World Water Assessment Programme

Executive Summary

Water for People Water for Life

The United Nations
World Water Development Report

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Setting the Scene

The World's Water Crisis

At the beginning of the twenty-first century, the Earth, with its diverse and abundant life forms, including over six billion humans, is facing a serious water crisis. All the signs suggest that it is getting worse and will continue to do so, unless corrective action is taken. This crisis is one of water governance, essentially caused by the ways in which we mismanage water. But the real tragedy is the effect it has on the everyday lives of poor people, who are blighted by the burden of water-related disease, living in degraded and often dangerous environments, struggling to get an education for their children and to earn a living, and to get enough to eat. The crisis is experienced also by the natural environment, which is groaning under the mountain of wastes dumped onto it daily, and from overuse and misuse, with seemingly little care for the future consequences and future generations. In truth it is attitude and behaviour problems that lie at the heart of the crisis. We know most (but not all) of what the problems are and a good deal about where they are. We have knowledge and expertise to begin to tackle them. We have developed excellent concepts, such as equity and sustainability. Yet inertia at leadership level, and a world population not fully aware of the scale of the problem (and in many cases not sufficiently empowered to do much about it) means we fail to take the needed timely corrective actions and put the concepts to work.

For humanity, the poverty of a large percentage of the world's population is both a symptom and a cause of the water crisis. Giving the poor better access to better managed water can make a big contribution to poverty eradication, as *The World Water Development Report* (WWDR) will show. Such better management will enable us to deal with the growing per capita scarcity of water in many parts of the developing world.

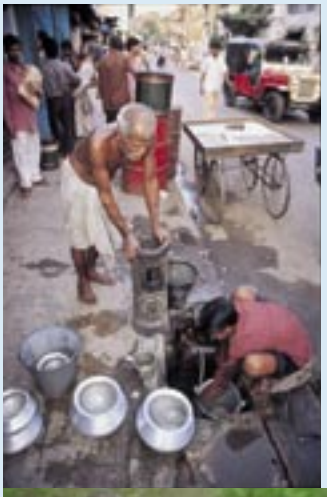
Solving the water crisis in its many aspects is but one of the several challenges facing humankind as we confront life in this third millennium and it has to be seen in that context. We have to fit the water crisis into an overall scenario of problem-solving and conflict resolution. As pointed out by the Commission for Sustainable Development (CSD) in 2002:

> Poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base of economic and social development are overarching objectives of, and essential requirements for, sustainable development.

Yet of all the social and natural resource crises we humans face, the water crisis is the one that lies at the heart of our survival and that of our planet Earth.

This first WWDR is a joint undertaking of twenty-three United Nations (UN) agencies, and is a major initiative of the new World Water Assessment Programme (WWAP) established in 2000, with its Secretariat in the Paris headquarters of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). This report is organized in six main sections: a background, an evaluation of the world's water resources, an examination of the needs for, the uses

of and the demands on water ('Challenges to Life and Well-Being'), a scrutiny of water management ('Management Challenges'), seven representative case studies highlighting different water scenarios, and conclusions and annexes. The two 'challenges' sections are based on the seven challenges identified at the 2nd World Water Forum in 2000 plus a further four challenges identified in the production of this report. The book is documented throughout with revealing figures, tables and global maps that include country-based information, as well as boxes illustrating lessons learned. This Executive Summary covers the key points of the report, and for the detailed synthesis, conclusions and recommendations, readers are referred to its relevant sections.



Milestones

The latter part of the twentieth century up to the present has been the era of large world conferences, not least on water, and the sequence shall continue as 2003 embraces not only the 3rd World Water Forum (in Japan) but is set to be the International Year of Freshwater. These conferences, the preparations that preceded them and the discussions that followed, have sharpened our perceptions of the water crisis and have broadened our understanding of the needed responses. The Mar del Plata conference of 1977 initiated a series of global activities in water. Of these, the International Drinking Water and Sanitation Decade (1981-1990) brought about a valuable extension of basic services to the poor. These experiences have shown us, by comparison, the magnitude of the present task of providing the huge expansion in basic water supply and sanitation services needed today and in the years to come. The International Conference on Water and the Environment in Dublin in 1992 set out the four Dublin Principles that are still relevant today (Principle 1: 'Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment'; Principle 2: 'Water development and management should be based on a participatory approach, involving users, planners and policymakers at all levels'; Principle 3: 'Women play a central part in the provision, management and safeguarding of water'; Principle 4: 'Water has an economic value in all its competing uses and should be recognized as an economic good').

