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Water

a shared responsibility

The United Nations World Water Development Report 2

Executive Summary

World Water Assessment Programme
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UN WATER

Water, a shared responsibility

The United Nations World Water Development Report 2 (WWDR 2)

For some, the water crisis means having to walk long distances every day to fetch enough drinking water – clean or unclean – just to get by. For others, it means suffering from avoidable malnutrition or disease caused by drought, flood or inadequate sanitation. Still others experience it as a lack of funds, institutions or knowledge to solve local problems of water use and allocation.

Many countries are still not on track to reach the water-related targets of the Millennium Development Goals (MDGs) – threatening their security, development and environmental sustainability – and millions of people die each year from treatable water-borne diseases. While water pollution and the destruction of ecosystems increase, we are witnessing the consequences that climate change, natural disasters, poverty, warfare, globalization, population growth, urbanization and disease – all of which impinge on the water sector – have on so many of the people of the world.

It is widely accepted that sustainable and equitable water management must be undertaken using an integrated approach, that assessment of the resource is the basis for rational decision-making, and that national capacities to undertake such assessments must be further supported and expanded at local through international levels. It is therefore paramount to provide the best possible understanding of the state of the world's freshwater resources to the world at large.

The triennial World Water Development Report (WWDR) lays the foundation for a continuous, global monitoring system and shows the United Nations system at work, pooling the unique perspectives and expertise of the 24 UN agencies that comprise UN-Water, in partnership with governments and other entities concerned with freshwater issues.

Water, a Shared Responsibility (March 2006) is the main outcome of Phase 2 of the World Water Assessment Programme (WWAP), founded in 2000 as a collective response of the UN system to assist countries in reaching their commitments in key water-related challenge areas. WWDR 2 offers a comprehensive and holistic assessment of the world's water, while bringing the issues of water governance, knowledge accessibility and the specific challenges of managing water into the mainstream of development thinking and practices, across all the major intersections of water, human well-being and development.

Bearing in mind users needs, the 2006 Report aims to be practical in orientation, offers best practices as well as in-depth theoretical and analytic analyses to help stimulate ideas and actions for better stewardship in the water sector. The use of hundreds of maps, tables, figures, boxed examples, indicators and case studies illustrate that only our global cooperation will help to ensure an integrated, equitable and sustainable management of the world's most precious resource – water.

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PREFACE

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World Water Development Report 2

In the three years since the launch of the first World Water Development Report (2003), the world has witnessed considerable change. There have been many instances of major water-related disasters: the 2004 Indian Ocean tsunami; the 2004 and 2005 hurricanes in the Caribbean, the west Pacific and the United States; the 2005 floods in Central and Eastern Europe as well as in many other regions; and the extensive droughts in Niger, Mali, Spain and Portugal. These are reminders of both the destructive power of water and the misery deriving from lack of it in so many regions of the world.

These extreme events are only the most prominent illustrations of fundamental changes that are affecting water resources worldwide. In many cases, this evolution is most probably linked to slow but persistent changes in global climates, a phenomenon that is supported by a growing body of evidence: the combination of lower precipitation and higher evaporation in many regions is diminishing water quantities in rivers, lakes and groundwater storage; while increased pollution is damaging ecosystems and the health, lives and livelihoods of those without access to adequate safe drinking water and basic sanitation.

Major demographic changes are also seriously affecting the quality and quantity of available freshwater on the planet. While the more developed countries enjoy relatively stable populations, the less-developed regions of the world are generally experiencing rapid growth and population shifts, particularly in towns, small cities and mega-cities. In many rapidly growing urban areas, it is proving impossible to build the infrastructure necessary to deliver water supply and sanitation facilities to service the population, leading to poor health, low quality of life and, in many cases, to social unrest. To the urban demands for water must be added the increasing demands on water for food production, energy creation and industrial uses.

Large shifts in the geographic distribution of populations occur in various contexts, often adding to water supply problems and social tension. In areas, such as Darfur, there are both internally displaced persons and transboundary refugees. Legal and illegal economic migrants are swelling populations in parts of the United States and Western Europe, as elsewhere. Tourism to many holiday destinations of the world often exerts a strain on the water supplies of these regions. Whether it is the result of continued unrest and warfare, terrorist activities or economic instability, population movement is a factor that has a substantial impact on water availability in the world.

It is against these changes in the global situation - some rapid and very noticeable, others insidious and yet persistent - that the governance of water resources must be assessed. This second Report, *Water, A Shared Responsibility*, sets water issues against this evolving background and places greater emphasis on governance issues.

It is proving extremely difficult for many governments to effectively confront the many and intertwined issues concerning water. Not only is it difficult for departments within national governments to collaborate effectively, but problems are compounded when many management decisions have to be taken at sub-national and community levels, as the linkage and cooperation between different levels of government is often tenuous at best. The challenges for government agencies to link to NGOs and the private sector for resolving water issues further complicate management and decision-making. The task of managing water becomes even more complex when rivers flow from one country to another. The building of cooperative upstream-downstream relationships is becoming increasingly important with close to half of the world's people living in river basins or above aquifers that cross international borders.

An important goal of the World Water Assessment Programme - founded in 2000 at the request of governments within the Commission on Sustainable Development - is therefore to assist governments in developing and implementing their national water management plans. Thus, a number of case studies have been developed and included in the Report. In the first Report, 7 case studies involving 12 countries were included to illustrate the variety of circumstance in different regions of the world. Since then, the number of case studies has grown to 17 involving 42 countries. In a single volume, it is not possible to describe all case studies in detail. Thus we have chosen to summarize the case studies in the Report and publish the details of each study on our website. This strategy also allows us to make necessary updates as new data and information become available.

As we move through the International Decade for Action, 'Water for Life', 2005-2015, the World Water Development Reports will provide a series of assessments to facilitate the monitoring of change in the water sector, both on a global basis and within a growing number of case-study countries and river basins. The purpose of the Decade is to focus on the implementation of water-related programmes and projects, while striving to ensure cooperation at all levels, including the participation and involvement of women, to achieve the internationally-agreed water-related goals (Agenda 21, the UN Millennium Declaration and the JPOI as well as those of the 12th and 13th sessions of the Commission on Sustainable Development). A number of issues identified by UN-Water as priorities for the Decade include coping with water scarcity, access to drinking water, sanitation and hygiene, and disaster risk reduction, particularly in Africa.

The triennial World Water Development Reports will provide substantive content for the Decade's agenda (subsequent editions of the Report are scheduled for production in 2009, 2012 and 2015) and lay the foundation for a continuous, global monitoring system, pooling the unique perspectives and expertise of the 24 UN agencies that comprise UN-Water, in partnership with governments and other entities concerned with freshwater issues.

We trust that you will find this and future Reports both informative and stimulating.

CHAPTER 1
Living in a Changing World

There is a enough water for everyone. The problem we face today is largely one of governance: equitably sharing this water while ensuring the sustainability of natural ecosystems. At this point in time, we have not yet achieved this balance.

The key challenges of contemporary water management can only be understood within the very broad context of the world's socio-economic systems. Changing demographics and population movements; shifts in geopolitics, with new country boundaries and alliances; fast developing information and communication technologies; plus the impacts of climate change and extreme weather conditions are all making the world a more challenging place for decision-makers. Poverty, warfare and preventable disease still affect much of the world's population, often in developing countries and in increasingly crowded urban conditions. These are elements of the broad and often fast changing contexts within which we must place our discussions on water resources management.

It is within this setting that the world's water managers must administer what is becoming an increasingly scarce and fluctuating resource. In an attempt to maximize development opportunities in a sustainable fashion, this must be done within the socio-economic context of the water basin concerned. The pressures that they face in this task are many and varied. It is increasingly recognized that an Integrated Water Resources Management (IWRM) approach is needed to consider all such factors and issues simultaneously in order to secure the equitable and sustainable management of freshwater. This integrated approach to water management is a central tenet of the Report and underpins the perspective taken in all chapters across all challenge areas.

The Millennium Development Goals (MDGs) are providing important global targets. Setting targets is vital for focusing attention and providing incentives to mobilize action on key issues of development. Recognizing the need to speed up poverty alleviation and socio-economic development, 8 MDGs with specific quantifiable targets were set by the United Nations (UN) General Assembly Millennium Meeting in 2000 to be achieved by 2015 from a 1990 baseline. Additional goals related to sanitation and the inclusion of IWRM in national plans were established during the World Summit on Sustainable Development in 2002 in Johannesburg.

By setting these goals, the UN system has taken a lead role in finding ways to share the world's resources more equitably, while offering more protection from natural hazards. Moves towards eradicating extreme poverty, which affects 40 percent of the world's population, are underway. Water has a crucial role to play in this endeavour. This report examines these issues, as well as the current developments in and thinking behind more refined and better adapted monitoring tools for the water sector.

Setting targets establishes concrete quantifiable objectives, while focusing attention on the issues at hand and providing incentives to take action and mobilize the resources necessary for reaching the goals. However, targets are needed not only at the global level, but also at national, sub-national and community levels, where action has to be taken, for which regular and reliable monitoring is required. Setting up such a monitoring system for water-related goals and targets is also a central element of this Report.

Above
A typical dug well in Bahai, north eastern Chad, which was also shared with refugees arriving from Sudan in early 2004.

WATER AND THE MILLENNIUM DEVELOPMENT GOALS

GOAL 1. ERADICATE EXTREME POVERTY AND HUNGER[1]

Water is a factor of production in virtually all enterprise, including agriculture, industry and the services sector. Improved nutrition and food security reduces susceptibility to diseases, including HIV/AIDS, malaria among others. Access to electricity is key to improving quality of life in the modern age. Competition between the various sectors must be balanced by policies that recognize the ability and responsibility of all sectors to address the issues of poverty and hunger.

Targets:

- Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day
- Halve, between 1990 and 2015, the proportion of people who suffer from hunger

WWDR2 Water-related Indicators:

- Percentage of undernourished people
- Percentage of poor people living in rural areas
- Relative importance of agriculture
- Irrigated land as percentage of cultivated land
- Relative importance of agriculture water withdrawals in water balance
- Extent of land salinized by irrigation
- Importance of groundwater in irrigation
- Dietary Energy Supply (DES)

see **Water for Food, Agriculture and Rural Livelihoods: Chapter 7**

- Trends in industrial water use
- Water use by sector
- Organic pollution emissions by industrial sector
- Industrial water productivity
- Trends in ISO 14001 certification, 1997-2002
- Access to electricity and domestic use
- Electricity generation by fuel, 1971-2001
- Capability for hydropower generation, 2002
- Total primary energy supply by fuel
- Carbon intensity of electricity production, 2002
- Volume of desalinated water produced

see **Water and Industry: Chapter 8**
see **Water and Energy: Chapter 9**

GOAL 2. ACHIEVE UNIVERSAL PRIMARY EDUCATION

Promotion of a healthy school environment is an essential element of ensuring universal access to education and school enrolment, attendance, retention and performance are improved; teacher placement is improved. In this respect access to adequate drinking water and sanitation is key.

Target:

- Ensure that, by 2015, children everywhere, boys and girls alike will be able to complete a full course of primary schooling

WWDR2 Water-related Indicator:

- Knowledge Index

see **Enhancing Knowledge and Capacity: Chapter 13**

GOAL 3. PROMOTE GENDER EQUALITY AND EMPOWER WOMEN

Educating women and girls will permit them to fulfil their potential as full partners in the development effort.

Target:

- Eliminate gender disparity in primary and secondary education, preferably by 2015 and in all levels of education no later than 2015

WWDR2 Water-related Indicator:

- Access to information, participation and justice in water decisions

see **Challenges of Governance: Chapter 2**

GOAL 4. REDUCE CHILD MORTALITY

Improvements in access to safe drinking water and adequate sanitation will help prevent diarrhoea, and lay a foundation for the control of soil-transmitted helminths and schistosomiasis among other pathogens.

Target:

- Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate

WWDR2 Water-related Indicators:

- Mortality in children <5 yrs
- Prevalence of underweight children <5 yrs
- Prevalence of stunting among children <5 yrs

see **Protecting and Promoting Human Health: Chapter 6**

GOAL 5. IMPROVE MATERNAL HEALTH

Improved health and nutrition reduce susceptibility to anaemia and other conditions that affect maternal mortality. Sufficient quantities of clean water for washing pre-and-post birth cut down on life-threatening infection.

Target:

- Reduce by three-quarters, between 1990 and 2015, the maternal mortality rate

WWDR2 Water-related Indicator:

- DALY (Disability Adjusted Life Year)

see **Protecting and Promoting Human Health: Chapter 6**

1. Although industry and energy are not directly addressed by the Millennium Development Goals, they play an important role in providing employment, income and improved standard of living.

WATER AND THE MILLENNIUM DEVELOPMENT GOALS

GOAL 6. COMBAT HIV, AIDS, MALARIA AND OTHER DISEASES

Improved water supply and sanitation reduces susceptibility to/severity of HIV/AIDS and other major diseases.

Targets:

- Halt by 2015 and begin to reverse the spread of HIV/AIDS
- Halt by 2015 and begin to reverse the incidence of malaria and other major diseases

WWDR2 Water-related Indicator:

- DALY (Disability Adjusted Life Year)

see **Protecting and Promoting Human Health: Chapter 6**

GOAL 7. ENSURE ENVIRONMENTAL SUSTAINABILITY

Healthy ecosystems are essential for the maintenance of biodiversity and human well-being. We depend upon them for our drinking water, food security and a wide range of environmental goods and services.

Target:

- Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources

WWDR2 Water-related Indicators:

- Water Stress Index
- Groundwater development
- Precipitation annually
- TARWR volume (total annual renewable water resources)
- TARWR per capita
- Surface water (SW) as a % TARWR
- Groundwater (GW) as a % of TARWR
- Overlap % TARWR
- Inflow % TARWR
- Outflow % TARWR
- Total Use as % TARWR

see **the State of the Resource: Chapter 4**

- Fragmentation and flow regulation of rivers
- Dissolved nitrogen (NO_3 + NO_2)
- Trends in freshwater habitat protection
- Trends in freshwater species
- Biological Oxygen Demand (BOD)

see **Coastal and Freshwater Ecosystems: Chapter 5**

Targets:

- Halve by 2015 the proportion of people of people without sustainable access to safe drinking water and basic sanitation
- By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers

WWDR2 Water-related Indicators:

- Urban Water and Sanitation Governance Index
- Index of Performance of Water Utilities

see **Water and Human Settlements in an Urbanizing World: Chapter 3**

- Access to safe drinking water
- Access to basic sanitation

see **Protecting and Promoting Human Health: Chapter 6**

GOAL 8. DEVELOP A GLOBAL PARTNERSHIP FOR DEVELOPMENT[2]

Water has a range of values that must be recognized in selecting governance strategies. Valuation techniques inform decision-making for water allocation, which promote sustainable social, environmental and economic development as well as transparency and accountability in governance. Development agendas and partnerships should recognize the fundamental role that safe drinking water and basic sanitation play in economic and social development.

Targets

- 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 special needs of landlocked and small island developing states

WWDR2 Water-related Indicators:

- Water sector share in total public spending
- Ratio of actual to desired level of public investment in water supply
- Rate of cost recovery
- Water charges as a percent of household income

see **Valuing and Charging for Water: Chapter 12**

- Water interdependency indicator
- Cooperation indicator
- Vulnerability indicator
- Fragility indicator
- Development indicator

see **Sharing Water: Chapter 11**

- Disaster Risk Index
- Risk and Policy Assessment Index
- Climate Vulnerability Index

see **Managing Risks: Chapter 10**

- Progress toward implementing IWRM

see **Challenges of Governance: Chapter 2**

2. Only the most relevant targets have been listed for this goal.

In order to monitor progress towards these development goals, we need milestones. These come in the form of indicators, which are well-defined statistics that can be interpreted beyond their face-value to provide an indication of the condition and direction of the system or process being measured. These indicators must meet well-defined scientific criteria and be selected through a carefully planned and implemented process, including stakeholder involvement and testing, making their development a lengthy and reiterative process. They are invaluable tools for policy-makers, who need information to be able to make informed decisions about the distribution of scarce resources.

Indicator development for this report focuses on utilizing and adapting existing knowledge, datasets and indicators to develop robust and reliable indicators that are easy to use and understand to promote better water resource management. This is done by providing a clear assessment of the state of water resources, identifying the emergence of critical water resources issues and monitoring progress towards achieving water policy objectives.

Water is a fluctuating resource, making it difficult to measure in time and in space. This means that coordinating and harmonizing data collection on both spatial and temporal scales is critical. As information needs may differ at local, regional and global levels, indicators developed for one spatial scale may not be applicable to another. WWAP's 17 case studies serve to provide a basis on which to analyse change in the water sector by highlighting a number of scenarios in different geographic regions where conditions of water-related stress and socio-economic circumstances are different.

Temporal scales also present challenges. For instance, water availability depends strongly on the season. Thus a mean annual value of water availability may conceal a severe shortage of water in dry periods and an excess of water during the wet season.

Water is an essential component of security, and numerous key development issues influence water resources and the natural environment. In all of these issues, the situation is never static, often changing in ways that are difficult to predict. The main point, however, is the extent to which all of these development problems affect the poor and underprivileged. It is a challenge to the application of IWRM to factor in the many variables insofar as possible into the water management framework so as to reduce vulnerability and to increase the resilience and resourcefulness of individuals, communities and governments, especially in lower-income countries.

Action to address poverty alleviation, equitable resource allocation and risk management, while preserving natural ecosystems, is a challenge and responsibility for all levels of society. The UN, and the international community in general, has an responsibility for action; but that responsibility must be shared with national governments, and sub-national and local communities. In the end, each one of us has an individual responsibility to act and succeed, not only for the sake of global society, but also for that of generations to come.

Above
Kibera slum, Nairobi, Kenya.

Right
Young men washing in the river, India.

CHAPTER 2
The Challenges of Governance

Decisions on water management are a top priority. Who has the right to water and its benefits? Who is making water allocation decisions on who is supplied with water – and from where, when and how?

By
UNDP
(United Nations Development Programme)

with
IFAD
(International Fund for Agriculture Development)

Such decisions on water governance are made by the minute across the world. The settings vary, as do the people and groups involved: urban and rural households, neighbourhoods, small businesses and corporate boardrooms, the offices of local, state and national governments, and the international arena. In real life situations, the difference between having and not having daily access to fair water provision is a matter of survival. How and for whom water is governed affects river flows, groundwater tables and pollution levels. It also determines the share of water between upstream and downstream water users. The capacity of countries to provide water supply and sanitation for all and implement both poverty reduction strategies and Integrated Water Resource Management (IWRM) plans to meet new water demands as well as manage conflicts and risks depends to a large extent on their ability to establish sound and effective governance systems.

The concept of governance has evolved and gained ground over the past decade. Within the international political arena, the issue of governance was once avoided in North-South development dialogue. Today, it is increasingly accepted as a vital issue to be addressed at all levels. The framing of water challenges in terms of governance has allowed a broadening of the water agenda. The scrutiny of corruption, democratization processes and power imbalances between both rich and poor countries and rich and poor people is increasingly accepted. Indeed, governance and politics are increasingly viewed as a part of the problem and therefore as an essential part of any solution to water crises.

