asia Institute, Clayton, Victoria.

Parashar, R.K. 1999. Interbasin water transfer: Indian Scenario. In: *Interbasin Water Transfer.* Technical Documents in Hydrology 28. United Nations Educational, Scientific and Cultural Organization/International Hydrological Programme (UNESCO/IHP), Paris.

Pearce, F. 1994. Neighbours sign deal to save Aral Sea. *New Scientist* 141(1909): 10.

Peng, J., Stevens, D.K. & Yiang, X. 1995. A pioneer project of wastewater reuse in China. *Water Research* 29(1): 357-363.

Perez, C. & Tschinkel, H. 2003. *Improving Watershed Management in Developing Countries: A Framework for Prioritising Sites and Practices.* Network Paper No. 129. ODI Agricultural Research & Extension Network, London. http://www.odi.org.uk/agren/papers/agrenpaper_129.pdf (19.5.2006).

Pimentel, D., Harvey, C., Resosudarmo, P., Sinclair, K., Kurz, D., McNair, M., Crist, S., Sphpritz, L., Fitton, L., Saffouri, R. & Blair, R. 1995. Environmental and economic costs of soil erosion and conservation benefits. *Science* 267(5201):1117–1123.

Pinkayan, S. 1999. *Case study of Hydro Power Projects*, Workshop on Greater Mekong Subregional Development, 10-11 November, Bangkok, Thailand.

Polak, P., Nanes, B. & Adhikari, D. 1997. A low cost drip irrigation system for small farmers in developing countries. *Journal of the American Water Resources Association* 33(1): 119-124.

Postel, S. 1992. *Last Oasis: Facing Water Scarcity.* Norton, New York.

Postel, S.L., Daily, G.C. & Ehrlich, P.R. 1996. Human appropriation of renewable fresh water. *Science* 271(5250): 785-788.

Postel, S. 2000. Redesigning Irrigated Agriculture. In: Starke, L. (Ed.): *State of the World 2000*. Norton, New York.

Postel, S., Polak, P., Gonzales, F. & Keller, J. 2001. Drip Irrigation for Small Farmers: A New Initiative to Alleviate Hunger and Poverty. *Water International* 26(1): 3-13.

Rafikov, A.A. 1983. Environmental change in the southern Aral region in connection with the drop of the Aral Sea level. *Izvestiya Vsesoyuznogo Geograficheskogo Obshchestva* 1983(1): 17-25.

Rahman, K. 1999. Interbasin water transfer: Bangladesh perspective. In: *Interbasin Water Transfer.*

Technical Documents in Hydrology 28. United Nations Educational, Scientific and Cultural Organization/International Hydrological Programme (UNESCO/IHP), Paris.

Rao, R. 1992. Pitfalls of the Indira Gandhi canal. *Ambio* 21(6): 439.

Revenga, C., Murray, S., Abramovitz, J. & Hammond, A. 1998. *Watersheds of the world.* World Resources Institute (WRI), Washington, D.C.

van Riesen, S. 1999. National Report: Germany. In: *International Report 9: The Present State of Sewage Treatment*. IWSA World Water Congress, 20-24 September, Buenos Aires, Argentina.

Rogers, P., Bhatia, R. & Huber, A. 1998. *Water as a Social and Economic Good: How to Put the Principle into Practice.* TAC Background papers no.2. Global Water Partnership/Swedish International Development Cooperation Agency (GWP/SIDA), Stockholm. www.gwpforum.org/gwp/library/Tac2.pdf (16.5.2006).

Rogers, P., de Silva, R. & Bhatia, R. 2002. Water is an economic good: How to use prices to promote equity, efficiency, and sustainability. *Water Policy* 4(1): 1-17.

Rostankowski, P. 1982. Transformation of nature in Soviet Union: proposals, plans, and reality. *Soviet Geography* 22: 381-390.

Salem-Murdock, M., Niasse, M., Magistro, J., Nuttall, C., Horowitz, M.M., Kane, O., Grimm, K. & Sella, M. 1994. *Les barrages de la controverse: Le cas de la vallée du fleuve Sénégal*. L'Harmattan, Paris.

Saleth, R.M. 2001. Water Pricing: Potential and Problems. In: Meinzen-Dick, R.S & Rosegrant, M.W. (Eds.): *Overcoming Water Scarcity and Quality Constraints.* International Food Policy Research Institute (IFPRI), Washington D.C.

Sananikone, O. 1996. Chad. In: Webster, L. & Fidler, P. (Eds.): *The Informal Sector and Microfinance Institutions in West Africa*. World Bank, Washington D.C.

Sanmuganathan, K. 2000. Assessment of irrigation options. *WCD Thematic Review IV: 2.* World Commission on Dams, Cape Town. www.dams.org/docs/kbase/thematic/tr42main.pdf (22.5.2006).

Schiechti, H.M. 1985. *FAO watershed management field manual. Vegetative and soil treatment measures.* FAO Conservation Guide 13/1. Food and Agriculture Organization of the United Nations (FAO), Rome.