The UN Conference on the Environment and Development (UNCED) in 1992 produced Agenda 21, which with its seven programme areas for action in freshwater, helped to mobilize change and heralded the beginning of the still very slow evolution in water management practices. Both of these conferences were seminal in that they placed water at the centre of the sustainable

development debate. The 2nd World Water Forum in The Hague in 2000, and the International Conference on Freshwater in Bonn in 2001 continued this process. All of these various meetings set targets for improvements in water management, very few of which have been met.

However, of all the major target-setting events of recent years, the UN Summit of 2000, which set the Millennium Development Goals for 2015, remains the most influential. Among the goals set forth, the following are the most relevant to water:

1. to halve the proportion of people living on less than 1 dollar per day;
2. to halve the proportion of people suffering from hunger;
3. to halve the proportion of people without access to safe drinking water;
4. to ensure that all children, boys and girls equally, can complete a course of primary education;
5. to reduce maternal mortality by 75 percent and under-five mortality by two thirds;
6. to halt and reverse the spread of HIV/AIDS, malaria and the other major diseases;
7. to provide special assistance to children orphaned by HIV/AIDS.

All of this needs to be achieved while protecting the environment from further degradation. The UN recognized that these aims, which focus on poverty, education and health, cannot be achieved without adequate and equitable access to resources, and the most fundamental of these are water and energy.

The Hague Ministerial Declaration of March 2000 adopted seven challenges as the basis for future action. These have additionally been adopted as the basis for monitoring progress by the WWDR:

1. Meeting basic needs – for safe and sufficient water and sanitation
2. Securing the food supply – especially for the poor and vulnerable through the more effective use of water
3. Protecting ecosystems – ensuring their integrity via sustainable water resource management
4. Sharing water resources – promoting peaceful cooperation between different uses of water and between concerned states, through approaches such as sustainable river basin management
5. Managing risks – to provide security from a range of water-related hazards
6. Valuing water – to manage water in the light of its different values (economic, social, environmental, cultural) and to move towards pricing water to recover the costs of service provision, taking account of equity and the needs of the poor and vulnerable
7. Governing water wisely – involving the public and the interests of all stakeholders.

A further four challenges were added to the above seven to widen the scope of the analysis:

8. Water and industry – promoting cleaner industry with respect to water quality and the needs of other users
9. Water and energy – assessing water's key role in energy production to meet rising energy demands
10. Ensuring the knowledge base – so that water knowledge becomes more universally available
11. Water and cities – recognizing the distinctive challenges of an increasingly urbanized world.

It is these eleven challenges that structure the WWDR.

Coming up to 2002 and the World Summit on Sustainable Development (WSSD), UN Secretary General Kofi Annan identified WEHAB (Water and sanitation, Energy, Health, Agriculture, Biodiversity) as integral to a coherent international approach to sustainable development. Water is essential to success in each of these focus areas. The WSSD also added the 2015 target of reducing by half the proportion of people without sanitation.

Thus 2002/2003 is a significant staging post in humankind's progress towards recognizing the vital importance of water to our future; an issue that now sits at or near the top of the political agenda.

Signing Progress: Indicators Mark the Way

A key component of the WWAP is the development of a set of indicators for the water sector. These indicators must present the complex phenomena of the water sector in a meaningful and understandable way, to decision-makers as well as to the public. They must establish benchmarks to help analyze changes in the sector in space and time in such a way as to help decision-makers to understand the importance of water issues, and involve them in promoting effective water governance. Good indicators help water sector professionals to step 'outside the water box', in order to take account of the broad social, political and economic issues affecting and affected by water. Furthermore, targets are essential to monitor progress towards achieving the Millennium Development Goals related to water.

Indicator development is a complex and slow process, requiring widespread consultation. New indicators have to be tested and modified in the light of experience. To date, the WWAP has agreed upon a methodological approach to water indicator development and has identified a range of indicators, through recommendations by the UN agencies participating in WWAP.

A better understanding has been gained of the problems related to indicator development: data availability, and information scaling

and aggregation from different sources. The specific challenges related to the production of water indicators include the slow progress of the water sector in adapting existing earth-systems modelling data into water resource assessments (e.g. greenhouse warming impacts on regional water resources) and a relatively poor understanding of how complex drainage systems function in relation to anthropogenic challenges in comparison to a good understanding of hydrology at the local scale. Further, the decline of measuring stations and systems for hydrology (a widespread international problem) limits good data acquisition. However, this decline can be offset by the great monitoring opportunities offered by contemporary remote sensing capabilities and computerized data analysis capacity. There remains however an urgent need for a broad set of socio-economic variables to help quantify the use of water. The conjunction of these latter variables with the hydrographic variables can create two fundamental quantities – the rate of water withdrawal/consumption and the available water supply. Together these produce a valuable indicator of relative water use and the ability of water resource systems to provide the services we need. Large uncertainties in current estimates of global water withdrawals complicate good assessments of relative water use.