Over the past decade, water issues have featured high on the international political agenda. Hopes and expectations have been raised by recent agreements on time-bound water targets to improve the water situation for billions of people established at the Millennium Summit and the 2002 World Summit on Sustainable Development (WSSD). Paradoxically, actual funding for the water sector in developing countries is currently stagnating. A positive sign, though, is that some countries, such as South Africa, have stepped up their commitments towards fulfilling national and international water and development targets.

Water stress tends to occur where individual rights and liberties are limited. A country-based comparison of per capita water availability and democratic governance would show that many countries are facing a *double challenge* of water scarcity and stress *and* limited political rights and civic liberties. This is particularly the case for the Middle East and North Africa. Reform of the water sector, therefore, must go hand-in-hand with overall governance reform. It is highly unlikely that more effective participation, transparency, decentralization and IWRM will take firm root in water sectors unless the country's overall governance system allows it. As part of the broadening

Above
Hydraulic drilling stations, equipped with pumps that are usually manual, are gradually replacing the traditional village wells, as seen here in northern Côte d'Ivoire.

Right
Pipeline, outskirts of Gangtok, Sikkim, India.

of the water agenda, there is an increasing need to harmonize and coordinate international water targets and principles with other international regimes, such as global or regional trading alliances. *Unless water concerns are integrated within broader national and international processes of trade, stability and more equitable governance, the chances of achieving the international water targets remain poor.* There is thus a need to collaborate with new partners outside the water realm and form more inclusive water development networks.

Development becomes more deeply rooted in systems where governments, private firms and civil society work together in collaborative undertakings. Recent decades have seen a great deal of emphasis placed on increasing the role of the private sector in water management. Complete privatization of water services in developing countries, however, has not been able to meet expectations for improved and extended water supply and sanitation services. There is, thus, a need for improving dialogue on water between governments, civil society and the private sector. Better governance combined with an integrated management approach, increased transparency, participation and dialogue in a climate of trust-building could improve negotiations and minimize the tensions within the water sector. It is perhaps naïve to think that all disputes and differences can be bridged, but a society that claims to attack water problems must make serious efforts to develop effective institutions and processes that can mediate disputes (through the judiciary system, informal conflict resolution mechanisms and elections), or at least minimize their impacts (e.g. compensation to vulnerable groups).

National water reform and implementation is progressing, although sometimes at a painstakingly slow pace. Although progress is being made in some areas, such as the recognition of water rights, other needed reforms - such as decentralization - have been slow to come. Recent moves by governments in lower-income countries to delegate responsibility have had limited success. Governments are not delegating the needed powers and resources and have, in some cases, taken back the delegated responsibility. However, the difficulty of implementing specific reforms like this are often related to larger organizational problems within the sector.
In many developing-country settings, the water sector and its institutions are plagued by fragmentation, marginalization and low capacity. Unfortunately, the marginalization of water departments and ministries in a country's overall political affairs is common. Many countries did not meet the WSSD 2005 target of developing IWRM plans. Ultimately, these plans and the international water targets they strive to meet will mean little unless they are supported by legislation and properly implemented.

Country readiness to meet the Johannesburg target on IWRM planning by 2005

Region	Number of Countries surveyed	Good Progress	Some Steps	Initial Stage
Africa				
Central Africa	7		3	4
Eastern Africa	5	1	2	2
Med (North Africa)	5	1	3	1
Southern Africa	12	2	5	5
West Africa	16	2	4	10
Total	*45*	*6*	*17*	*22*
Asia and Pacific				
Central Asia	8	2	4	2
China	1	1		
South Asia	6		4	2
Southeast Asia	8		4	4
Pacific	18	2	8	8
Total	*41*	*5*	*20*	*16*
Latin America and the Caribbean				
Caribbean	6		6	
Central America	7	2	3	2
South America	9	1	5	3
Total	*22*	*3*	*14*	*5*
Total	**108**	**14**	**51**	**43**

Source: GWP, 2003.

Many government reforms fail because they never get past the implementation stage. How can the prospects for effective implementation be improved? It has been observed that a reform programme has a much better chance of succeeding if there is *economic rationality* in its design, *political sensitivity* in its implementation, and close and constant attention to political-economic interactions and social-institutional factors. Countries must intensify actions and political commitment towards the implementation of existing water policies, plans and legislation. This would go a long way towards achieving international water targets.

The global battle against corruption requires increased effort and action at all levels. Corruption costs the water sector millions of dollars every year. It siphons off scarce monetary resources and diminishes a country's prospects for providing water and sanitation for all. Although corruption takes place in all countries, in some it occurs on a more systematic basis. It is often viewed as a part of normal business practice between public agencies, citizens and the private sector - as well as within the public sector itself. However, the fight against corruption is on the increase. Many bilateral and multilateral organizations, governments, civil-society organizations and private businesses are currently developing internal and external governance guidelines and codes of conduct, and are sponsoring anti-corruption/improved governance research and development programmes. Nonetheless, if the movement to abate corruption is to be truly effective, it must include efforts in the following areas:

- public-sector reform
- increased salaries for public officials
- strict enforcement of existing rules and regulations
- improved accountability and transparency
- multilateral cooperation and coordination to track financial flows and monitor international contracts.

Governance systems are intrinsically linked to political processes and power. The road to improved governance means engaging with political power and learning how to manoeuvre in highly politicized contexts. Improving water governance is a challenge as it necessarily involves reform efforts that reach beyond the water sector. Water stakeholders at all levels can assist reform by working towards integrated policies and outcomes that encourage multi-stakeholder participation and decentralization. Furthermore, making strategic inputs into policy-making and other decision-making processes will require stakeholders to manoeuvre to a much greater extent in different social and political contexts. This means understanding the political game and its rules.

There is no blueprint for improved governance – each society must find its own route. It is important to develop institutions and governance systems that can respond effectively to situations characterized by variability, risk, uncertainties and change. Conventional water planning remains rigid and the challenge remains to develop adaptive governance frameworks and institutions. More attention needs to be given to resilient institutions and approaches that can govern or guide the complex, surprise-laden process of water governance central to long-term management at regional, basin, aquifer and local levels. This suggests that the most appropriate solutions may be those that emphasize, both the importance of enabling processes and frameworks that can be applied to resolve issues in situations of economic or other constraints and in contexts of change.

Above
A woman leads the discussion at the Bubel Village Reflect group, Orissa, India. The group examines local development problems and agrees collective action.

CHAPTER 3

Water and Human Settlements in an Urbanizing World

By
UN-HABITAT

Water resources management challenges differ enormously depending on the type of human settlement. The spectrum of settlement types stretches from the very low-density scattered single dwellings found in rural areas, through villages and small towns, to the much more dense and crowded cities and mega-cities. Half of the world's population and most of the world's economic output is located in urban areas. Today, large cities present a particular challenge, with 400 cities worldwide housing over 1 million inhabitants.

There have been significant trends worldwide towards the growth of urbanization. In most African and Asian countries, people are migrating from rural to urban settlements. Most notable are reports of burgeoning populations in the peripheries of many of the world's mega-cities. Not so heavily reported, but nonetheless significant, is the growth of large numbers of smaller cities and towns, most of which are feeling the strains of rapid expansion. In the developing world, with total populations set to increase, overall rural populations are expected to remain largely unchanged in numbers, while urban populations are expected to grow rapidly. However, differences will remain: Latin America is significantly more urbanized than Africa or Asia, although Asia lays claim to some of the world's largest cities. By contrast, in some of the more developed countries where the vast majority of the population lives in cities, there are signs of counter migration: people abandoning the cities for better living standards in surrounding smaller communities.

Above
Jakarta slum on a river bank, Indonesia.

Low-lying coastal situations are becoming increasingly densely inhabited. Not only are many of the cities and mega-cities of the world located in coastal areas, but rural densities near coastlines are also increasing. Many of these locations are below, or very close to, sea level. As a result, the likelihood of flooding is growing as sea levels rise and the intensity and occurrence of storms increase. The vulnerability of populations in such regions poses additional challenges for the civil authorities responsible.

Challenges posed by expansion in many cities and mega-cities are compounded by the unsuitability of much of the land for human settlement. This is the case for the developing world in particular. The best and most suitable land for settlement is already occupied, while the remaining land, generally occupied by poor, recent migrants, is often the most flood-prone in valley bottoms or the most landslide-prone on surrounding hillsides. These are also areas where the implementation of basic services such as drinking water and sanitation are the most difficult and expensive. The problem is exacerbated by the rate of population increase, which far exceeds the absorptive capacities of the communities. The infrastructures needed to service the influx simply cannot be built within such short time-scales.

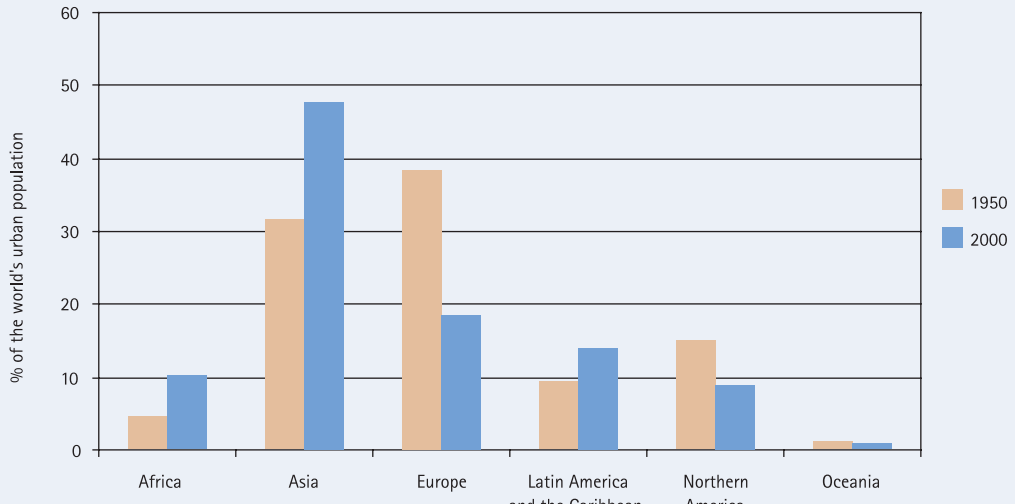
As human settlements are the major polluters of water resources, good water and wastewater management is essential to limit pollution and minimize health risks. The expansion of urban areas and agricultural frontiers usually present new opportunities for disease. This is likely to continue as the global population keeps growing and pressure increases to develop agriculture, roads and transportation systems in previously unsettled areas. Furthermore, as industries tend to be concentrated in or

around cities, and agricultural production predominantly in the surrounding available areas, measures to stem pollution and introduce and maintain efficient and safe drinking water and wastewater disposal mechanisms must be extended. This is essential to ensure the health of populations and particularly the inhabitants of large urban communities. Failure to meet these challenges will have a disastrous effect on the further expansion of cities.

Water resources management will always face the challenge of balancing the needs of different water users. This is the case both in large urban or relatively small rural communities. The water needs of the agricultural production, energy and industrial sectors are often in competition. So, while the overriding need to ensure adequate clean water for drinking, hygiene and sanitation and wastewater disposal, are of paramount importance, they nonetheless need to be balanced with consideration of these and other needs.

Human settlements provide the context for action. The struggle to achieve the Millennium Development Goals (MDGs) for water and sanitation will have to be achieved in cities, towns and villages. This is where much of the industrial production and economic activities are concentrated and where most critical governance decisions are made. With the strong physical and financial growth of cities in comparison to more dispersed rural settlements, water challenges are becoming increasingly urban in nature. City and municipal governments play critical roles in water management ensuring provision of water, sanitation and wastewater removal. How tasks related to water governance fit within broader frameworks of environmental and economic policy are of crucial importance. It is at this level that policy initiatives become reality and need both political and administrative support as conflicts have to be resolved and consensus found among competing interests and parties. Actions must be coordinated and managed in these areas if there is to be significant improvement in the lives of at least 100 million slum dwellers by 2020.

Comparative distribution of the world's urban population, 1950–2000



Source: Derived from statistics in UN, 2004.

Above
Watercans in Santiago, Cape Verde.

Slums in Curitiba, Brazil.

CHAPTER 4

The State of the Resource

By

UNESCO
(United Nations Educational, Scientific and Cultural Organization)

WMO
(World Meteorological Organization)

with

IAEA
(International Atomic Energy Agency)

There are many demands made on the world's water resources: drinking, hygiene, the production of food, energy and industrial goods, and the maintenance of natural ecosystems. Global water resources, however, are limited and unevenly distributed. This complicates water management, particularly for decision-makers, who are faced with the challenge of managing and developing water resources in a sustainable fashion in the face of the pressures of economic growth, major population increases and climate change.

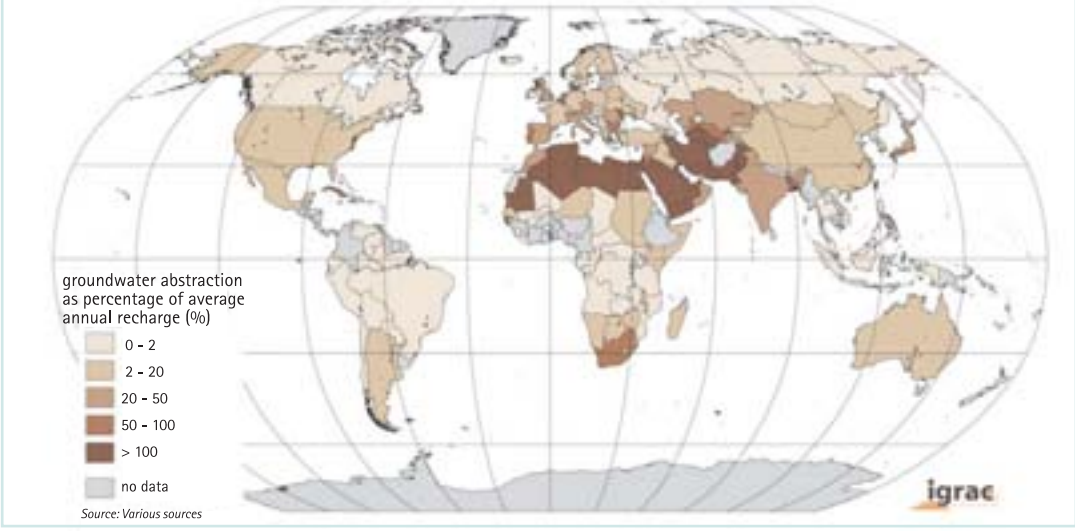
Over the past decade, awareness has grown over the need to develop sustainable practices for the protection, management and efficient use of water resources. Natural units, such as river basins and aquifer systems, are becoming widely recognized and increasingly adopted by national and regional programmes. However, the combination of different economic, environmental and social pressures often results in increased water use, competition and pollution - in addition to highly inefficient water supply practices. Responsibility for this lies in the fact that decision-making, at almost all levels, remains principally driven by short-term economic and political considerations and lacks the long-term vision needed to implement sustainable development practices. If our water resources are to continue providing valuable and beneficial services, there must be a higher level of commitment and awareness towards developing and maintaining long-term integrated approaches and solutions.

Above
Rainwater is collected in this container and filtered to provide drinking water in Komati, Swaziland.

Because the roles and interactions of the hydrological cycle components are often not fully appreciated, it is difficult to set up adequate protection and prevention strategies. Climate, particularly precipitation and temperature, is the primary driver of water resources, interacting with landmasses, oceans and topography. Yet, all components of the hydrological cycle - precipitation, infiltration, runoff, evaporation, and transpiration - must be taken into account when developing water management plans. It is important that the role played by each is better understood: for example, how rain and snow directly supply terrestrial ecosystems and soil moisture with a water source for agricultural development and terrestrial ecosystems, or how glacial melting influences water availability in many nations.

More data are needed on groundwater and aquifer systems, particularly for developing countries where the lack of adequate surface water resources is most extreme. Groundwater can be of great value, particularly in arid regions where surface water is often scarce. Although aquifers can be tapped to supplement inadequate surface resources, there are high potential risks if the aquifers are not replenished naturally or by human intervention. It becomes only a matter of time before these resources run out or become economically inaccessible. High levels of exploitation - more than 50 percent of recharge - are currently occurring in many countries in the Middle East, Southern and Northern Africa, Asia, certain countries in Europe, and Cuba. Tracking and comparing groundwater use to recharge volumes at national and sub-national levels is therefore vital - particularly for individual aquifers. This enables

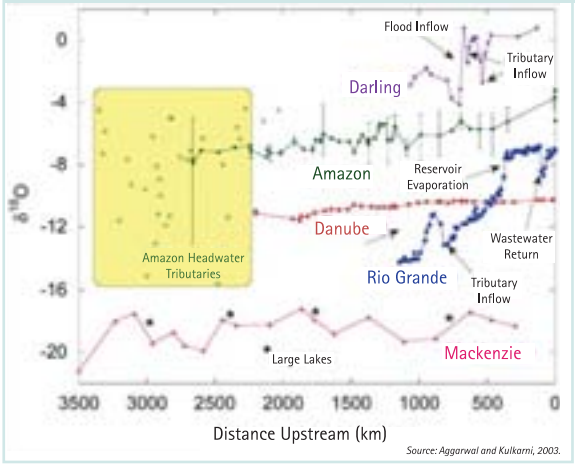
Groundwater abstraction rate as a percentage of mean recharge



identification of areas where corrective action is needed to maintain groundwater development sustainability.

Although, several large-scale efforts are underway to upgrade monitoring and networks, for example in Europe and India, groundwater assessment, monitoring and data management activities are for the most part minimal or ineffective in many developing countries and are being downsized in many developed counties. This is particularly true in both Asia and Africa where there has been a dramatic reduction in water monitoring programmes. Increased financial investment is needed to increase understanding of groundwater resources and aquifer systems. Meanwhile, regions that depend on groundwater should develop more comprehensive water level and quality monitoring programmes.

Oxygen-18 content of stream water along the main stem of large rivers



In many regions of the world, human influence is becoming more important than natural factors. River regimes are being very significantly influenced in many regions through the construction of dams and diversions. These range from the very large - such as the Three Gorges Dam in China - to the multitude of small dams such as the hillside terrace systems common in Southeast Asia, which although individually small, have a large cumulative effect on river flows. Dams act as very effective sediment traps, so effective in fact, that each dam is given a 'lifetime' after which the lake will become completely filled and the dam will cease to be effective.

Landscape change, or the removal, destruction or impairment of natural ecosystems, has the greatest critical impact on the sustainability of natural water resources. Deforestation, urbanization and increase in areas of farmland all significantly influence the quality and quantities of water flows. Furthermore, landscape changes complicate our ability to predict impacts on water resources. This makes it much harder to advance our understanding of future effects of climate change.

Poor quality water and unsustainable supplies limit national economic development and can lead to adverse health and livelihood conditions. Today, we are reasonably able to recognize the impacts of pollution and excessive groundwater and surface water withdrawals on water quality and quantity. Specific programmes should now be funded to reduce these impacts in developing countries. Meanwhile, at national and river-basin levels, there is an

Above
Bus driving across flooded plateau in the Andes, Bolivia.

emerging awareness of the need for good data on water quality. This is essential to evaluate impacts and to design improved water use and re-use strategies to meet quality and quantity demands.