Schiller, E.J. & Droste, R.L. (Eds.) 1982. *Water Supply and Sanitation in Developing Countries.* Ann Arbor Science, Ann Arbor.

Serageldin, I. 1994. *Water Supply, Sanitation, and Environmental Sustainability, the Financing Challenge*. The World Bank, Washington DC.

Shelef, G. 2001. *Wastewater treatment, Reclamation and Reuse in Israel.* The Begin-Sadat Center for Strategic Studies, Ramat Gan. www.biu.ac.il/SOC/besa/waterarticle3.html (16.5.2006).

Sheng, T.C. 2001. Important and Controversial Watershed Management Issues in Developing Countries. In Stott, D.E., Mohtar, R.H. & Steinhardt, G.C. (Eds.): *Sustaining the Global Farm – Selected papers from the 10th International Soil Conservation Organization Meeting, May 24-29, 1999, West Lafayette, IN.* International Soil Conservation Organization (ISCO) in cooperation with the United States Department of Agriculture (USDA) and Purdue University, West Lafayette.

Shereif, M.M., Easa, M.E., El-Samra, M.I. & Mancy, K.H. 1995. A demonstration of wastewater treatment for reuse applications in fish production and irrigation in Suez, Egypt. *Water Science and Technology* 32(11): 137-144.

Shiklomanov, I. 1999. Water transfer as one of the most important ways to eliminate water resources deficits and to solve water management problems. In: *Interbasin Water Transfer.* Technical Documents in Hydrology 28. United Nations Educational, Scientific and Cultural Organization/International Hydrological Programme (UNESCO/IHP), Paris.

Smith, D.V. & Jalal, K.F. 2000. *Sustainable Development in Asia.* Asian Development Bank (ADB), Manila.

Stoner, R.F. 1990. Future irrigation planning in Egypt. *Conference on the Nile.* Royal Geographical Society and University of London, England.

Swallow, B.M., Garrity, D.P. & van Noordwijk, M. 2001. The effects of scales, flows and filters on property rights and collective action in watershed management. *Water Policy* 3(6): 457-474.

Tadesse, H. 1998. The Nile River Basin – Its use and development. *Ethioscope* 4(1): 13-23.

Tanzeema, S. & Faisal, I.M. 2001. Sharing the Ganges: a critical analysis of the water sharing treaties. *Water Policy* 3(1): 13-28.

Thapa, G.B. 2001. Changing Approaches to Mountain Watersheds Management in Mainland South and Southeast Asia. *Environmental Management* 27(5): 667-679.

UN Millennium Project 2005. *Health, Dignity, and Development: What Will it Take?* Earthscan, London.

UNEP 1993. *The Aral Sea: Diagnostic Study for the Development of an Action Plan for the Conservation of the Aral Sea.* Action Plan, United Nations Environmental Programme (UNEP), Nairobi.

UNEP 1995. *Water quality of world river basins.* UNEP Environmental Library 14, UNEP, Nairobi.

UNESCO 1999. Summary statement. In: *Interbasin Water Transfer.* Technical Documents in Hydrology 28. United Nations Educational, Scientific and Cultural Organization/International Hydrological Programme (UNESCO/IHP), Paris.

UNESCO 2000. *Water Related Vision for the Aral Sea Basin for Year 2025.* Division of Water Sciences, UNESCO, Paris.

UN-HABITAT (United Nations Human Settlements Programme) 2003. *Water and Sanitation in the World´s Cities: Local Action for Global Goals.* Earthscan, London.

United Nations, 1989. *Population Growth and Policies in Mega-cities: Jakarta.* Population Policy Paper 18, United Nations, New York.

Varis, O. 2000. The Nile Basin in a global perspective: natural, human, and socioeconomic resource nexus. *Water International* 25(2): 624-637.

Varis, O. 2006. Megacities, Development and Water. *International Journal of Water Resources Development* 22(2): 199-225.

Varis, O. & Somlyódy, L. 1997. Global urbanization and urban water: can sustainability be afforded? *Water Science and Technology* 35(9): 21-32.

Varis, O. & Fraboulet-Jussila, S. 2002. Water resources management in the lower Senegal River basin—conflicting interests, environmental concerns, and policy options. *International Journal of Water Resources Development* 18(2): 245-260.

Varis, O., Kajander, T. & Lemmelä, R. 2004. Climate and Water—on the Search for Improved Links from Climate Models to Water Resources Management and Vice Versa. *Climatic Change* 66(3): 321-344.

Vickers, A. 2001. *Handbook of Water Use and Conservation.* Water Plow Press, Amherst.

Vidal, A., Comeau, A., Plusquellec, H. & Gadelle, F. 2001. *Case Studies on Water Conservation in the Mediterranean Region.* Food and Agriculture Organization of the United Nations (FAO), Rome.

Voropaev, G.V. 1976. Problem of the redistribution of the water resources of the USSR and its simulation. *Soviet Hydrology* 15(4).