Much work is needed to collect and prepare the geophysical and socio-economic data sets for future WWDRs. In addition to the geography of water supply, issues of technological capacity to provide water service, population growth, levels of environmental protection and health services, and investments in water infrastructure must be included in future analyses. At this point, we have made a start on the long-term project to develop a comprehensive set of user-friendly water indicators, which will build on the experience and ongoing monitoring activities of Member States and the UN agencies involved.

A Look at the World's Freshwater Resources

The Natural Water Cycle

Although water is the most widely occurring substance on earth, only 2.53 percent is freshwater while the remainder is salt water. Some two thirds of this freshwater is locked up in glaciers and permanent snow cover. The available freshwater is distributed regionally as shown in figure 1.

In addition to the accessible freshwater in lakes, rivers and aquifers, man-made storage in reservoirs adds a further 8,000 cubic kilometres (km^3). Water resources are renewable (except some groundwaters), with huge differences in availability in different parts of the world and wide variations in seasonal and annual precipitation in many places. Precipitation is the main source of water for all human uses and for ecosystems. This precipitation is taken up by plants and soils, evaporates into the atmosphere via evapotranspiration, and runs off to the sea via rivers, and to lakes and wetlands. The water of evapotranspiration supports forests,

Source:
Website of the UNESCO/ IHP Regional Office of Latin America and the Caribbean.

Figure 1:
Water availability versus population.
The global overview of water availability versus the population stresses the continental disparities, and in particular the pressure put on the Asian continent, which supports more than half the world's population with only 36 percent of the world's water resources.

rainfed cultivated and grazing lands, and ecosystems. We withdraw 8 percent of the total annual renewable freshwater, and appropriate 26 percent of annual evapotranspiration and 54 percent of accessible runoff. Humankind's control of runoff is now global and we are significant players in the hydrological cycle. Per capita use is increasing (with better lifestyles) and population is growing. Thus the percentage of appropriated water is increasing. Together with spatial and temporal variations in available water, the consequence is that water for all our uses is becoming scarce and leading to a water crisis.

Freshwater resources are further reduced by pollution. Some 2 million tons of waste per day are disposed of within receiving waters, including industrial wastes and chemicals, human waste and agricultural wastes (fertilizers, pesticides and pesticide residues). Although reliable data on the extent and severity of pollution is incomplete, one

estimate of global wastewater production is about 1,500 km^3. Assuming that 1 litre of wastewater pollutes 8 litres of freshwater, the present burden of pollution may be up to 12,000 km^3 worldwide. As ever, the poor are the worst affected, with 50 percent of the population of developing countries exposed to polluted water sources.

The precise impact of climate change on water resources is uncertain. Precipitation will probably increase from latitudes 30°N and 30°S, but many tropical and sub-tropical regions will probably get lower and more erratic rainfall. With a discernable trend towards more frequent extreme weather conditions, it is likely that floods, droughts, mudslides, typhoons and cyclones will increase. Stream flows at low-flow periods may well decrease and water quality will undoubtedly worsen, because of increased pollution loads and concentrations and higher water temperatures.

Recent estimates suggest that climate change will account for about 20 percent of the increase in global water scarcity.

We have made good progress in understanding the nature of water in its interaction with the biotic and abiotic environment. We have better estimates of climate change impacts on water resources. Over the years, our understanding of hydrological processes has enabled us to harvest water resources for our needs, reducing the risk of extreme situations. But pressures on the inland water system are increasing with population growth and economic development. Critical challenges lie ahead in coping with progressive water shortages and water pollution. By the middle of this century, at worst 7 billion people in sixty countries will be water-scarce, at best 2 billion people in forty-eight countries.