Coping with the ever-increasing demand for water means locating solutions to particular problems. How to compensate for the natural variability of the hydrological cycle so as to provide a continuously available resource? How to overcome the reduced availability in water quantity or quality resulting from human and development impacts? Prevention strategies and new technologies that augment existing natural water resources, reduce demand, and achieve higher efficiency, are part of the response to the increasing burden on our available water resources. Past solutions have included storing runoff in reservoirs, diverting flows from water-abundant to water-scarce regions, and extracting aquifer resources - methods that provided ample water where and when it was needed. These methods are likely to remain part of most water resources development strategies. In order to meet current and future water demands, greater attention should be given to approaches such as innovative uses of natural supplies and new technologies. Non-conventional water resources, such as water re-use and desalination, are being increasingly used and new technologies such as artificial re-charge are also becoming more common. Capturing rainwater at the source through harvesting is yet another method used to increase the availability of natural water sources.

Above
Shanghai, China

Right
Food remains in the Mekong River after the daily market activities, Viet Nam.

Water demand reduction and efficiency approaches should be an integral part of modern water resources management. Most arid climates suffering from water shortages have long-standing water conservation traditions. These are being maintained or supplemented with demand-management practices that target efficiency - often referred to as water demand management (WDM). However, tropical and cold climates with abundant rainfall are accustomed to water supply projects and tend to adopt management practices that are particularly adapted to those specific settings. Yet, the economic benefits of extending the lifespan of water supply and treatment plants and the operating efficiency of sewage treatment systems can be considerable. On the environmental front, conservation allows for the diversion of unused water to sustain ecosystems and also lowers the pollution levels in lakes, rivers and groundwater. While WDM should be promoted, it requires a distinct change in the behavioural patterns of institutions, utilities and individuals - a change that will need education, awareness-raising and political commitment to achieve effective implementation.

Water resources assessments (WRA), provide scientists, engineers and managers as well as policy makers and planners a foundation on which many decisions can be made. WRA, the process of monitoring (measuring, collecting and analysing) the quantity and quality of water resources, is the basis for the formulation of policies and legislations striving for sustainability of water resources. Consequently, there are economic, social and environmental benefits from periodic water resources assessments (WRAs) in all basins and aquifers, and in individual nations as well as on a regional level, especially where transboundary water resources exist.

CHAPTER 5
Coastal and Freshwater Ecosystems

If the Millennium Development Goals for freshwater, biodiversity and climate change, among others, are to be achieved, management responses must take into account ecosystem concerns. At the 2002 World Summit on Sustainable Development (WSSD), in addition to halving the proportion of people lacking access to safe drinking water and basic sanitation by 2015, countries committed themselves to achieving a significant reduction in the rate of biodiversity loss in aquatic ecosystems by 2010. Reconciling these two targets constitutes a major challenge.

By
UNEP
(United Nations Environment Programme)

The implementation of Integrated Water Resource Management (IWRM) schemes on regional and local scales, the increasing use of ecosystem approaches focusing on river basins, the decommissioning of several controversial dams in North America, and many different river and wetland restoration projects, suggest that these commitments are at last being taken seriously - albeit not in all parts of the world.

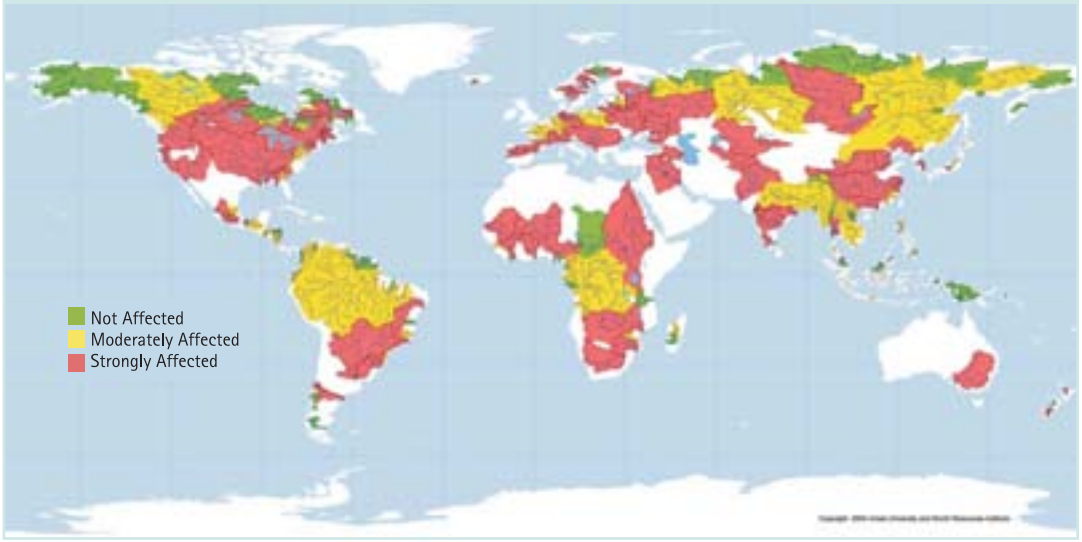
Healthy freshwater ecosystems are essential for the maintenance of biodiversity and human well-being. We depend upon freshwater ecosystems for our food security and a wide range of environmental goods and services. Freshwater biodiversity is extremely rich, with high levels of endemic species, but also very sensitive to environmental degradation and over-exploitation. Often also called inland waters, these ecosystems comprise a range of highly productive habitats containing a significant proportion of freshwater. They include lakes and rivers, wetlands and floodplains, small streams, ponds, springs and aquifers. The term 'wetland' describes a particular group of aquatic habitats representing a variety of shallow, vegetated ecosystems - such as bogs, marshes, swamps, floodplains and coastal lagoons - which are often buffers against extreme weather events like hurricanes. The degradation of these wetlands puts coastal areas at risk.

In many areas, freshwater ecosystems and species are deteriorating rapidly. Often faster than terrestrial and marine ecosystems. This is having an immediate impact on the livelihoods of some of the world's most vulnerable human communities. Effects include reduction in food protein levels, clean water and potential income generation; the undermining of poverty reduction strategies; and extinction rates unprecedented in human history. Available data such as the Living Planet Index (LPI) tend to support the hypothesis that freshwater species are more threatened by human activities than species in other realms. On average, populations fell by about 47 percent between 1970 and 2000. This represents a much sharper decline than those measured in either terrestrial or marine ecosystems, with the most serious drop being seen in Southeast Asia.

Trends in the status of freshwater biodiversity and pollution measurements - such as biochemical oxygen demand (BOD) and nitrate concentrations in water - indicate the continuing deterioration of many

Above
Global warming has caused the Vatnajokull glacier (Iceland) to retreat.

Fragmentation and flow regulation by Large River System (LRS)



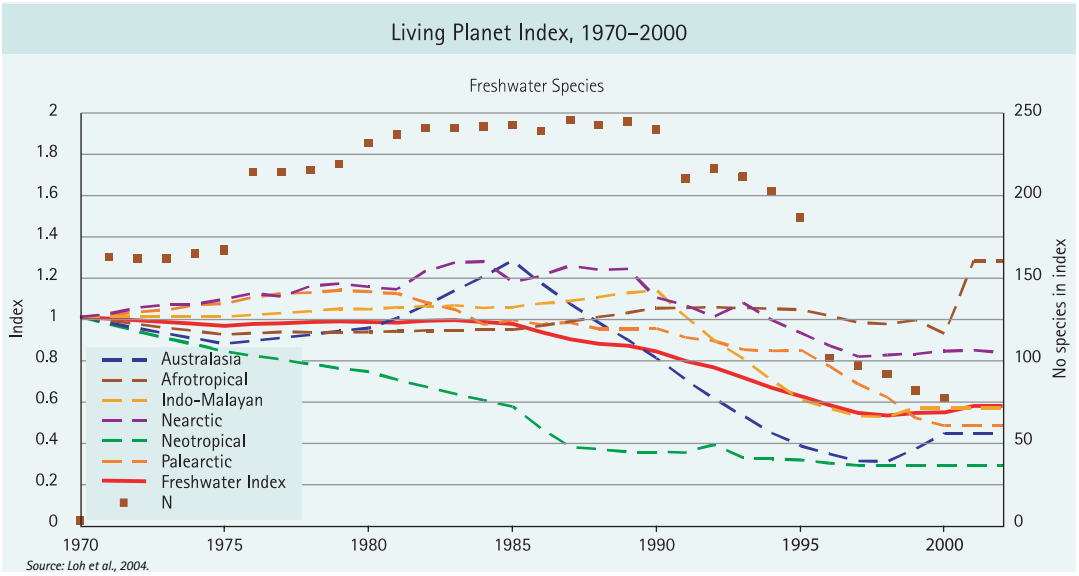
freshwater ecosystems. The first global study on river flow status has demonstrated the increasing fragmentation of river basins as a result of damming and other flow impediments. Waterfalls, rapids, riparian vegetation and wetlands can all disappear when river flow is altered by damming. Major local and regional threats to freshwater ecosystems include habitat alteration, land-use change, especially deforestation and agricultural intensification, river fragmentation and flow regulation, water pollution, invasive species and climate change. Failure to address these problems will have immediate social and economic costs and long-term, potentially irreversible effects on biodiversity.

Above
Heavy rains falling in the province of Misiones wash the soil and carry off significant quantities of ferruginous earth into the Río Uruguay (Argentina), turning the waters a dark, reddish ochre.

Freshwater management is experiencing a crisis. Biodiversity and the conservation of species, habitats and ecosystem functions must become an integral part of all sound water resource management programmes. Practical approaches are urgently required for the sustainable use of aquatic ecosystems. One major impetus in this direction is the WSSD's Plan of Implementation, through which participating governments agreed to develop IWRM and water efficiency plans by 2005.

There is now an urgent need to implement IWRM approaches. Although now widely accepted, it should be noted that IWRM approaches should be tailored to local circumstances and needs. This will require the development of a series of tools and methodologies - in some cases adapting those used in different habitats and situations. Some governments and international development and conservation organizations use the Integrated River Basin Management (IRBM) approach. This concept is similar to IWRM and considers the river or lake basin/aquifer as the ecologically defined management unit. IRBM can therefore be applied at a variety of scales depending upon the size of the river basin. This can range from small catchments of a few square kilometres to major national basins, as well as transboundary basins where allocation and pollution issues cross international borders.

At the same time, partnerships between governments, communities, non-governmental organizations, industry interests and research groups must move beyond general commitments to specific actions and flexible and durable working arrangements. Effective institutional management structures should allow for public input, changing basin priorities, and the



incorporation of new information and monitoring technologies. The adaptability of management structures should also extend to non-signatory riparian countries (i.e. those within the same hydrological system) by incorporating provisions that address their needs, rights and potential accession. In the past, some attempts to resolve partnership issues have included the establishment of freshwater and regional seas agreements at local, basin or regional levels (e.g. in the Mekong, the Black Sea and the Danube, the Mediterranean and Lake Chad). While such initiatives have met with some success, they often still lack the policy tools necessary to promote long-term IWRM.

Considerable improvements in data quality are urgently needed. This is required, in particular, to evaluate progress towards the 2010 targets for reducing rates of biodiversity loss set by WSSD and the Convention of Biological Diversity. Although data on biodiversity and water quality exists for some species groups, habitats and regions, there are still large gaps in the information available on many species, and very little information is available on the extent and quality of aquatic ecosystems. In the end, ecosystem indicators are only as good as the data that support them.

Left
A scheme to irrigate the desert has caused the Aral sea to shrink. It is now too saline for fish and too shallow for ships to navigate.

Franz Joseph Glacier, in Te Wahipounamu, New Zealand.

CHAPTER 6

Protecting and Promoting Human Health

By

WHO
(World Health Organization)

UNICEF
(United Nations Children's Fund)

The state of human health is inextricably linked to a range of water-related conditions: safe drinking water, adequate sanitation, minimized burden of water-related disease and healthy freshwater ecosystems. Urgent improvements in the ways in which water use and sanitation are managed are needed to improve progress towards meeting the Millennium Development Goals (MDGs) related to human health.

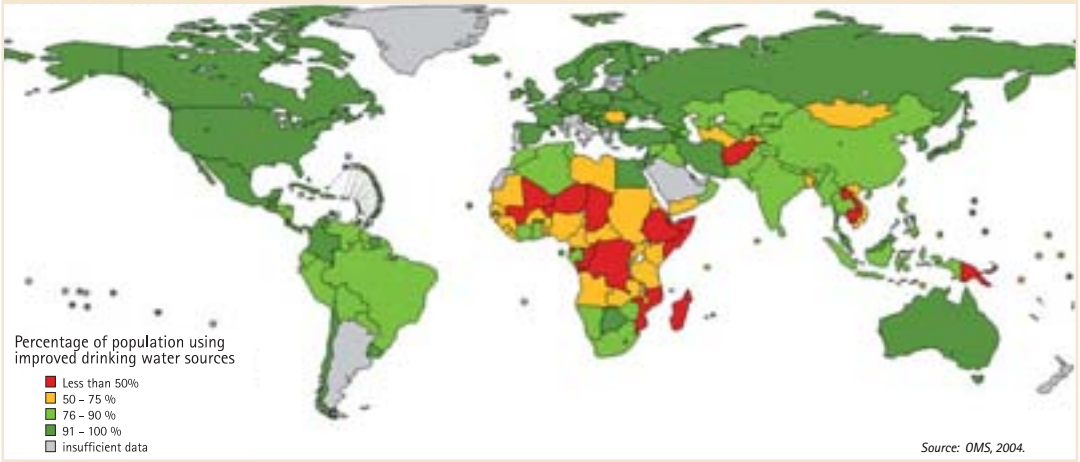
Human health cuts across the major sectors in water resources development and management. A range of different water conditions and parameters determine the health of communities. In the domestic sphere, whether in urban or rural areas, the focus is on lack of access to sufficient supplies of safe drinking water, adequate sanitation and the promotion of hygiene practices. All of these are important in arresting the transmission of diarrhoeal diseases and other gastro-intestinal infections. Where water is needed for food and energy, the focus is on the impact of reservoir construction for hydropower and irrigation development and the ensuing risks of diseases, such as malaria, schistosomiasis, filariasis and Japanese encephalitis. Health can also be a key factor in mobilizing communities to participate in nature conservation and environmental management, in particular, for communities that depend on ecosystems for their livelihood or manage health risks related to water-associated diseases. Community health status is, therefore, the ultimate indicator of the success or failure of integrated water resources development and management.

Above
This woman's hands bear the marks of arsenic poisoning through drinking water.

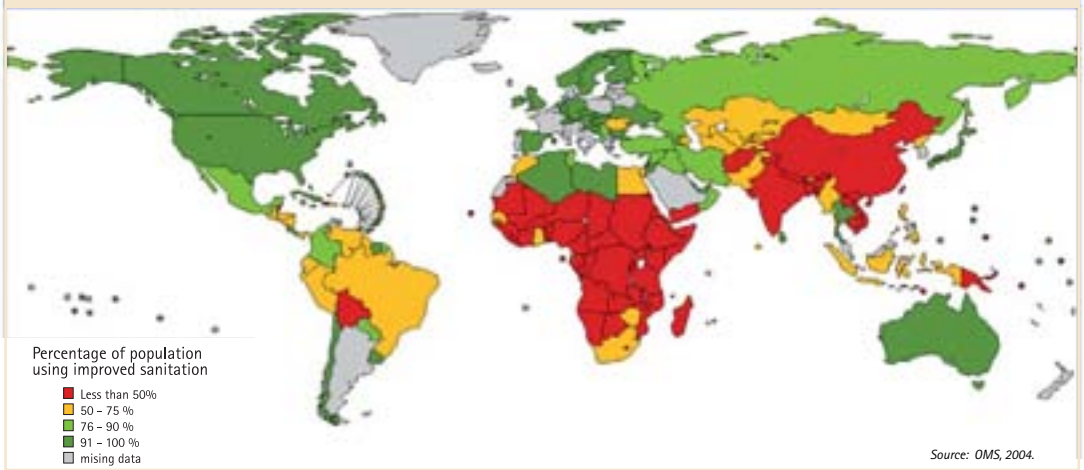
Infectious diseases, especially diarrhoea and malaria, continue to dominate the global burden of water-related disease. The burden of water-related diseases is a good indicator of the state of access to water and sanitation. Diseases associated with lack of access are measured principally using Disability-Adjusted Life Years (DALY). Data are organized by age and include information on sex and geographical region for diarrhoea, malaria, schistosomiasis, lymphatic filariasis, onchocerciasis, dengue, Japanese encephalitis, trachoma, intestinal nematode infections, protein-energy malnutrition and drowning. In 2002, diarrhoeal diseases and malaria accounted for 1.8 and 1.3 million deaths respectively. These were almost entirely children under 5 years of age. Diarrhoea remains the leading cause of death from water-related diseases in children. In developing countries it accounts for 21 percent of all deaths in children under 5. Although diarrhoea mortality is decreasing, the proportion of deaths due to persistent diarrhoea and dysentery is increasing. Malaria causes illness in about 400 million people every year. With its share of the global burden of disease increasing, it is one of the most urgent global health problems.

In Africa and Asia, water-related diseases continue to impose a particularly large burden on health. Sub-Saharan Africa and South Asia carry the largest burden: it is estimated that each child under 5 years of age in a developing country suffers on average three episodes of diarrhoea per year. While the burden of diarrhoea is distributed over both Africa and South Asia, malaria largely affects children under 5 in Africa. Malaria is responsible for approximately 30 percent of out-patient clinic visits in African countries where the disease is endemic. In many of the

Coverage with improved drinking water sources, 2002



Coverage with improved sanitation, 2002



same regions, the population faces intense year-round malaria transmission. This results in a high number of cases, in particular among children and pregnant women. Since the late 1990s, cholera has also posed a large problem in Africa, where between 100,000 and 200,000 cases are officially reported each year.

Many water-related diseases could be controlled by universal access to safe water and adequate sanitation/hygiene/water management practices. Improvements in water supply and sanitation will prevent diarrhoea and help reduce instances of intestinal helminths (parasitic worms) and schistosomiasis. Current evidence shows that 1.7 million deaths could also be avoided each year by providing access to safe drinking water, sanitation and hygiene. The single most effective intervention is hand washing with soap, which could cut diarrhoea deaths in half. Many infectious skin and eye diseases are also related to poor hygiene and inadequate water supplies. Soil-transmitted helminths also flourish where poverty, inadequate sanitation and minimal healthcare prevail.

There is evidence that water resources development has an impact on the incidence of malaria and other vector-borne diseases. Malaria control is hampered by a number of constraints, including the increasing resistance of mosquitoes and malaria parasites to insecticides and inexpensive drugs, climate and environmental change, population movements and behavioural change. It is widely recognized that water resource development projects, especially irrigation systems, can also provide ecological conditions conducive to the spread of malaria. The relationship between malaria and water resources development is, however, highly situation specific. It depends on the climate, people's behaviour and the ecology, biology and efficiency of vectors. Mosquito breeding is often associated with faulty irrigation design and maintenance or water management practices. At present, environmental management methods are prevented from playing a more important role in

Below
A woman collecting a supply of unsafe water, Indonesia.

malaria control due to lack of scientific evidence of effectiveness as well as uncertainty regarding the feasibility of implementation. Recent international research initiatives have focused on possibilities of reducing malaria as part of an ecosystem approach to human health.