Voropaev, G.V. 1978. The scientific principles of large-scale aerial redistribution of water resources in the USSR. In: Golubev, G. & Biswas, A.K. (Eds.): *Interregional Water Transfers: Problems and Prospects*. Pergamon Press, Oxford.

Vy, T. 2001. Sewage Water Aquaculture in Hanoi: Current Status and Further Development. In: Raschid-Sally, L., van der Hoek, W. & Ranawaka, M. (Eds.): *Wastewater Reuse in Agriculture in Vietnam: Water Management, Environment and Human Health Aspects. Proceedings of a Workshop held in Hanoi, Vietnam, 14 March 2001*. IWMI Working Paper 30. International Water Management Institute (IWMI), Colombo.

Vörösmarty, C., Sharma, K.P., Fekete, B.M., Copeland, A.H., Holden, J., Marble, J. & Lough, J.A. 1997. The storage and aging of continental runoff in large reservoir systems of the world. *Ambio* 26(4): 210-218.

Wallace, J.S. & Batchelor, C.H. 1997. Managing Water Resources for Crop Production. *Philosophical Transactions of the Royal Society of London: Biological Sciences* 352: 937-947.

Wang, L., Wang, B., Qi, P., Dong, W. & Dai, A. 2001. Eco-pond systems for wastewater treatment and utilisation. *Water 21* (August 2001): 60-63.

Wang, R., Oyang, Z., Ren, H. & Min, Q. 1999. *China Water Vision: The Eco-sphere of Water, Environment, Life, Economy & Society.* Chinese Academy of Sciences, Beijing (presented at the 2nd World Water Forum, The Hague, March 17-22, 2000).

Watershed 1998. From the Mekong to the Chao Phraya: The Kok-Ing-Nan Water Diversion Project. *Watershed* 4(2): 10-13.

WCD 2000. *Dams and Development. A New Framework for Decision Making.* The Report of the World Commission on Dams. Earthscan, London. www.dams.org (3.5.2006).

WHO 1989. *Health guidelines for use of wastewater in agriculture and aquaculture*. WHO Technical Report Series 778. World Health Organization (WHO), Geneva.

WHO & UNICEF 2005. Joint Monitoring Programme for Water Supply & Sanitation. Water & sanitation data query tool. WHO and United Nations Children´s Fund (UNICEF), Geneva and New York. www.wssinfo.org/en/welcome.html (16.5.2006).

Winblad, U. & Kilama, W. 1985. *Sanitation Without Water.* Macmillan, Hong Kong.

World Atlas 1999. *World Atlas & Industry Guide.* International Journal on Hydropower and Dams, Vol. 7. Aqua-Media International, Sutton.

World Bank 1994. *Aral Sea Program - Phase 1.* Briefing Paper for the Proposed Donors Meeting in June 23-24, 1994, Paris. Europe and Central Asia Region, Aral Sea Program Unit, the World Bank, Washington D.C.

World Bank 1997. *World Development Indicators 1997 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 1999. *World Development Indicators 1999 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2001. *World Development Indicators 2001 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2003. World Development Indicators 2003. CD-ROM. The International Bank for Development and Reconstruction /World Bank. Washington, D.C.

World Bank 2004a. *World Development Indicators 2004 on CD-ROM.* The International Bank for Development and Reconstruction / The World Bank, Washington D.C.

World Bank 2004b. Reversal of Land and Water Degradation in the Niger River Basin. The World Bank, Washington D.C. www.gefweb.org/Documents/Project_Proposals_for_Endorsem/Regional_-_Niger_River_Basin.pdf (22.5.2006).

World Commission on Water for the 21st Century 2000. *The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socioeconomic Development.* www.gwpmed.org/products_documents/country_reports/africa.pdf (17.5.2006).

Worldwatch, 1993. *State of the World.* Worldwatch Institute, Washington D.C.

Woube, M. 1994. Environmental degradation along the Blue Nile River basin. *Ambio* 23(8): 519-520.

Yin, H. & Li, C. 2001. Human impact on floods and flood disasters on the Yangtze River. *Geomorphology* 41(2-3): 105-109.

Xiubin, H., Zhanbin, L., Mingde, H., Keli, T. & Fengli, Z. 2003. Short communication. Down-scale analysis for water scarcity in response to soil-water conservation on Loess Plateau of China. *Agriculture, Ecosystems and Environment* 94(3): 355-361.

Ziqiang, H., Xijun, W. & Zhongren, S. 2002. Loss of Soil and Water in Loess Plateau of Yellow River Basin and its Preventive Countermeasure. In Juren, J., Lianxiang, W., Deyi, W., Xiaoning, T. & Jing, N. (Eds.): *Proceedings of the 12th ISCO Conference. Volume I.* 26-31 May 2002, Beijing.

Zougmoré, R., Mando, A. & Stroosnijder, L. 2004. Effect of soil and water conservation and nutrient management on the soil-plant water balance in semi-arid Burkina Faso. *Agricultural Water Management* 65(2): 103-120.