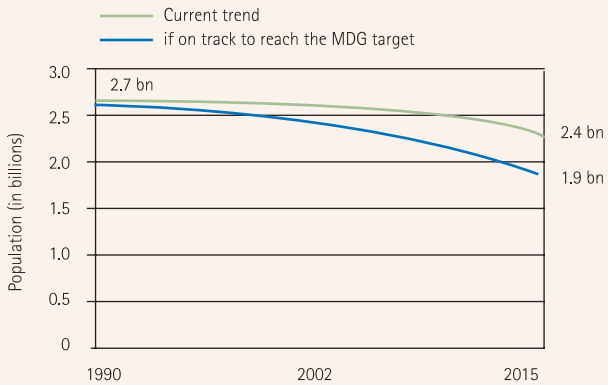
Chemical pollution of surface waters, mainly by industry and agricultural runoff, also pose major health hazards in some developing countries. In Bangladesh, over the past twenty years, more than 4 million tubewells have been installed to provide safe drinking water to 95 percent of the population. However, high concentrations of arsenic have recently been discovered in tubewell water. The scale of the problem and the full impact of arsenic poisoning will only become apparent at a later stage as the effects on health (e.g. malignant tumors or skin lesions) occur only after extended periods of exposure. Moreover, as some chemicals, such as arsenic and fluoride, occur naturally in groundwater, it can often be difficult to accurately attribute health problems to specific factors in the environment. This situation (also found in parts of China, India, and East Africa) calls for a pragmatic combination of affordable and sustainable water supply programmes aimed at minimizing the combined health risks posed by pathogens, arsenic and other natural and manufactured chemicals possibly present in the environment.

Above
A toilet block in Dar es Salaam, Tanzania.

Progress has been made in increasing safe water and sanitation coverage, but greater improvements are needed to meet global water and sanitation targets. This is particularly the case in sub-Saharan Africa. Worldwide, between 1990 and 2002, about 1.1 billion people gained access to improved water sources (Datasets and information on water supply and sanitation coverage are provided by the Joint Monitoring Programme, JMP, a programme maintained by the World Health Organization, WHO, and United Nations Children's Fund, UNICEF). Global sanitation coverage rose from 49 percent in 1990 to 58 percent in 2002. Although the world is now globally on-track to achieve the MDG drinking water target, the sanitation target - to halve the proportion of people without improved sanitation - will not be met by 2015 without additional effort. Sanitation coverage in developing countries (49 percent) is only half that of the developed world (98 percent). Though major progress was made in South Asia between 1990 and 2002, little more than one-third of South Asians currently have access to improved sanitation. Over half of those without improved sanitation - nearly 1.5 billion people - live in China and India. In sub-Saharan Africa, progress reports indicate that neither the drinking water nor sanitation targets will be met by 2015. Some 2.6 billion people - half of the developing world - continue to live there without improved sanitation. If the 1990-2002 trend continues, the world will fall short of its sanitation target by more than half a billion people.

Over the long term, many environmental health interventions have proved to be more cost-effective than medical interventions. As such, global disease control priorities should clearly be based not only on the global burden of disease but also on the availability of cost-effective interventions. Based on a study in Burkina Faso, the cost of implementing a large-scale hygiene promotion programme was estimated at US $26.9 per case of diarrhoea averted. Cost-effectiveness of a latrine revision programme in Kabul, Afghanistan ranged from US $1,800-4,100 per death due to diarrhoea averted, depending on age and payer perspective. Studies show that universal access to piped water and sewerage can reduce the burden of water-related disease to nearly zero at an estimated cost of US $850-7,800 per DALY averted, but this is clearly higher than typical income levels in developing countries. Low-cost technologies, however, (standpipes and latrines, as opposed to piped water and sewerage connections to individual homes), would likely improve the cost-effectiveness to US $280-2,600 per DALY averted, if disinfection at the point of use is added.

Projected population without access to improved sanitation



Source: WHO/UNICEF, 2004.

CHAPTER 7

Water for Food, Agriculture and Rural Livelihoods

The world's agriculture has responded well to the challenges raised in the second half of the twentieth century. Per capita food production increased by 25 percent as the global population doubled, leading to a progressive improvement in global nutrition. This response has steadily reduced the proportion of malnourished people.

By

FAO

(Food and Agriculture Organization of the United Nations)

IFAD

(International Fund for Agriculture Development)

In developing countries, this outcome was the result of a targeted effort founded on the conceptual premise of the 'green revolution': farming high-yield crop varieties supported with adequate plant nutrition, water and protection from pests. The productivity of agricultural land has doubled, as has the productivity of water usage in agriculture. As a result, food prices have gradually decreased, leading to a progressive reduction in the share of agriculture in the world's economy.

The demand for food is not negotiable. While the global rate of demographic growth is declining, the number of people added every year to the world's population - about 75 million - is still large. As populations grow, the available resources per capita shrink and higher productivity is required to compensate. To satisfy the estimated increase in demand for food between 2000 and 2030, production of food crops in developing countries is projected to increase by 67 percent. At the same time, a continuing rise in productivity should make it possible to keep the projected increase in water usage for agriculture down to about 14 percent.

On average, it takes about 3,000 litres of water per person to produce our daily intake of food. The water absorbed by plants is used to raise nutrients from the soil, at which point the water is released into the air through transpiration. By far, most of the water used by crops is derived from rainfed soil moisture. Irrigation provides only about 10 percent of agricultural water but has a significantly strategic role: it supplements rainfall where soil moisture is insufficient to reliably satisfy the needs of the crops. It is especially important in areas vulnerable to excessive climatic variability or where multiple cropping requires the provision of water outside the rainy season.

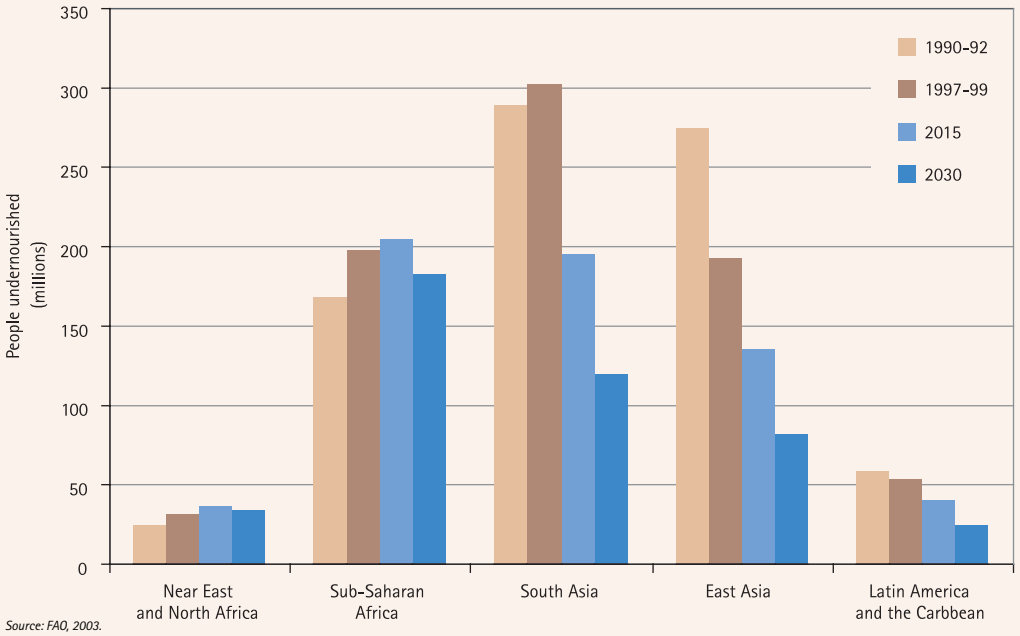
By ensuring water supply, irrigation guarantees crop production and encourages farmers to invest in more productive agriculture. However, although it represents only a marginal part of the water used in agriculture, irrigation is, by a substantial margin, the largest consumptive user of the Earth's freshwater resources.

Above
Workers harvest carp raised in a stock pond, India.

Large-scale, state-supported irrigation schemes that contributed substantially to increases in agricultural production are now struggling to adapt. These schemes enhanced the livelihood of farmers, while producing food at lower cost for the benefit of urban and rural populations alike. However, the rapidly changing economic environment has seen relatively disappointing performances in recent years. These schemes are now at the core of a protracted debate involving technical, economic and, ultimately, social questions. Many systems are too institutionally and technically ill-equipped to respond to the

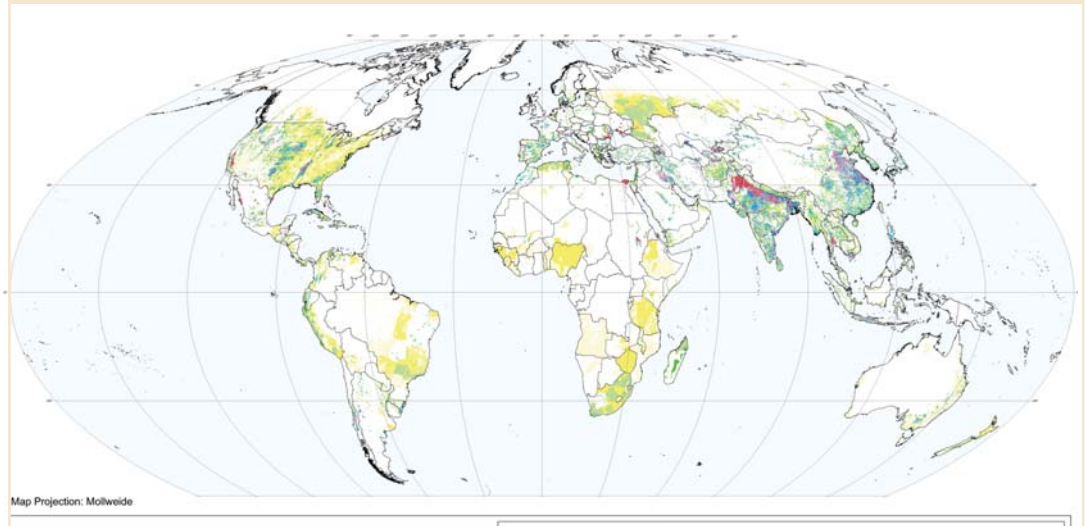
challenges presented by increased water scarcity, the need for agricultural diversification and the pressure of rapid globalization. Modernization of irrigated agriculture is therefore essential to ensure much-needed gains in water productivity. Irrigation institutions must respond to the needs of farmers to ensure flexible and reliable delivery of water, increased transparency in management, and a balance between efficiency and equity in access to water. This will not only require a change in attitudes, but also well-targeted investment in infrastructure modernization, institutional restructuring, and upgrading of the technical capacities of farmers and water managers.

Estimated and projected number of undernourished people by region, 1991–2030



Source: FAO, 2003.

Distribution of areas under irrigation in the world, 2000

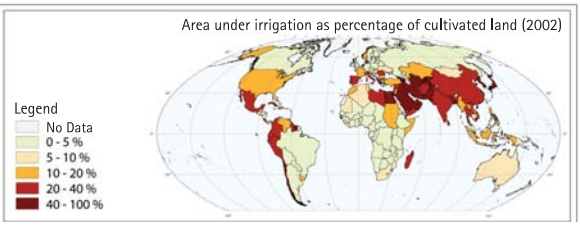


Note: Irrigation is concentrated in arid and semi-arid areas, where it represents a significant share of cropland, and in the humid tropics of Southeast Asia, where it made it possible to move from one to two or even three harvests of rice per year.

Source: Siebert et al, 2005; FAO/Aquastat, 2005.

Area under irrigation in percentage of land area

0 <0.1 | 0.1 - 1 1 - 5 | 5 - 10 10 - 20 | 20 - 35 35 - 50 | 50 - 75 75 - 100



Agriculture is now coming under increasing scrutiny as water resources shrink and competition between sectors intensifies. Pursuing a narrow development goal of increased agricultural productivity has led to the breakdown of many once resilient ecosystems. The amount of water available to agriculture is now being progressively limited by degraded land and water systems, competition from other economic sectors, and the need to conserve the integrity of aquatic ecosystems. Agriculture has come under pressure to reduce the level of its negative impacts, particularly those associated with the use of fertilizers and pesticides, as well as wasteful use of water. As competition increases, irrigation needs to be carefully examined to discern where society can benefit most effectively from its application. Access to natural resources needs to be negotiated with other users in a transparent fashion in order to achieve optimal uses under conditions of growing scarcity.

It is now widely acknowledged that agricultural water management can have positive impacts far beyond the economics of crop production. This *multi-functionality of agriculture* has been recognized and is today promoted in many countries. Farmers need to be encouraged and guided, through appropriate policies and incentives, to conserve natural ecosystems and their biodiversity and to minimize agriculture's negative impact. This goal will only be achieved if the appropriate policies are in place.

Historically, governments have tended to neglect agricultural development in favour of industrial and urban-centred activities. National policies and international economic factors often have devastating consequences on rural people in developing countries, preventing them from actively contributing to their country's economy. However, it is now more generally acknowledged that agriculture is the main engine of growth in most developing economies. As the globe is progressively achieving food security, 13 percent of its population (850 million people, living mostly in rural areas) do not have access to sufficient food to lead healthy and productive lives. In particular, a group of thirty countries, most of them in Africa, experiences difficulty both in producing enough food for their own population and in generating sufficient resources for importing necessary goods unavailable within their borders. These countries are highly dependent on agriculture. Progress in improving their food security capacity depends on, more than any other factor, the development of local food production. In most cases, they need a substantial increase in investment in rural areas, where water management plays a central role in raising the productivity of agriculture and related rural activities.

The agriculture sector today faces a series of complex challenges.

- More food of better quality needs to be produced using less water per unit of output.
- Rural people need to be given the resources and opportunities to live healthy and productive lives.
- Clean technologies that ensure environmental sustainability must be applied.
- Agriculture must contribute in a productive way to local and national economies.

Ultimately, a 'business as usual' attitude in the food and rural livelihoods sector will seriously hinder the attainment of the Millennium Development Goals of freeing humanity from extreme poverty and hunger and ensuring environmental sustainability.

Left
Sprinkler irrigation on an experimental field of asparagus, Brazil.

Middle
Cattle drinking from a river bank, Ethiopia.

Below
Women harvesting cereal in Rajastan, India.

CHAPTER 8
Water and Industry

By
UNIDO
(United Nations Industrial Development Organization)

Industry is a large promoter of economic growth, particularly in developing countries. The 2002 World Summit on Sustainable Development held in Johannesburg proposed a Plan of Implementation that makes strong links between the related goals of industrial development, poverty eradication and sustainable management of natural resources. Industrial growth is highly desirable for countries adopting poverty-reduction policies. It is necessary to diversify economies, create jobs, and add value to the products and raw materials being produced.

In the fast-growing East Asia and Pacific region, industry now provides 48 percent of total GDP. This proportion is still increasing. In heavily indebted poor countries, the proportion of GDP provided by industry grew quickly from 22 percent to 26 percent between 1998 and 2002. In rich countries, by contrast, the proportion of GDP coming from the production of manufactured goods is declining slowly. It currently provides 29 percent of GDP, with services making up the bulk of the economy.

Above
Industrial site in Grangemouth, Scotland.

Industrial pollution and waste is endangering water resources by damaging and destroying ecosystems worldwide. This undermines water security for both individual and water-consuming industries. Municipalities are finding that the quality of water they supply is compromised by industrial waste. Meanwhile, pollution also has a direct economic impact on fisheries. Industries in developed and developing countries that require clean water are in turn finding that their water security is increasingly affected by water shortages and deteriorating water quality.

Limiting industrial pollution means increasing good environmental governance. It is possible to decouple industrial development from environmental degradation, radically reduce natural resource and energy consumption, and at the same time, have clean and profitable industries. It is important that the necessary legal and institutional arrangements be in place to enable this growth to take place in a sustainable fashion. Many such governance initiatives now exist at international and national levels, as well as at the level of industrial sectors and individual companies. Some of the more recent key international agreements and multilateral environmental agreements affecting industrial water use and pollution impacts include:

- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. This provides an international mechanism for addressing issues of waste generation, movement, management and disposal.
- The Stockholm Convention on Persistent Organic Pollutants (POPs). This governs the production, handling, transport and use of certain highly toxic organic chemicals that remain intact in the environment for long periods, and become widely distributed geographically.
- The EU Water Framework Directive on Integrated River Basin Management for Europe. This

coordinates the objectives of European water policy in order to protect all waters, including surface water and groundwater. It uses a river basin management approach, and incorporates the Integrated Pollution Prevention and Control (IPPC) Directive that addresses industrial installations with a high pollution potential.

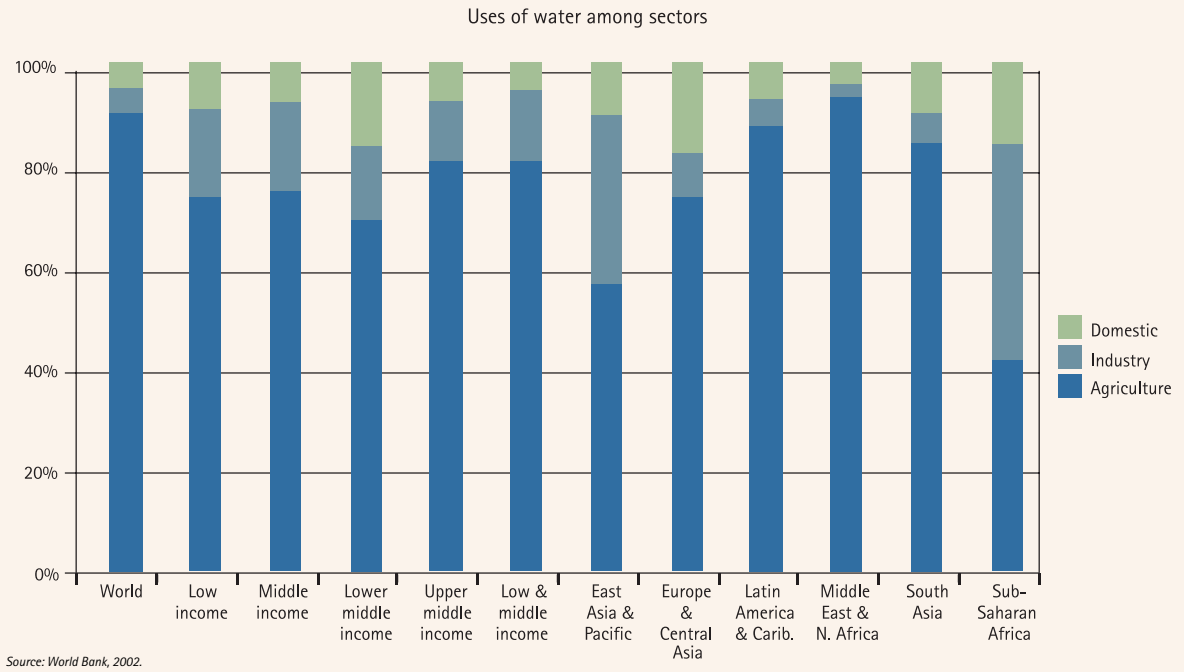
Agreements to curb industrial water pollution must be translated into national policies if they are to become truly effective. Regulatory and economic measures are needed for local, regional and national water management. This is essential to further improve industrial water productivity and reduce industrial water pollution. Measures can take the form of policy instruments and economic incentives. Examples of these include stepped water tariffs for industry, subsidies for industries implementing innovative environmental technologies, and financial and advisory support for industries funding new research.

Efforts to control industrial pollution are emerging from within the sector. Many industries are also improving their strategies for water use, influenced by changing consumer attitudes, the pressure for better corporate governance, and cost-cutting measures. There has been an exponential increase over the past decade in the numbers of worldwide industrial companies seeking certification with ISO 14001, the international environmental standard. Companies adhering to the standard implement environmental management systems, conduct environmental audits, and evaluate their environmental performance. Their products adhere to environmental labelling standards, and waste streams are managed through life cycle assessments. Increasingly, companies recognize that such actions demonstrate commitment to being environmentally responsible as well as profitable, enhancing both their corporate image and their competitiveness.

Above
Plastic bottles thrown into Rio Pinheiros, Sao Paulo, Brazil.

Where water quantity is concerned, it is important to consider the productivity of the water used. The industrial value added (or units of product produced) per unit of water used varies enormously by country and industrial sector, depending on the value of the product and the value placed upon the water used in the process. However, it is a useful benchmarking tool whereby companies can track successful process modifications that lead to better environmental management. There are various strategies available to the management of industries to improve water productivity. These include water auditing, matching water quality to use requirements, on-site water recycling and reuse, and using reclaimed water rather than freshwater where feasible.

Water use by industry vs. domestic use and agriculture



Source: World Bank, 2002.

Where water quality is concerned, Zero Effluent Discharge should be the ultimate goal of companies and municipalities. Zero Effluent Discharge entails water recycling and recovery of all wastes. It also avoids the release of contaminants into the aquatic environment. However, if avoiding discharges altogether is not economically or technically feasible, there are many valuable intermediate strategies that can be taken at factory level to reduce industry's impact on water quality. These include:

- cleaner production assessments
- Transfer of Environmentally Sound Technologies (the TEST strategy promoted by UNIDO)
- stream separation (avoiding the mixing of contaminants)
- raw material and energy recovery from waste
- selecting optimal wastewater treatment technologies.

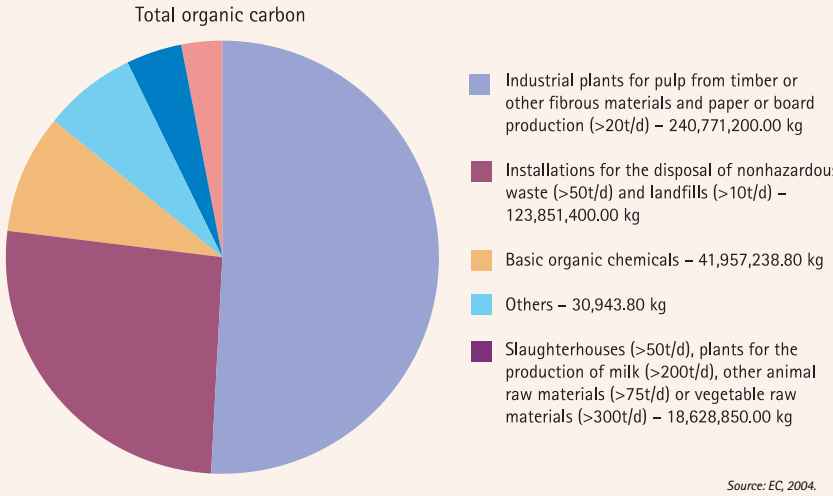
Above
Water treated on site at a rubber factory, Malaysia.

Voluntary measures and self-regulation allow industries to monitor performance and demonstrate commitment to improving the environment. Adopting *Environmental Impact Assessments (EIAs)* and *Environmental Management Systems (EMS)* are two primary ways of achieving this. EIAs investigate the environmental impact of new projects and significant extensions of existing projects, using scientific evaluation and consultation with public and environmental authorities. An EMS (such as ISO 14001) helps a company achieve its stated environmental policy by setting responsibilities, defining environmental objectives and the operational procedures, training needs, monitoring and communication systems to be used. For companies, registration with the environmental standard ISO 14001 provides an internationally recognized framework with which to demonstrate their environmental commitment while enhancing profitability and competitiveness. Other Best Environmental Practices (BEPs), which promote the sustainable use of water include:

- Environmental audits. These assess the effectiveness of the management system in place, its conformity with the organization's environmental policy and programme, and the organization's compliance with relevant environmental regulatory requirements. Environmental audits often include water and energy audits.
- Best Available Technology (BAT). This is a useful standard-setting tool for emissions reduction in many industrial sectors.

Virtually all manufacturing processes require water to a greater or lesser degree. The water demands of industry are legitimate. At issue is how water used by industry is returned to the system and the manner in which the industry sector's demands will be balanced against the demands of other sectors.

Release of total organic carbon (TOC) directly or indirectly to water in 13 European Union Member States, 2003



Source: EC, 2004.

CHAPTER 9
Water and Energy

The connection between water and energy is often overlooked. Experience has shown that the simultaneous analysis of water and energy use at policy level can enable a significant increase in productivity and sustainability in the use of both resources. Yet the strong links between water and electrical power usage (termed the water/energy nexus) are, at present, not fully taken into account in policy-making, management and the operation of both water and electricity generation systems.

By
UNIDO
(United Nations Industrial Development Organization)

Economic development needs an adequate and steady supply of energy to be sustainable. Water is a key resource for energy generation, primarily through the use of hydroelectric power, but also in nuclear-based energy generation, coal slurry technology and small-scale hydroelectric schemes, among others. Energy is equally essential for freshwater supplies, for example, in groundwater pumping, desalination technology and delivery and distribution systems. Reducing the inefficiencies that occur in energy production (during electricity generation, transmissions, distribution and usage) will reduce electric power requirements leading to greater water savings. Equally, diminishing the inefficiencies and leaks that occur in water distribution systems (for agriculture and municipalities in particular, as well as other human activities) makes efficiency gains possible in the electricity sector and offers big potential water savings in electricity production.

Many opportunities to promote greater socio-economic development are being lost. Over 2 billion people in developing countries do not have access to reliable forms of energy. In Africa alone, an estimated 526 million people lack access to electricity. In many developing countries, access to electricity lags far behind access to improved water supplies. Improving access to electricity, although not one of the Millennium Development Goals (MDGs), was one of the targets adopted at the 2002 World Summit on Sustainable Development.

Hydropower can be made even more sustainable. Hydropower contributes 19 percent of global electric power generation, although its importance varies from country to country. Twenty-four countries generate more than 90 percent of their electricity through hydropower, whereas others generate none at all. Europe makes use of 75 percent of its hydropower potential, while Africa has developed only 7 percent. This is viewed as a possible cornerstone of Africa's future development, with significant export potential and plans to establish a continent-wide electricity grid. Hydropower brings flexibility to a national network grid, due to its ability to meet sudden demand. Run-of-river hydropower stations - from large to small - are clean, affordable and sustainable renewable energy providers. However, hydropower projects involving large reservoir construction fall into a different category. There remains considerable difference of opinion worldwide as to whether they should be classified as renewable energy and if they should be prioritized by developing countries for investment.

Above
The Ataturk Dam (Turkey) is the largest in a series of 22 dams and 19 hydroelectric stations built on the Euphrates and Tigris rivers.

Below
Solar photovoltaic panel for pumping water, Kabekel village, Gambia.

The construction of new dams needs greater transparency, accountability, stakeholder involvement and oversight of the contractual process. All of these are essential to promote social equity and good governance. In many places, large dams are built as much for the purposes of water storage, irrigation, and flow regulation as for the hydropower benefits that they may provide. Large hydropower investments can be made more sustainable by:

- prioritizing run-of-river projects for new investment
- piggybacking alternative energy sources to hydropower, for instance through the coupling of wind and hydropower
- adding hydropower capacity to existing infrastructure such as water storage dams and barrages
- extending the life and improving the efficiency of existing hydropower schemes.

Small hydropower projects (SHP) can provide a viable alternative to their larger counterparts. SHP is especially appropriate for providing off-grid electrification for isolated rural areas with a sparse population. This is providing there are adequate water resources available and seasonal variations in power output are taken into account. These smaller-scale projects lack the level of controversy associated with large hydro, because their impact on the local environment is limited. The use of SHP can contribute to poverty alleviation through sustainable socio-economic development, increasing employment opportunities for local people, improving rural living standards, and promoting environment friendly development. Investment in SHP plants by private firms and individuals can be encouraged through preferential policies. Examples include tax reductions, soft loans/grants from government, and promoting indigenous manufacturing capability for small hydropower equipment.

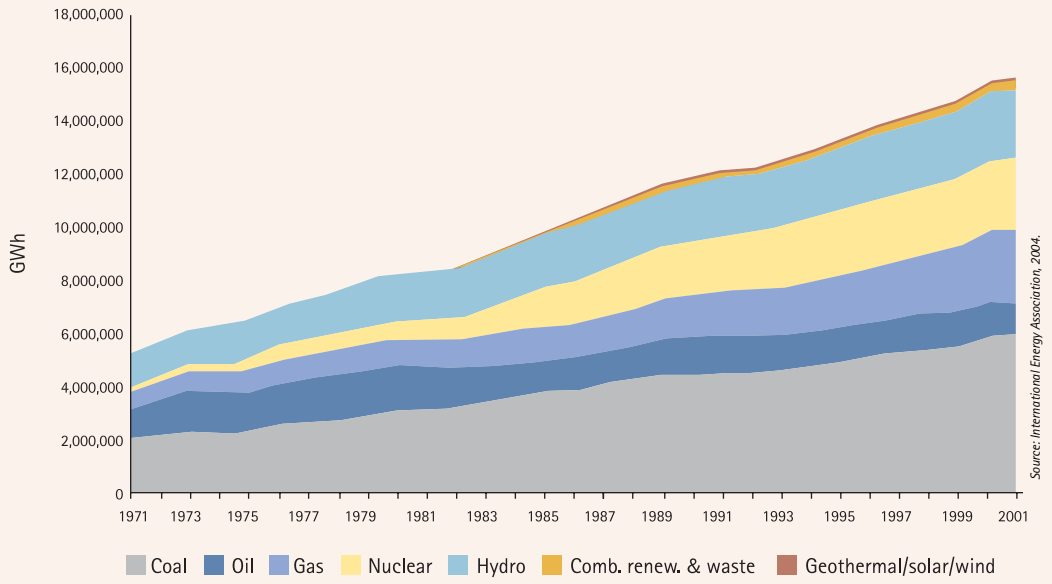
Above
Coal-fired power station in Bergheim, Germany.

Right
Kut Al Amara dam, Iraq.

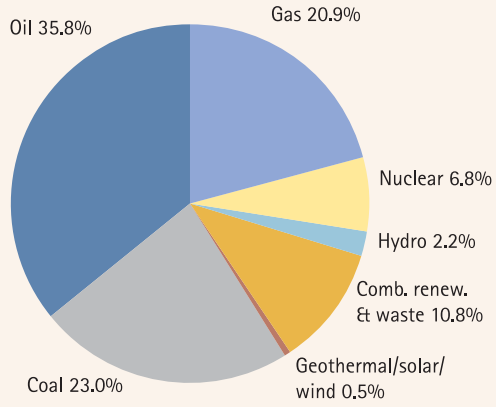
The impact of an energy-intensive water delivery system can be dire in areas with scarce water and energy resources. Energy intensity measures the amount of energy used per unit of water delivered. Some sources of water supply are more energy intensive than others. Thermal desalination, for example, requires more energy than wastewater recycling, while water pumping consumes significant energy resources worldwide. Implementing energy efficiency in the water and wastewater industries reduces operations and maintenance costs. It decreases both emissions and the capital costs of new supply. It also improves water quality, service coverage, the solvency and operations capacity of water utilities and a host of other related benefits. Reductions in energy use in water and wastewater systems can be encouraged through delegation of larger-scale energy and water management to local levels. Involvement of water and wastewater decision-makers, however, is vital for success, with the first step being energy and water audits of utilities. Furthermore, their involvement provides the support needed to implement energy efficiency measures, ensuring that energy and wastewater reduction efforts are sustainable.

Recent environmental concerns demand that a greater investment be made in renewable energies. Environmental concerns, particularly over climate change, nuclear waste disposal and safety and security of energy supply, have prompted governments to introduce policies aimed at accelerating the use of renewable energy and Combined Heat and Power (CHP). Total worldwide investment in renewable energy rose from $6 billion in 1995 to approximately $22 billion in 2003, and is increasing rapidly. However, the economies of scale associated with large-scale thermal and hydropower electricity generation, and the existence of transmission and distribution grids, continue to give them a significant cost advantage over renewable alternatives. Subsidies of all types have previously been used in many countries to establish a 'top down' energy supply system, favouring thermal and large hydropower generating plants of ever increasing capacity - a trend that now needs to be reversed.

Global generation of electricity by source, 1971-2001



Total primary energy supply by source, 2002



Source: International Energy Agency, 2005.

National strategies to increase the use of renewable energies can go further. Governments joining the Kyoto Protocol are bound to reduce greenhouse gas emissions and promote clean energy investments. These targets can be achieved through the implementation of a number of national policy reforms that would stimulate the use of renewable energy. These include the provision of subsidies for the development and deployment of renewable energy-based mini-grids, the introduction of measures to promote distributed power generation, the provision of capital resources for small-scale rural energy investments (including the support of micro finance schemes), and the provision of stable subsidies such as investment tax credits and accelerated depreciation in addition to other economic incentives.

New approaches are needed to encourage end-use energy efficiency. Much of the world's future energy demand will have to be met by efficiency improvements. Whereas manufacturers of energy-consuming equipment have successfully improved the performance of individual components such as pumps, compressors, fans and steam boilers, these components only provide a service to the user when operating as part of a system. There is scope to improve energy efficiency and reduce greenhouse gas emissions across the entire industrial sector by improving the design and operation of the systems that deliver energy. Energy efficiency can be stimulated by policy measures such as:

- introducing requirements to incorporate life-cycle energy costs into bidding procedures for capital projects
- encouraging improvements in the design and operation of pumping systems, for instance through innovation awards for energy efficiency
- requiring energy efficiency standards and labels for appliances and equipment
- increasing the implementation of energy efficiency measures in the industrial sector by incorporating commitments to energy efficiency into the ISO certification process (ISO 9001/14001), the international environmental standard.

CHAPTER 10

Managing Risks: Securing the Gains of Development

By

WMO
(World Meteorological Organization)

ISDR
(International Strategy for Disaster Reduction)

UNU
(United Nations University)

In the last decade, 90 percent of natural disasters have been water-related events. Tsunamis, floods, droughts, pollution and storm surges are just a few examples of hazards that can constitute a risk for societies and communities. These are likely to increase in the changing environmental context. Hazards like these become disasters when risks are not managed with the objective of reducing human vulnerability. Floods and droughts are the most deadly freshwater disasters, disrupting socio-economic development in particular in developing countries. Efforts to reduce disaster risks must be systematically integrated into policies, plans and programmes for sustainable development and poverty reduction.

Above
Refuges at Korem camp, Ethiopia.

Developing countries are disproportionately affected by disasters. Communities in developing countries tend to be hit the hardest, with losses rising to about five times higher per unit of Gross Domestic Product (GDP) than for their more developed counterparts. Such losses set back economic development and social growth, sometimes by decades. Better risk management is one of the key areas that needs to be addressed in order to break the vicious cycle of poverty.

The Johannesburg Plan of Implementation and the Millennium Development Goals have stressed the interaction between disaster risk reduction and sustainable development. Both have shown how hunger and disease significantly reduce people's ability to cope with natural disasters. They also emphasize the link between poverty and access to safer land areas or adequate means of transportation in emergency situations. Thus, disaster risk reduction efforts need to encompass a component enabling communities not only to recover from disasters, but also to rise above the poverty line. This unquestionably makes risk management a matter of social policy, aligned with ongoing global processes related to sustainable development.

There are two main challenge areas in risk assessment: scientific measurement and methods and social and political issues. These areas were identified in a recent 2004 WMO study focussing on risk management approaches and practices. The study was based on a survey involving 61 case studies across 5 continents. Scientific measurement and methods involve the need for:

- data to map hazards and assess impacts
- easy-to-use Geographic Information Systems (GIS)
- improvement in the accuracy of weather and flood forecasting
- improved knowledge on effects of climate change
- improved vulnerability assessment methods
- development of environmental strategies and, with the utmost urgency, the relevant data and information to improve early warning and forecasting services.

Social and political issues include the need for:

- an integrated approach to risk management including stronger integration of risk-related public policies and improved cooperation of decision-makers, risk managers and water managers

- the development of transboundary agreements
- participation of the public in risk management programmes
- promotion of national disaster prevention forums to help strengthen risk management frameworks and institutional coordination and management mechanisms.

Risk management is increasingly being considered in terms of prevention. Risk management has progressively undergone a shift from relief and emergency-oriented responses to risk assessment, prevention and mitigation strategies. A critical element is the development of new multi-hazard approaches to early warning, forecasting, preparedness and response. These approaches are the ideal method for saving lives and protecting infrastructure - notably through the use of existing observational and telecommunication systems. However, in order to be effective, integrated risk management requires strong links with the water resource management community. It needs to address the related issues from the perspectives of all affected sectors. New risk prevention strategies thus need to be considered as an integral part of wider socio-economic development and planning.

Understanding of water-related disaster risks has improved, but more flexible and adaptive risk management strategies are needed. Risk management analysis has evolved thanks to modelling and forecasting advances. Whereas, risk management previously focussed on technical control of hazards, assessments increasingly incorporate environmental and social factors, for example, the impact of climate variability and change on extreme weather events. Other critical components of risk management include public awareness, the coping capacity of communities, effective linkage between national and local authorities and issues related to risk perception. Disaster risk management policies must also anticipate present and future social patterns of exposure and vulnerability to water-related hazards. But more flexibility in the decision-making process is needed to adapt quickly to changing environments. Examples of adaptive strategies include the ability to devise new legislation when risk changes, better access to and circulation of information upon need, and development of a more comprehensive system of indicators.

Indicators are needed to assess the efficiency of current risk management practices and design strategies for disaster risk reduction. Indicators are essential for the identification and monitoring of underlying trends in disasters, hazards, vulnerability and risk. Risk factors include environmental degradation, population growth, the increasing value of assets in flood-prone areas and risk perception. Since the development of indicators is a relatively new field, water-related risk-based indicators remain scarce. They also suffer from limitations in terms of conceptual design and lack of data. Quantifiable indicators in particular are important when decisions involve trade-offs between development options with varying degrees of risk. Additional resources and research are also needed to develop and demonstrate the effectiveness of risk indicators in line with other water-related indices.

The poor availability of water and risk-related data represents a serious hurdle to improving risk management strategies. Water- and risk-related data are essential for designing multi-hazard approaches and risk-related indicators, operating efficient warning systems, developing awareness-raising programmes, and enabling institutions to adapt to environmental and social changes. Availability of and access to data are therefore essential for hazard analysis and vulnerability assessment. However, risk-related knowledge and information is often unavailable or missing. Difficulties include a loss of institutional memory and limited access to data or information. Risk knowledge and experience can be lost over time for various reasons: lack of funding for database maintenance, lack of information-sharing among administrations, and loss of institutional memory when staff leaves. Knowledge and experience frequently lost include: overviews of natural processes in river basins, the location of stored data, station maintenance, the operation of models, and checking forecasts for consistency. Thus, poor management of knowledge prevents the development of sound risk monitoring policies and efficient implementation of preventative or protective strategies.

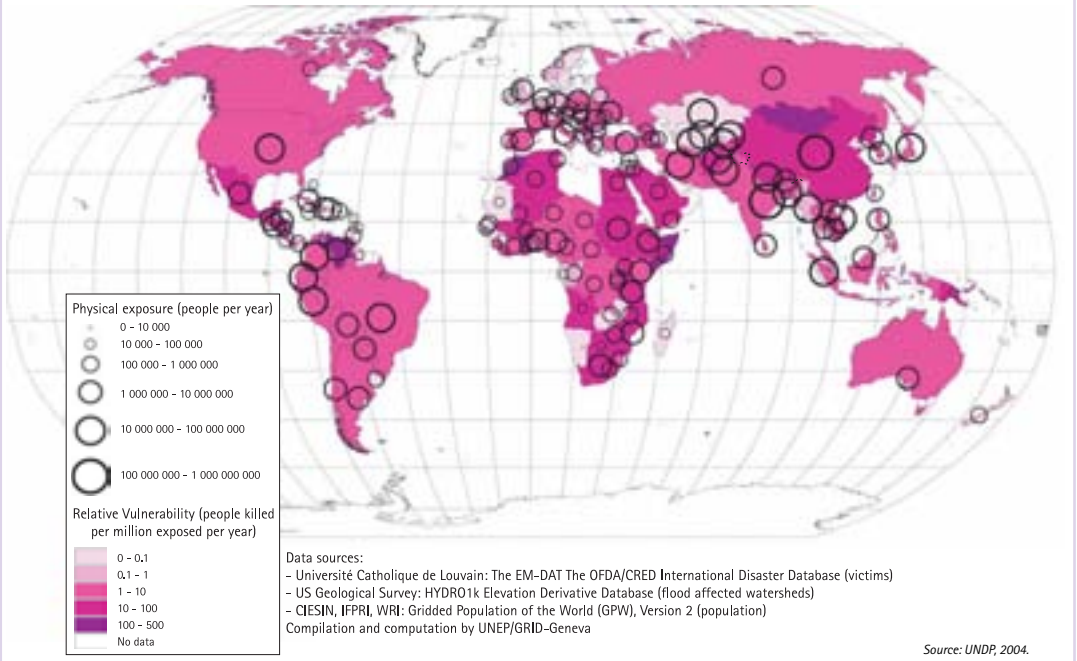
Left
Coastal destruction in wake of the 26 December 2004 tsunami in Indonesia.

Below
The Piazzetta under water, Venice, Italy.

Six core priority objectives have been identified for disaster risk reduction over the next ten years. Reviewing progress made in implementing the Yokohama Strategy for a Safer World, UN/ISDR (United Nations / International Strategy for Disaster Reduction) identified the following objectives:

1. Ensure that disaster risk reduction is established as a national policy with a strong organizational basis
2. Identify and monitor risks
3. Use information and education to build a culture of prevention
4. Reduce underlying risk factors
5. Strengthen disaster preparedness and contingency planning
6. Sustain international support for disaster reduction efforts at national and local levels. Several gaps and challenges are analysed in the Report on the World Conference on Disaster Reduction held in Kobe, Hyogo, Japan in January 2005.

Physical exposure and relative vulnerability to floods, 1980–2000

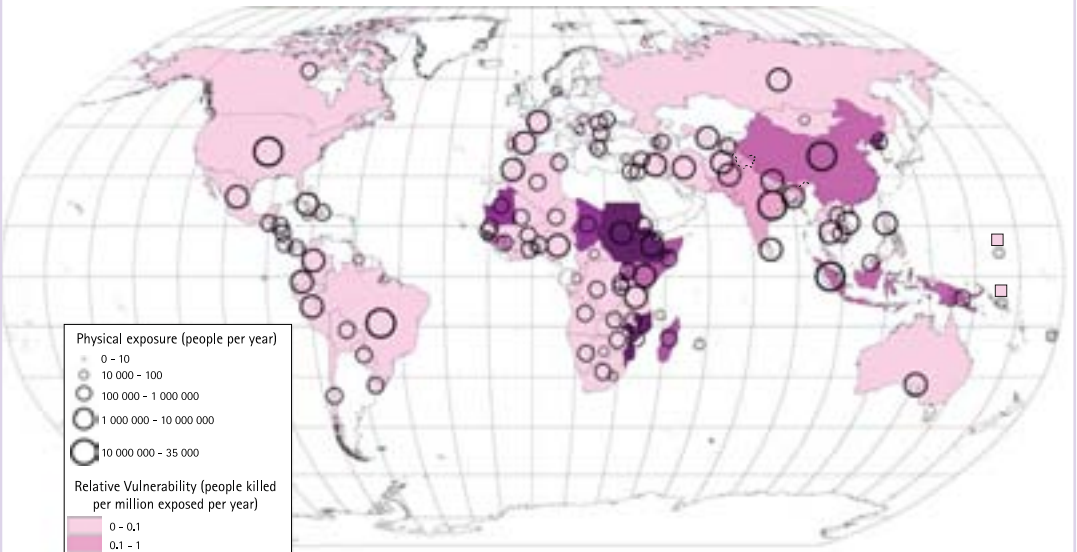


Data sources:
- Université Catholique de Louvain: The EM-DAT The OFDA/CRED International Disaster Database (victims)
- US Geological Survey: HYDRO1k Elevation Derivative Database (flood affected watersheds)
- CIESIN, IFPRI, WRI: Gridded Population of the World (GPW), Version 2 (population)

Compilation and computation by UNEP/GRID-Geneva

Source: UNDP, 2004.

Physical exposure and relative vulnerability to droughts, 1980–2000



Data sources:
- Université Catholique de Louvain: The EM-DAT The OFDA/CRED International Disaster Database (victims)
- International Research Institute for Climate Prediction (droughts extent)
- CIESIN, IFPRI, WRI: Gridded Population of the World (GPW), Version 2 (population)

Compilation and computation by UNEP/GRID-Geneva

Source: UNDP, 2004.

CHAPTER 11
Sharing Water

The focus of the emerging water culture is water sharing: Integrated Water Resources Management (IWRM) looks for more effective and equitable management of water through increased cooperation. Bringing together institutions dealing with surface water and aquifer resources, calling for new legislative agreements worldwide, raising public participation, and exploring alternative solutions to resolving disputes, are all part of the process.

By
UNESCO
(United Nations Educational, Scientific and Cultural Organization)

Access to adequate supplies of freshwater is a highly contested issue in interstate water relations. However, cooperation rather than conflict is becoming the norm. Conflicts occur, in particular, between users sharing the same resource - a situation often exacerbated by traditional values, customs and practices, historical factors and geographical vagaries. However, in an increasing number of cases, treaties, agreements and the principles of international water law are helping to crystallize mechanisms for resolving disputes. As decision-making processes in water governance and management become more complicated, legislative and institutional developments and guidelines for capacity building have become increasingly critical for ensuring equitable and efficient water sharing.

The strengthening of institutional mechanisms and legal frameworks for Integrated Water Resources Management (IWRM) is of central importance both for facilitating this process, and ensuring that the burden of associated transaction costs is equitably shared. IWRM must take place within institutional environments conducive to its development. This means capacity-building structures, regulatory principles and organizational mechanisms for promoting cooperation and conflict management. Treaties, conventions, agreements, as well as international conferences that mobilize politicians, administrators, NGOs and knowledge communities are also critical elements in the creation of such a nurturing environment.

Despite considerable progress, basic problems still remain. These include:

- how to get parties to the table to cooperate on joint water management issues where no agreement exists.
- how to hold countries that have agreements, treaties or other coordinating mechanisms accountable for implementing those agreements.
- the types of enforcement mechanisms that can be used to promote compliance.

Involving disadvantaged or disenfranchised groups early on in the process, especially at local levels, may prevent grievances from becoming hostilities.

Measuring performance in water sharing is difficult due to the generally poor availability of good data and information. Appropriate data and information are required for balanced, informed decision-making. The development of measurable indicators could help to track water sharing trends. Indicators can concentrate the debate on concrete points of contention.

Above
Feluccas on the Nile River near Philae, Egypt. 14 states share its basin.

Below
The Danube basin is shared between the highest number of nations, with 18 riparian states.

Proposed indicators emphasize relevance, validity, reliability and comparability over time and space:

- a water *interdependency* indicator, exemplified by the amount of water inflow from other river basins
- a *cooperation* indicator, measured on the basis of the number of significant joint projects, treaties or other formal agreements
- a *vulnerability* indicator, resulting from the ratio of water demand and supply
- a *fragility* indicator, measured in terms of environmental deterioration and social unrest (especially poverty and rivalries), within and between countries
- a *development* indicator, summarized by competence/commitment for dealing with and managing water-related conflicts.

Above
Itaipu dam and hydro-electric power station, on the river Parana, Brazil / Paraguay.

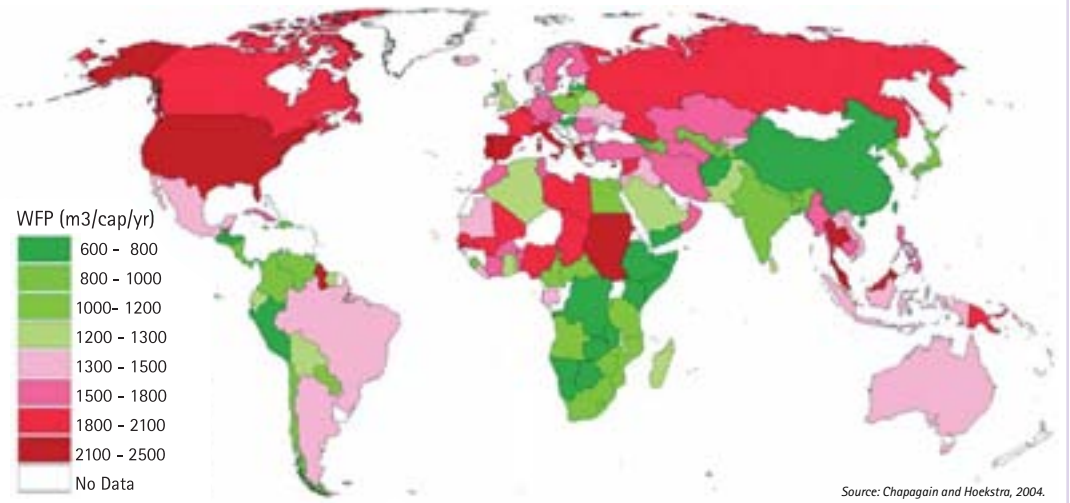
IWRM favours long-term and contingency planning, building resilience into vulnerable systems, and increasing diversity and flexibility. New management approaches will be based on regional cooperation principles, focusing on river basins and aquifer systems, with an emphasis on social needs and environmental sustainability. They will focus on interrelated natural resources problems, reduce potential points of friction and stress, and eliminate conflicting demands through risk management and vulnerability assessment. Classical legal tools and more informal approaches both have important roles to play in defusing conflict and developing cooperation. This point is made repeatedly in security studies, management schemes, administrative guidelines, conventions and bilateral agreements.

Techniques or approaches for calculating equitable water sharing force us to consider and coordinate water demands and needs across all sectors. The transition to IWRM will, further, require institutional structures for cooperation and integration, as well as for knowledge sharing, experience and responsibility. *Above all, political will and commitment are important preconditions for successful cooperation in all aspects of water sharing.*

In the future, particularly contentious issues may involve aspects of transboundary water sharing and environmental security. Sharing, which can imply increased interdependency, may be perceived by some as a threat to sovereignty. However, in a world that is progressively more globalized and linked ever more closely (by both information and communications technology and trade and political collaboration), new policies and programmes that promote increasing interdependence and global approaches to meeting environmental challenges (such as virtual water trade) may become more and more common.

New water-sharing models should not imply that only optimal solutions are acceptable. Reasonable approximations would be part of necessary trade-offs, balancing the 'ideal', or desired, future and the 'real', or pragmatic and practical, solution. Thus, shared water management will become a realistic and thoughtful instrument for a balanced approach and a useful tool for managing long-standing confrontations - if not outright conflict - over water resources. In conclusion, in examining shared water experiences at local, national and international levels, there have been successes as well as failures. Water increasingly appears to be the catalyst for cooperation and, thus, not only divides, but also unites peoples and societies.

National water footprints around the world, 2004



Source: Chapagain and Hoekstra, 2004.

12

CHAPTER 12
Valuing and Charging for Water

By
UNDESA
(United Nations Department of Economic and Social Affairs)

The availability and affordability of water is of growing political and economic concern. Growing populations and rising incomes stimulate the demand for improved water supply and sanitation services, both directly and indirectly through demand for food, manufactured products, energy and environmental services. Given its unique life-sustaining properties and innumerable roles, water incorporates many values – social, cultural and environmental, as well as economic. All of these must be considered in designing water-related policies and programmes if equitable, efficient and environmentally sustainable management of water resources is to be achieved.

The distinction between 'valuing' and 'valuation' of water is revealed in how society perceives the 'worth' of water in all its different uses. Valuing water means recognizing the cultural, aesthetic, social and environmental values of water and water services. With increasing appreciation of the non-market values associated with water, society is demanding water policy reforms that reflect these considerations. In attempting to estimate in financial terms the benefits that society derives from water, the technique of economic valuation aids our understanding of the larger concept of the value of water.

Economic valuation allows a rational and systematic means of assessing practices related to the allocation and management of water resources. Economic valuation is a process by which a monetary value is attached to the benefits and costs associated with a real or projected improvement in water services. This can assist stakeholders, planners and policymakers both to understand the trade-offs associated with different governance options, and to select among these so as to optimize social, environmental and economic outcomes in line with goals such as the MDGs.

Economists have devised alternative techniques for valuing and comparing the projected outcomes associated with different governance strategies. The broad spectrum of social, cultural and environmental values associated with water are not always recognized in market transactions. These techniques, though still imperfect in reflecting the true extent to which society values water and water services, aid our understanding of the trade-offs between different development options and contribute to increasing accountability and transparency in water governance and management. The objective of employing benefit-cost analysis is to improve the efficiency of water use - for instance, in agriculture the amount of 'crop per drop' produced - so that all the diverse demands for water resources may be better served. Improving water use efficiency becomes increasingly significant in a world where competition for resources has intensified. Economic evaluation is a

Left
Water shop in Aboemey City, Benin.

tool to aid in assessing benefits and costs of alternative governance strategies.

Benefit–cost analysis can assess both the potential net benefits of proposed public–policy initiatives and the realized benefits of previous policies. Research in Asia, over the past three decades, demonstrates that economic returns on public investments in irrigation have been modest compared with those from alternative investments (research, rural roads and education) - or even with the cost of capital. Additional research has revealed very high benefit-cost ratios for investments in water supply and sanitation in areas where facilities are lacking. Such findings would indicate that a reallocation of resources towards investment in domestic water supply and sanitation would result in a net improvement in social welfare.

Charging for water services (household, commercial, industrial and agriculture) requires consensus on the underlying principles and objectives. These include full-cost recovery and protection of the needs of the poor and the marginalized. Moreover, it requires a thorough, systematic analysis of all costs and perceived benefits. Finally, tariff structures must attempt to balance society's multiple, often competing, objectives. Worldwide, the 'user pays' principle is becoming an increasingly important guide to tariff-setting.

Left
Public water pump in Amboseli Reserve, Kenya.

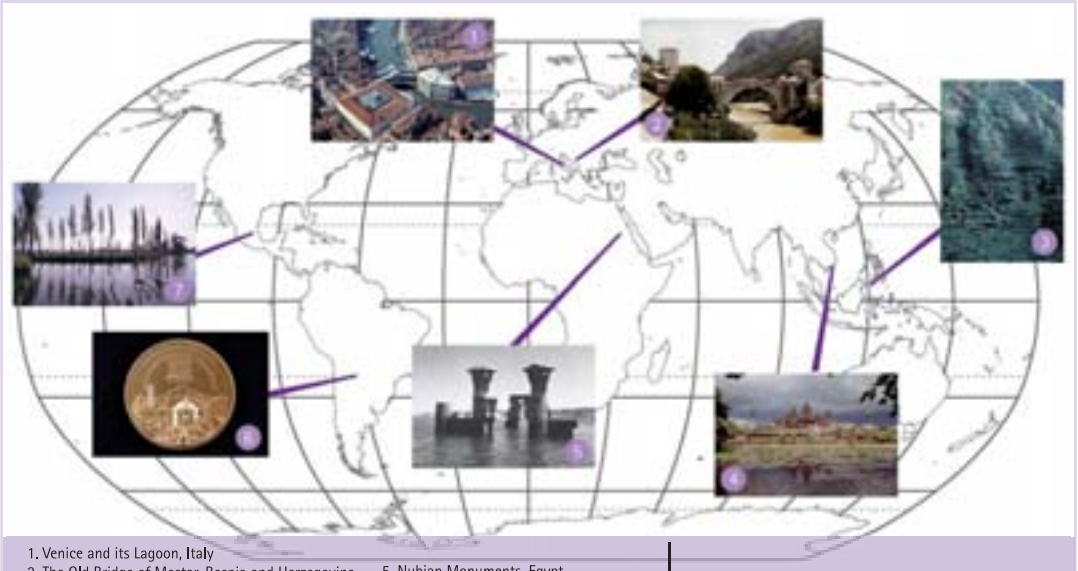
Right
Slums by the Mekong River, Viet Nam.

Water charges are too low in many areas of the municipal and agricultural sectors. Current levels of charges often fail to recover costs. As a result, subsidies and under-investment (inadequate maintenance, rehabilitation and expansion of water services) are rife. Historically, charges have been set below costs. One central reason is the general perception of water and sanitation as public goods. Social outcry and political pressures have mitigated against raising rates. Full-cost charging puts clean water and adequate sanitation facilities beyond the means of the majority of the underprivileged. As a result, subsidies from other water users, governments and donor agencies continue to be needed to achieve water supply and sanitation goals.

Reform of charging policies is critical to improving the performance of water services and the productivity of water in all sectors. Updated charging structures need to be more widely implemented to improve cost recovery, to facilitate adequate maintenance and expansion of water supply systems, and to provide incentives for conservation and reuse. Reform is also necessary to ensure that water supply and sanitation services remain available and affordable to low-income populations. The political unpopularity of increased charges will eventually have to be overcome. This can be accomplished through both phased-in reforms and educational programmes designed to help customers understand the full cost and value of reliable clean water and sanitation services. It is important to recognize that users' willingness to pay - and even the success of economic valuation - depends in large part on the quality and availability of relevant data and information.

Despite its usefulness, economic valuation may not always provide the guidance for determining best governance policy or the most appropriate level of tariff. Over the years many different techniques have been proposed for assessing the socio-cultural and environmental concerns related to water resources supply and management. Still none has yet been found to reflect fully all public concerns and values associated with water. As a consequence, decision-making regarding the management and allocation of water resources among competing uses is often accomplished through political

World Heritage Sites with important water-related value



1. Venice and its Lagoon, Italy
2. The Old Bridge of Mostar, Bosnia and Herzegovina
3. Rice Terraces of the Cordilleras, the Philippines
4. Angkor, Cambodia
5. Nubian Monuments, Egypt
6. Heritage Medal for City of Potosi, Bolivia
7. Xochimilco and Mexico City, Mexico

These are just a few of the water-related sites on the World Heritage Cultural Properties list. More information on this programme and these and many other sites can be found at whc.unesco.org.

processes, or third party assisted negotiations with the participation of multiple stakeholders (water users, various levels of government and the scientific community, among others).

Governments must be open to innovative initiatives for augmenting water supplies and services. These include small-scale private suppliers, public-private partnerships at different scales, community participation, markets for tradable access rights, transfer payments for environmental services, and trade and development policies attuned to 'virtual water' flows. Given the unique characteristics and role of water with regards to public health, environmental security and development at large, the regulatory role of government will remain an important element in water governance. Private sector participation, though not suitable in all cases, can nevertheless play a significant role in assisting in the development of cost efficient water supply and service systems in many areas, thus helping to realize the objectives of sustainable and Integrated Water Resources Management (IWRM).

'Virtual water', a concept recognizing 'embedded' water in various goods and services, focuses on optimizing returns to water as a factor of production - and thus, more efficient use of water. Similarly, payment for environmental services (PES) acknowledges the link between land and water resources and therefore the value of managing terrestrial resources to preserve ecosystem functions. Benefits capture analysis focuses on the 'who' as well as the 'how much' in the economic evaluation of alternative paths for water resources development, selected to bring us further towards meeting MDG targets.

It is critical to reach a better understanding of both the multi-faceted nature of the value of water and of the related economic tools. Planners and policy-makers need to understand the strengths and limitations of valuation techniques and the potential role they play in informing discussions and decisions regarding water resources management and allocation. There is also a need for technicians who can clearly express these economic concepts, utilize available tools, and assist stakeholders in expressing their values and preferences. This would enable these techniques to contribute fully to information sharing and transparency in water governance. The real challenge in valuing water, however, lies not in mastering the econometric techniques needed to conduct such tasks as economic valuation. Instead, it rests in reflecting in governance and management decisions the diverse values of water recognized by its many users.

Below
Men and women bathing in the Ganges, India.

13

CHAPTER 13

Enhancing Knowledge and Capacity

By

UNESCO

(United Nations Educational, Scientific and Cultural Organization)

The information and communication technologies (ICTs) revolution helped to bring about many improvements in how data and information are globally collected, stored and shared. These advances have helped to improve both our understanding of global hydrological systems and measurement of river hydraulic data from space. However, uncertainty regarding global and regional water balance estimates remains due to considerable deficiencies in the land-based hydrological station networks over large parts of the globe.

The worldwide situation with regards to the hydro meteorological information exchange is unbalanced and deteriorating. There is increasing uncertainty and complexity regarding the monitoring of effects of increasing climate variability and population growth. It is now urgent that measures be undertaken to improve the state of water-related knowledge through strengthening and making more effective the global hydrological network.

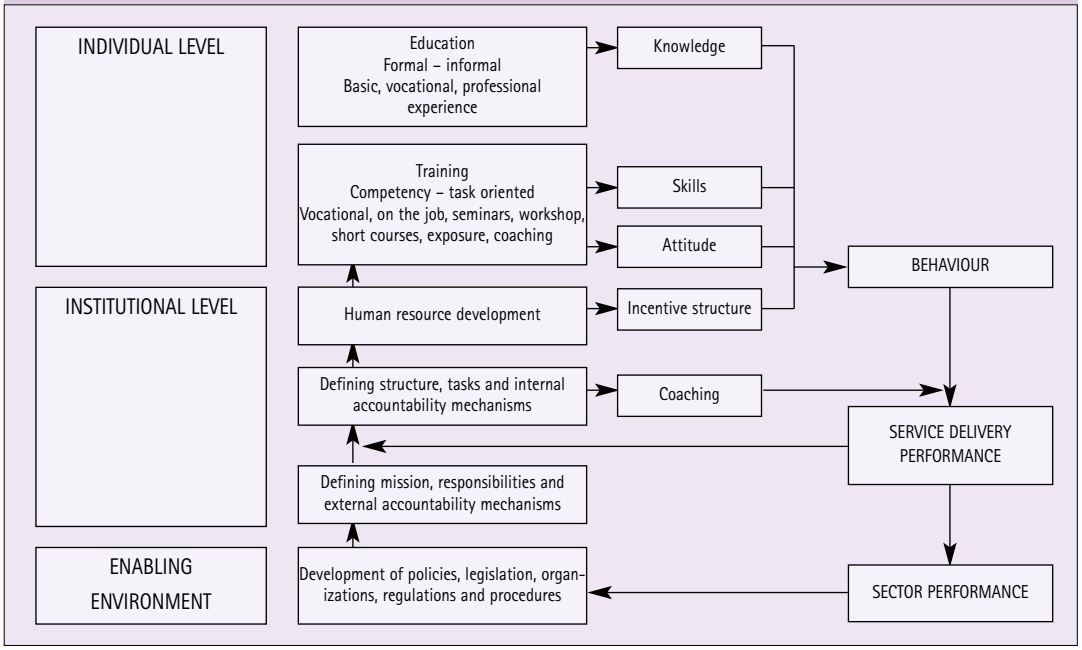
Local knowledge must be the starting point for all development projects. Local or indigenous knowledge is internationally recognized as vital to sustainable development and environmental management. Many of the activities affecting, and affected by, water management and use are performed by local people who may have little formal education but maintain a strong understanding of the water systems on which they rely.

Education is a key tool which helps to better prepare people to address local water issues. Education plays an important role in equipping people to solve problems of direct concern to them, whether in the areas of poverty, health, environment or water. With a basic education, people can not only access a broader range of knowledge on good water practice, efficient water use and safe hygiene, but are empowered with the necessary skills to consider alternatives, make choices, and enjoy a better life. Widespread education also helps empower the voices of vulnerable groups in water resource management. Women, for example, are central to providing, managing and safeguarding water, yet they often remain on the periphery of management decisions and planning for water resources. Increased education can provide

Above
Literacy programme in Buterere, Burundi.

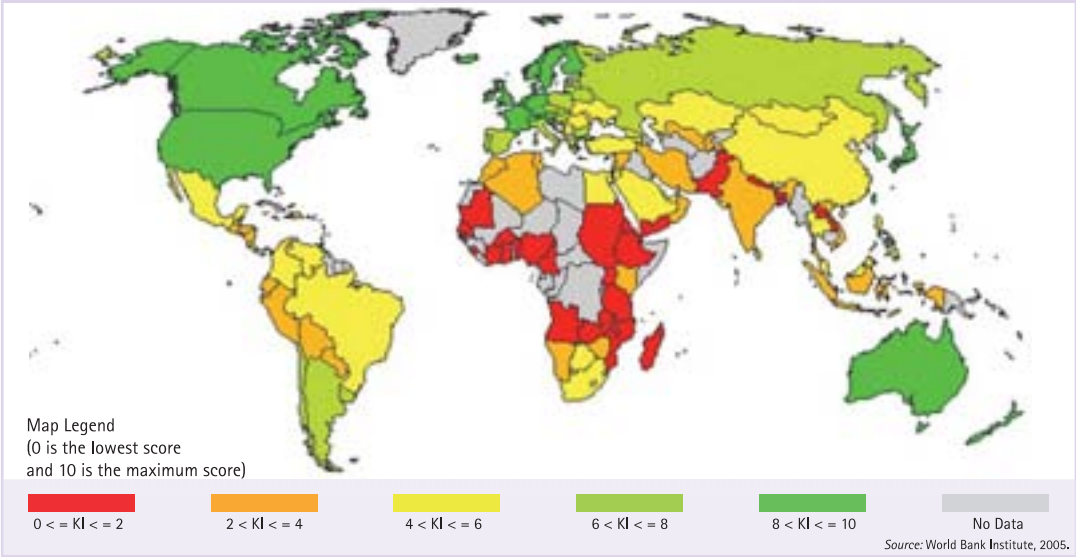
Right
On-going research at a water-quality research centre in Delft, Netherlands.

Capacity development: Levels, activities, outputs and goals



Source: van Hofwegen, 2004.

The Knowledge Index, 2005



Source: World Bank Institute, 2005.

Water resource managers need to assess their capacity needs. Self-assessments are urgently needed to set priorities, identify capacity gaps, and improve the effectiveness with which a nation can respond to external uncertainties. Many efforts to develop capacities at all levels are often being performed without the necessary assessments to formulate clear understanding of the issues. Nations should be encouraged to perform self-assessments of their knowledge base, existing capacity and capacity needs. These can strengthen a nation's abilities to prioritize organizational goals and improve self-evaluation methods. This increases awareness and develops a culture of performance monitoring. The evaluation thereby becomes a capacity development process in itself. The data and information gained from the self-assessments process should then be shared with the international community to allow for further indicator development in this field.

women and other groups with tools and the confidence to articulate their needs and participate in planning and decision-making processes regarding water resources development.

Left
Analysis of water samples for trace elements in Athens, Greece.

Greater investment in hydrological data networks is required. There has been a severe decrease in the data collected, especially in developing countries, owing to political and institutional instability, economic problems, budget constraints, emphasis on new infrastructure, and lack of professional education. Like insurance, knowledge is a commodity that should be acquired for protection against an uncertain, long-term future. Increased investment in the basic hydrological data collection network is needed to provide information to prevent gross errors in water resources decision-making in an unanticipated future. Investments in ground-based monitoring networks are particularly needed to complement recent advances made in remote sensing and geographic information systems. Additionally, popularizing information by translating it into a variety of media products adapted to the needs of specific stakeholders at different levels, can be effective in generating broad awareness of and commitment to IWRM objectives.

At the institutional level, there are three important capacity development needs. Institutional capacity should be increased to ensure that institutions have:

- clear and strong mandates to promote and enhance the institutionalization of good water management and water use throughout all levels of society
- an organizational system conducive to effective and efficient management decisions
- improved decision support mechanisms established through research on lessons learned and indigenous knowledge.

Above
Mid-career professionals receive on-the-job training by local experts in Indonesia.

Right
Madhukari Ganokendra (People's Centre), in Rajapur village, western Bangladesh, holds monthly meetings to discuss primary school attendance and other important issues for the community to take action on.

The statistics community must work with water experts and regional stakeholders to adapt existing sustainable development/environmental monitoring surveys. This is important to take into account more water-sector specific information at a global level. Sector-based capacity assessments can contribute much-needed information to statistical databases on existing capacity and associated initiatives. In addition, these assessments can promote awareness of capacity gaps and be themselves a capacity-enhancing process to those involved. The increased data can then be used to identify generic indicators that would allow a global assessment of nations' capacities to address their water-related problems.

Indicators must be informative for local stakeholders as well as national policymakers. The development of robust and reliable indicators can be of great help to decision-makers at all levels, providing information on progress toward goal-attainment while locating the gaps in knowledge. They can also assist in identifying and focusing development resources in the neediest of areas. In this context, capacity development can be a powerful tool for improving effective governance in nations. While capacity development is dependent on the existing government's political will to implement reforms, it is also required to introduce new governance systems and familiarize decision-makers and implementers with different ways of managing water.

Research is an important tool for developing knowledge on global water issues. But to be effective, it must reach a wider audience. While there has been an increase in the number of water research centres set up in developed countries, such institutes remain rare in developing countries. There is thus a need for greater research on water issues specific to the social and environmental contexts of developing countries. Enhanced horizontal cooperation (North-south and South-south) can help increase the amount of applied research geared at solving practical, region-specific water resource problems. The development of country-specific indexes on water-related knowledge and capacity would greatly facilitate this exchange. Lastly, multilingual translation tools, which would permit information to be more easily transmitted from country to country, would also help to promote the exchange of valuable knowledge and best practices.

CHAPTER 14

Case Studies: Moving Towards an Integrated Approach

The first edition of the World Water Development Report (WWDR1) illustrated various water-related issues in 7 case studies involving 12 countries. In the second edition (WWDR2), the number of pilot case studies has grown to 17 comprising 41 countries. As in WWDR1, these case studies highlight a number of scenarios in different geographic regions where conditions of water-related stress and socio-economic circumstances are different.

1. **The Autonomous Community of the Basque Country:** The Basque Community faces the challenges of ensuring the sustainability of ecosystems in a densely populated and highly developed setting.

2. **The Danube River Basin:** The second largest water basin in Europe extends through the territories of 18 countries, each with varying social, economic and topographic features. Consequently, implementing the EU-Water Framework Directive uniformly throughout the basin is a major challenge.

3. **Ethiopia:** Ethiopia ranks as one of the poorest countries in the world. Limited funds restrict the ability to use water resources to alleviate the heavy burdens of disease, extreme poverty and hunger. Therefore, external financial aid is crucial to meet even very basic water and sanitation needs.

4. **France:** As a developed country, France's main national challenge is meeting the water needs of different sectors while implementing the EU Water Framework Directive.

5. **Japan:** Unfavorable topographic conditions combined with variability in rainfall patterns render a great portion of the population of Japan susceptible to water-related disasters. Updated legislation sets forth the necessary precautions to mitigate this risk. Advanced technology and stringent regulations also ensure the sustainability of ecosystems and precious water resources.

6. **Kenya:** Severe droughts aggravate the precarious economic circumstances of rising poverty in Kenya, affecting the food security of millions of people in a country where chronic undernourishment is already a problem. Unfortunately inadequate funding prevents development efforts in all sectors.

7. **The Lake Peipsi/Chudskoe–Pskovskoe Basin:** Socio-economic improvement in the region is bringing positive change. Estonia, an EU member bound by the Water Framework Directive, and the Russian Federation are working together towards developing a joint management of the programme for the lake's resources. Institutional changes taking place in both countries are likely to improve the water sector's response to current challenges.

8. **The Lake Titicaca Basin:** Poverty remains the underlying cause of many social problems in this region. While the battle against poverty is ongoing in Peru and Bolivia, efforts to break this vicious circle have not yet managed to create significant change.

9. **Mali:** Access to abundant water resources remains a problem which hampers national economic development and the livelihoods of Malians. Poor water and sanitation infrastructure and poverty leave a significant percentage of the population suffering from malnutrition and water-borne diseases. Lack of data and the limited technical capacity of institutions are major issues impeding the planning and development of programmes and strategies for the better utilization of water resources and controlling increasing levels of pollution.

10. **State of Mexico:** The wise management of water resources is crucial for a country characterized by industrial centres, a wide range of economic activities, and densely populated urban settlements. In order to meet the water needs of its various sectors, schemes for transporting water from basins throughout Mexico have been put in place. Curbing the unsustainable uses of groundwater resources and pollution is high on the agenda of decision-makers.

Case study areas at a glance

11. **Mongolia (with special reference to the Tuul River Basin):** As a country in transition trying to adapt to a new economic and political order, Mongolia faces many challenges, such as poverty, limited access to safe water and sanitation, diseases and decaying environmental quality. Both the implementation of reforms and the enforcement of existing laws and regulations are necessary to improve the current situation. However, limited funds and scarcity of water and land resources remain the main obstacles.

12. **The La Plata River Basin:** Although, development efforts aim to improve the livelihoods of over 100 million inhabitants living in the fifth-largest basin in the world, increasing poverty and social inequality continue to be the main problems facing the five basin countries. The common vision of sustainable utilization of water resources brings all riparian countries together under the framework of the Intergovernmental Coordinating Committee and provides the basis for bilateral and multilateral cooperation.

13. **The Senegal River Basin:** The Senegal River Basin is mainly characterized by water scarcity and subsistence economies. Thanks to the construction of two main dams providing energy, irrigated agriculture and year-round navigation - and to a management approach promoting optimal distribution of water resources - the area is gradually developing.

14. **South Africa:** As a country that has recently emerged from a system of racial segregation, South Africa is trying to alleviate poverty through social programmes aimed at the poor and marginalized and promote economic development, while ensuring the sustainability of water resources and ecosystems. Capacity-building is considered as a main goal for the successful implementation of programmes and strategies.

15. **Sri Lanka:** Recently struck by the tsunami disaster, Sri Lanka suffered great social and economic losses that have laid a heavy burden on the fragile island economy. Although on track to achieve hunger-related MDGs, hundreds of thousands of children are still suffering from malnutrition. The multiplicity of institutions with both unclear responsibilities and legislation hinders better management and protection of the Island's water resources and ecosystems.

16. **Thailand:** The tsunami disaster in December 2004 caused heavy socio-economic damages and particularly affected the tourism sector - a major contributor to the economy. While recovery efforts are still underway, the country faces other challenges such as overexploitation of forests and heavy pollution by industry and urban settlements. In addition, reforms in the management of natural resources have not been effectively implemented due to a lack of synergy and coordination between ministries.

17. **Uganda:** Rapid population growth coupled with uncontrolled environmental degradation stemming from increased urbanization and industrialization puts considerable stress on the sustainability of natural resources. Debt relief under the IMF Heavily Indebted Poor Countries Initiative removed a large portion of external debts and enabled the country to allocate its financial resources to fight against poverty. However, the water sector in Uganda is still heavily dependant on external donors for its development.

CHAPTER 15

Conclusions and Recommendations for Action

Approximately 1 billion people worldwide, one-sixth of the total world population, live in extreme poverty, sickness, hunger, thirst, destitution and marginalization. The lifestyle of the extreme poor is based on subsistence living. Many poor families occupy land over which they have no formal legal rights - in a squatter community or slum, or farming on marginal lands owned by others with limited access to reliable water. Women and girls in particular often have the least entitlement to household or family assets. Very poor households are rarely connected to infrastructure, such as piped water, sanitation and electricity supply. The payment structure for many utility services (water, electricity), with their up-front connection and monthly consumption charges, are often too expensive for the poor.

All of this creates an ideal environment for disease transmission, vulnerability to loss of housing and possessions and, overall, a low quality of life. Poor families face difficulties accumulating surpluses - food and financial - and find it difficult to maintain consumption when their incomes are interrupted or their crops fail. In addition, limited or non- enforcement of laws, regulations and procedures concerning legal and political rights, environmental health and protection, occupational health and safety, crime prevention and safeguarding from exploitation and discrimination, are common. Unbridled competition from richer farmers and industrial concerns for water, productive land and fisheries, often put the poor at a serious disadvantage. It is also often very difficult for the poor to assert their rights and needs so as to receive a fair entitlement to public goods and services.

Water is central to alleviating poverty. Some 13 percent of the world's population - over 800 million people - do not have enough food and water to live healthy and productive lives. Providing the water needed to feed a growing population and balancing this with all the other demands on water, is one of the great challenges of this century. Providing water for environmental flows and industry will tax water resources even more. Extending water services to the 1.1 billion un-served with improved water supply and the 2.6 billion lacking improved sanitation will enlarge the challenge even further. Confronting water-related disease --including malaria, which causes 300 to 500 million episodes of sickness and 1.6 to 2.5 million deaths each year - must be done. In many parts of the world, available water quantity is decreasing and quality is worsening.

Above
Stream in the Andes, Peru.

Water insufficiency is primarily caused by inefficient supply rather than by water shortages. Water insufficiency is often due to mismanagement, corruption, lack of appropriate institutions, bureaucratic inertia and a shortage of investment in both human capacity and physical infrastructure. Water shortages and increasing pollution are socially and politically induced challenges. These can be addressed by modifying water demand and usage through increased awareness, education and water policy reforms. The water crisis is thus increasingly about how we govern access to and control over water resources and their benefits.

Above
Women's group for micro-finance, Andra Pradesh, India.

Many of the solutions to water problems lie in better governance. Water is central to promoting socio-economic development, protecting the environment, and achieving the Millennium Development Goals (MDGs). Yet, few lower-income countries include water as a key feature of their national planning and budgets. Mismanagement of water is widespread, characterized by lack of integration, sectoral approaches, and institutional resistance to change by large public agencies in a context of increasing competition. Only a minority of local authorities and water associations have the resources needed to carry out the responsibilities delegated from central governments.

Social and economic resilience is the key to sustaining development and meeting societal goals. The UN Millennium Project has stated that long-term success in meeting the MDGs depends on environmental sustainability. Without it, any gains will be short-lived and inequitable. Part of the problem is the very modest political effort devoted to sustainable development, compared with global economic growth.

Water problems and challenges are connected and should be addressed in a holistic manner. The various water issues are interdependent and greater wisdom is required in the allocation and management of water resources. A flexible approach is essential at both strategic and local levels. The answer to this, including meeting the MDGs, lies in a holistic, ecosystem-based approach known as Integrated Water Resources Management (IWRM). IWRM has to be tailored to prevailing socio-economic conditions. Local circumstances, however, can put obstacles in its way:

- lack of proper coordination of management activities
- lack of appropriate management tools
- inability to integrate water resources policies
- institutional fragmentation
- insufficiently trained or qualified manpower
- shortfalls in funding
- inadequate public awareness
- limited involvement by communities, NGOs and the private sector.

Because of these obstacles and other difficulties, very few countries have met the Johannesburg Plan of Implementation (JPOI) target stating that IWRM should be incorporated into national water resources plans by the end of 2005.

Reliable data is essential for IWRM. A holistic approach to water management requires knowledge of the different systems involved: not just hydrological, but socio-economic, political, institutional and financial. However, data on almost every subject relevant to water issues is often lacking and may be inconsistent, unreliable or incomplete. Collection of data in itself is insufficient. It must be synthesized, analysed and compared to other sources.

Strong indicators are needed to monitor progress. To facilitate understanding, advocacy and access to needed resources, trends must be discerned and progress monitored. We therefore need to develop indicators. However, the development of indicators is proving difficult for a variety of reasons, including the general lack of reliable and consistent data.

The water sector needs greater investment. Lack of reliable information and indicators has contributed to serious under-investment and inadequate donor aid to the sector. Private investors are discouraged because they perceive the sector as presenting higher risks, and

longer and lower returns on investment than other sectors. Both public and private sector investors are also deterred by inadequate governance. Recent information, however, shows that investments in the water sector have become increasingly cost-effective. Rapidly deployable interventions targeted at the poor including improved household water treatment and storage are one example. For the irrigation sector, drip irrigation and treadle pumps, are two cost-effective ways in which access to small-scale water technology can be provided to poor farmers.

Greater transparency, accountability and stakeholder involvement is needed.
One of the biggest roadblocks to achieving the MDGs is lack of investment by external donors. However, lack of good governance is often a constraint to such financing. This can be addressed by encouraging transparency and accountability. This necessitates greater stakeholder involvement at all levels of government and the involvement of major groups and the private sector.

International and national cooperation is required to meet the MDGs related to poverty alleviation and water. While it is imperative that as much action as possible to meet the MDGs must be initiated within countries themselves, there is also a moral obligation that the richer countries be prepared to share their wealth to meet the goals. The lower-income countries are tasked with delivering promised policy changes and improvements to governance; the industrialized countries must follow through with their long-standing commitments to increase ODA and technical assistance. It should be noted, however, that even if the MDGs are achieved there will still be a significant segment of society remaining unserved - and these will probably be the poorest of the poor.

There are many instances of improvement. The first step to better governance is awareness, followed by commitment and stakeholder involvement. Indicator development and case study work both show that progress is being made. Economic development can and does work in many parts of the world. The scale of extreme poverty is lessening, both in terms of the total numbers affected and as a proportion of the total world population. The rapidly growing lower-income countries - Brazil, China and India - have set up a wide range of initiatives for improved water governance and water service delivery challenges, which could be adapted by other countries. The growth in microfinance has the potential to provide essential capital for the extension of water service provision, through a much-enhanced availability of funds to the very poor, and to contribute also to lessening their insecurity. However, funding for microfinance houses must go beyond its traditional sources such as governments, aid agencies and charities. The cost of operations must also be decreased, because microfinance as presently organized is very labour-intensive.

Without access to secure water supplies, development will stall and the MDG targets will fall short. The Millennium Project has made clear that the world today has the wealth and tools to do what is needed. With determination and political will, the levels of international cooperation agreed in the Millennium Declaration, and re-confirmed at the 2005 UN World Summit, water sector reform and the MDGs can be achieved.

RECOMMENDATIONS

- To appreciate the context within which water issues must be approached.
- To recognize that the various issues of water are interrelated - and with growing demand and, in general, decreasing supply, competition between uses and users is increasing, requiring greater wisdom in allocation of the resource.
- To appreciate the variety of circumstance - solutions have to be tailored to situation.
- To understand that water moves within natural limits - but that these do not usually correspond to the administrative units within which societies organize themselves.
- To improve basic data through research. Greater knowledge and understanding are prerequisites for better management of all the systems involved.
- To focus on governance.
- To anticipate and adapt to changing circumstance.
- To all assume responsibility for action: There is a need for responsible action and involvement at all levels of society. Individuals at community level should be encouraged and given the means to take responsibility for their own problems. Likewise, at local and national levels, governments must take their share of responsibility. At international levels, responsibility must be taken to set goals and targets towards which the world should strive, and to assess the global situations with a view to sharing knowledge.

Above
Flooded slum on the edge of Pasig River, Manila, Philippines.

Photos credits

The World Water Assessment Programme would like to thank the Ankara Fotograf Sanatcilari Dernegi, Yann Artus-Bertrand, the Australian Water Partnership, Thomas Cluzel, Deanna Donovan, FAO, Richard Franceys, the GAP Bolge Kalkinma Idaresi Baskanligi Arsivi, Surapol Pattanee, the Secretariat of Water, Public Works and Infrastructure for Development of the Government of the State of Mexico, Andras Szöllösi-Nagy, UNESCO, UNESCO-IHE, UN-HABITAT, and UNHCR for generously providing photographs.

Yann Artus-Bertrand's photographs of the *Earth from Above* are meant to show that, now more than ever, levels and modes of consumption and exploitation of natural resources are not sustainable in the long term. Whereas world production of goods and services has multiplied by 7 since 1950, 20% of the world population has no access to drinking water, 25% has no electricity, and 40% has no sanitary installation. In other words, a fifth of the world's population lives in industrialized countries, consuming and producing in excess and generating massive pollution. The remaining four-fifths live in developing countries and, for the most part, in poverty. To provide for their needs, they make heavy demands upon the Earth's natural resources, causing a constant degradation of our planet's ecosystem and limited supplies of fresh water, ocean water, forests, air, arable land, and open spaces.
At this critical stage, the alternative offered by a sustainable development policy should help in bringing about the necessary changes in order to 'meet the needs of the present without compromising the ability of future generations to meet their own needs.'* Inseparable from the accompanying text commentaries, *Earth from Above* images invite each one of us to reflect upon the planet's evolution and the future of its inhabitants.
We can and must act individually on a daily basis for the future of our children.

Earth from Above team

* Quoted from the Brundtland report, *The World Commission on Environment and Development: Our Common Future*, Oxford University Press 1987.

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CENTRE-PIVOT IRRIGATION, Ma'an, Jordan (N 29°43' E 35°33'). This self-propelled, centre-pivot irrigation machine, invented by the American Frank Zybach in 1948 and patented in 1952, drills for water in the deep strata 30 to 400 m below the surface. A pivoting pipeline with sprinklers, extending about 500 m is mounted on tractor wheels, and irrigates 78 hectares of land. The countries of the Middle East and North Africa experienced the world's most rapid increase in grain imports in the 1990s. Production of 1 ton of grain requires about 1,000 tons of water, and these countries prefer to import grain to meet their growing needs rather than produce it domestically because of the scarcity of water. In fact, at the current rate of use in Jordan, subterranean water reserves could dry up before 2010. Underground water is already overexploited in the United States, India, and China. Watering technologies, however, waste less and respond better to plant needs, saving 20 to 50% of the water used in agriculture.

Chapter 2
HYDRAULIC DRILLING STATION IN A VILLAGE NEAR DOROPO, Republic of Côte d'Ivoire (9°47' N, 3°19' W). Throughout Africa the task of collecting water is assigned to women, as seen here near the regions of Doropo and Bouna, in northern Côte d'Ivoire. Hydraulic drilling stations, equipped with pumps that are usually manual, are gradually replacing the traditional village wells, and containers of plastic, enamelled metal, or aluminium are supplanting *canaris* (large terra-cotta jugs) and gourds for transporting the precious resource. The water of these pits is more sanitary than that of traditional wells, 70% of which is unfit for drinking. Today 20% of the world population is without drinkable water. In Africa this is true for two out of five people, but more than half of the population in rural areas has no access to clean water. Illnesses from unhealthy water are the major cause of infant mortality in developing nations: diarrhoea kills 2.2 million children below the age of 5. In Africa and Asia improved access to clean drinking water will be one of the major challenges of the coming decades, as their populations grow.

Chapter 5
CONFLUENCE OF THE RIO URUGUAY AND A TRIBUTARY, Misiones, Argentina (S 27°15' W 54°03'). Drastically cleared to make way for farming, the Argentine tropical forest is today a less effective defence against erosion than it was in the past. Heavy rains falling in the province of Misiones (2,000 mm per year) wash the soil and carry off significant quantities of ferruginous earth into the Río Uruguay, turning the waters a dark, reddish ochre. Swollen by tributaries bearing vegetal debris, the Río Uruguay (1,612 km long) empties into the Atlantic Ocean in the area of the Río de la Plata-forming the earth's largest estuary (200 km wide)-where the river dumps the sediment it has carried. The sediment accumulates in the access channels to the port of Buenos Aires, which must be dredged regularly to remain navigable. Deposits built up at the mouths of rivers can change landscapes by forming deltas or extending land into the sea.

Chapter 7
WORKING THE FIELDS NORTH OF JODHPUR, Rajasthan, India (N 26°22' E 73°02'). Rajasthan, the second-largest state in India in terms of area (342,240 km^2), lies in the northwest region of the country. Sixty-five percent of the state is covered by sandy desert formations, and the scarcity of surface water is largely responsible for the low productivity of its soil. However, the construction of irrigation systems, which benefit 27 percent of arable lands in India, has aided in the development of agriculture. Millet, sorghum, wheat, and barley are cultivated here. The harvesting of these grains at the end of the dry season is a task that normally falls to women, who, even while working in the fields, wear the traditional *orhni*, a long, brightly coloured shawl that is typical of the region. More than half of India's territory is devoted to farming, which produces one-fourth of the domestic national product. Each year the country harvests about 220 million tons of grains, more than one-tenth of world production, and it ranks second in the world in wheat and rice. But the old conflict between production increase and demographic growth is now also affected by declining subterranean water reserves; a severe drought in April 2000 affected 20 million people in Rajasthan.

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THANK YOU FOR YOUR TIME.




WATER, A SHARED RESPONSIBILITY

Foreword: **Kofi Annan**, *UN Secretary General*
Prologue: **Koïchiro Matsuura,** *UNESCO Director General*
Preface: **Gordon Young,** *WWAP Coordinator*

SECTION 1: CHANGING CONTEXTS

CHAPTER 1: Living in a Changing World

Emphasizing the central role of water use and allocation in poverty alleviation and socio-economic development, this chapter discusses some of the many ways in which demographic and technological change, globalization and trade, climate variability, HIV/AIDS, warfare, etc., affect and are impacted by water. Key concepts of water management, sustainability and equity are introduced, as is the pivotal role of the many activities of the UN system in the water sector.

CHAPTER 2: The Challenges of Governance
UNDP, with IFAD

Recognizing that the water crisis is largely a crisis of governance, this chapter outlines many of the leading obstacles to sound and sustainable water management: sector fragmentation, poverty, corruption, stagnated budgets, declining levels of development assistance and investment in the water sector, inadequate institutions and limited stakeholder participation. While the progress towards reforming water governance remains slow, this chapter provides recommendations for balancing the social, economic, political and environmental dimensions of water.

CHAPTER 3: Water and Human Settlements in an Urbanizing World – *UN-HABITAT*

Increasing population growth is creating major problems worldwide. Growing urban water supply and sanitation needs, particularly in lower- and middle-income countries, face increasing competition with other sectors. Rising incomes in other portions of the world population fuel demand for manufactured goods and environmental services and amenities, all of which require water. This chapter emphasizes the scale of the growing urban water challenges, pointing out that nearly one-third of urban dwellers worldwide live in slums.

SECTION 2: CHANGING NATURAL SYSTEMS

CHAPTER 4: The State of the Resource
UNESCO & WMO, with IAEA

This chapter reviews the main components of the water cycle and provides an overview of the geographical distribution of the world's total water resources, their variability, the impacts of climate change and the challenges associated with assessing the resource.

CHAPTER 5: Coastal and Freshwater Ecosystems – *UNEP*

Natural ecosystems, rich in biodiversity, play a critical role in the water cycle and must be preserved. In many areas, a variety of pressures on freshwater ecosystems are leading to their rapid deterioration, affecting livelihoods, human well-being and development. To reverse this trend, protecting ecosystems and biodiversity must become a fundamental component of Integrated Water Resources Management (IWRM).

SECTION 3: CHALLENGES FOR HUMAN WELL-BEING AND DEVELOPMENT

CHAPTER 6: Protecting and Promoting Human Health – *WHO & UNICEF*

The state of human health is inextricably linked to a range of water-related conditions: safe drinking water, adequate sanitation, minimized burden of water-related disease and healthy freshwater ecosystems. Urgent improvements in the way in which water use and sanitation are managed are necessary for improving progress towards meeting the MDGs related to human health.

CHAPTER 7: Water for Food, Agriculture and Rural Livelihoods – *FAO & IFAD*

The daily demand for food is not negotiable. As the largest consumer of freshwater, the agriculture sector faces a critical challenge: producing more food of better quality while using less water per unit of output, in order to help protect the complex aquatic ecosystems on which our survival depends. This chapter examines the challenges of feeding a growing population and balancing its water needs with other uses in a sustainable way. Water opens the pathways and empowers the livelihoods approach to poverty reduction.

CHAPTER 8: Water and Industry – *UNIDO*

Despite industry's need for clean water, industrial pollution is damaging and destroying freshwater ecosystems in many areas, compromising water security for both individual consumers and industries. This chapter focuses on industry's impact on the water environment through its routine water withdrawal and wastewater discharge, analysing a broad range of regulatory instruments and voluntary initiatives that could improve water productivity, industrial profitability and environmental protection.

CHAPTER 9: Water and Energy – *UNIDO*

To be sustainable, economic development needs an adequate and steady supply of energy. Today's changing contexts require the consideration of a range of strategies to incorporate hydropower generation and other renewable forms of energy production to improve energy security while minimizing climate-changing emissions. This chapter stresses the need for the cooperative management of the energy and water sectors to ensure sustainable and sufficient supply of both energy and water.

SECTION 4: MANAGEMENT RESPONSES AND STEWARDSHIP

CHAPTER 10: Managing Risks: Securing the Gains of Development – *WMO, ISDR & UNU*

The climate is changing, thus increasing the occurrence and intensity of water-related natural disasters and creating greater burdens on human and environmental development. Employing an integrated approach, this chapter explores some of the ways of better reducing human vulnerabilities and examines the recent developments in risk reduction strategies.

CHAPTER 11: Sharing Water – *UNESCO*

Increasing competition for water resources can have potentially divisive effects. Mechanisms for cooperation and shared governance among users must be further developed in order to ensure that the resource become a catalyst for cooperation and a medium for deterring political tensions, while encouraging equitable and sustainable development.

CHAPTER 12: Valuing and Charging for Water
UN-DESA

Water has a range of values that must be recognized in selecting governance strategies. Valuation techniques inform decision-making for water allocation, which promote not only sustainable social, environmental and economic development but also transparency and accountability in governance. This chapter reviews techniques of economic valuation and the use of these tools in water policy development and charging for water services.

CHAPTER 13: Enhancing Knowledge and Capacity
UNESCO

The collection, dissemination and exchange of water-related data, information and know-how are imbalanced and, in many cases, deteriorating. It is now more urgent than ever to improve the state of knowledge concerning water-related issues through an effective global network of research, training and data collection and by implementing more adaptive, informed, and participatory approaches at all levels.

SECTION 5: SHARING RESPONSIBILITIES

CHAPTER 14: Case Studies: Moving Towards an Integrated Approach

These 17 Case Studies from around the world examine typical water resource challenges and provide valuable on-the-ground insights into the facets of the water crisis and different management responses: **The Autonomous Community of the Basque Country** (Spain), **China** (Heihe Basin), **Danube River Basin** (Albania, Austria, Bosnia-Herzogovina, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, the Former Yugoslav Republic of Macedonia, Moldova, Poland, Romania, Serbia and Montenegro, the Slovak Republic, Slovenia, Switzerland, Ukraine), **Ethiopia, France, Japan, Kenya, Lake Peipsi** (Estonia, Russian Federation), **Lake Titicaca** (Bolivia, Peru), **Mali, the State of Mexico, Mongolia** (Tuul Basin), **La Plata Basin** (Argentina, Brazil, Bolivia, Paraguay, Uruguay), **South Africa, Sri Lanka, Thailand, Uganda.**

CHAPTER 15: Conclusions and Recommendations for Action

Drawing on the essential points and key messages presented throughout the Report, this chapter weaves together a set of conclusions and recommendations to guide future action and enhance the sustainable use, productivity and management of the world's increasingly scarce freshwater resources.

CD-ROM – The accompanying interactive, searchable and hyperlinked CD-ROM includes all of the WWDR2 data tables, graphs, charts and maps, as well as detailed sections on indicator and case study developments, among other valuable materials, all of which are available as of 22 March 2006 (World Water Day) at **www.unesco.org/water/wwap**

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A joint undertaking of the 24 UN agencies comprising UN-Water, and in partnership with governments and other entities concerned with freshwater issues, this volume, covering all regions and most countries of the world, provides an up-to-date global overview of the state and uses of freshwater, critical water-related problems and societies' coping mechanisms. Drawing on an extensive database, expert analysis, case studies, and hundreds of graphic elements, it is the most comprehensive undertaking to date of freshwater assessment, providing a mechanism for monitoring changes in the resource and its management and progress towards achieving development targets, particularly the Millennium Development Goals.

UNESCO

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Building on the conclusions of the first World Water Development Report, *Water for People, Water for Life* (2003), the 2006 Report confirms the ongoing, serious and growing water crisis – to a large extent a crisis of governance – and points to a prevalent lack of capacity and knowledge base as today's primary obstacles to achieving the necessary levels of water governance. This volume proposes a more integrated vision of water resources management to respond to changing environmental and socio-economic conditions.

UNHCR The UN Refugee Agency

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WWDR2 is aimed at a wide audience, including all those interested or directly involved in the formulation and implementation of water-related policies, as well as managers, researchers, teachers, students and, of course, water users themselves.

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