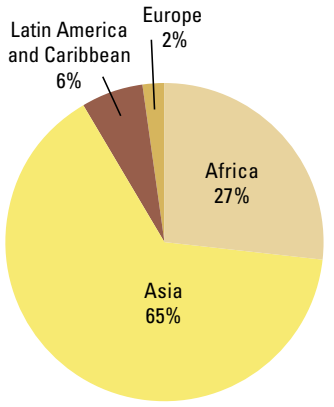
Challenges to Life and Well-Being

Challenge 1
Basic Needs and the Right to Health

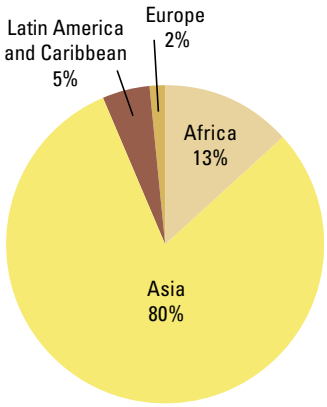
Water-related diseases are among the most common causes of illness and death, affecting mainly the poor in developing countries. Water-borne diseases causing gastro-intestinal illness (including diarrhoea) are caused by drinking contaminated water; vector-borne diseases (e.g. malaria, schistosomiasis) are passed on by the insects and snails that breed in aquatic ecosystems; water-washed diseases (e.g. scabies, trachoma) are caused by bacteria or parasites that take hold when there is insufficient water for basic hygiene (washing, bathing, etc.). In 2000, the estimated mortality rate due to water sanitation hygiene-associated diarrhoeas and some other water/sanitation-associated diseases (schistosomiasis, trachoma, intestinal helminth infections) was 2,213,000. There were an estimated 1 million deaths due to malaria. Worldwide, over 2 billion people were infected with schistosomes and soil-transmitted helminths, of whom 300 million suffered serious illness. The majority of those affected by water-related mortality and morbidity are children under five. The tragedy is that this disease burden is largely preventable.

Vaccination is not available for most water-related diseases, including malaria, dengue, and gastro-intestinal infections. Insecticide resistance has undermined the effectiveness of disease vector control programmes, and there is growing resistance of bacteria to antibiotics and of parasites to other drugs. However, at a domestic level, access to safe drinking water, sanitation that stops contaminants from reaching sources of drinking water, plus hand-washing and careful food handling are, collectively, key tools in fighting gastro-intestinal illness. And improved water management practices have great potential to reduce the vector-borne disease burden.

Presently, 1.1 billion people lack access to improved water supply and 2.4 billion to improved sanitation. In the vicious poverty/ill-health cycle, inadequate water supply and sanitation are both underlying cause and outcome: invariably, those who lack adequate and affordable water supplies are the poorest in society. If improved water supply and basic sanitation were extended to the present-day 'unserved', it is estimated that the burden of infectious diarrhoeas would be reduced by some 17 percent annually; if universal piped, well-regulated water supply and full sanitation were achieved, this would reduce the burden



Water supply, distribution of unserved populations



Sanitation, distribution of unserved populations

Figure 2:
Water supply and sanitation distribution of unserved population.
Asia shows the highest number of people unserved by either water supply or sanitation; yet it is important to note that proportionally, this group is larger in Africa due to the difference in population size between the two continents.

Source: WHO/UNICEF Joint Monitoring Programme, 2002. Updated in September 2002.

by some 70 percent annually. Analysis of the cost effectiveness of water interventions suggests further that:

1. Disinfection of water with chlorine tablets at the point of use and safe storage, combined with limited hygiene education, is the biggest health benefit at the lowest incremental cost;
2. Disinfection of water at the point of use is consistently the most cost-effective intervention. In addition, improved hand-washing is also highly effective.

Collectively, these results point to the need for a policy shift in lower-income countries towards better household water-quality management, coupled with improved individual and family hygiene, as well as the continued expansion of water supply and sanitation coverage, linked to upgraded service levels, that ensure reliable supplies and acceptable water quality.

The incorporation of sound, health-based practices for water resource systems should thus include water-quality management in source protection, and treatment and distribution of drinking water, using Health Impact Assessments (HIA) on all development projects to reduce the threat of vector-borne disease. Improvements in irrigation techniques – lining canals, using seasonal wetting and drying cycles, avoiding standing and slow running water, and educating farmers to the risk of disease – would all make a big difference. In addition, higher-level practices can also contribute, such as making the different water-use sectors responsible for the adverse health effects of their projects, having regular evaluations of the costs of

ill-health from water resource development, and evaluating the cost-effectiveness of water supply and water management interventions versus conventional health interventions.

To the above should be added the following sound health-based practices: improving personal protection via oral rehydration, using insecticide-impregnated mosquito nets, urging health workers to promote basic sanitation and improved hygiene behaviour, and mobilizing communities to improve drinking water facilities and to learn about drinking-water contamination and safe drinking water storage. Most of the above is neither complex nor expensive to achieve but will nonetheless require major policy shifts by governments to implement. The potential benefits are so great that the political will to introduce new policies must be found.

Challenge 2
Protecting Ecosystems for People and Planet

Water is an essential part of any ecosystem, both in quantitative and qualitative terms, and reduced water quantity and quality both have serious negative impacts on ecosystems. The environment has a natural absorptive, self-cleansing capacity. However, if this is exceeded, biodiversity is lost, livelihoods are affected, natural food sources (e.g. fish) are damaged and high clean-up costs result. Environmental damage is leading to increased natural disasters, with floods increasing where deforestation and soil erosion are preventing natural water attenuation. The draining of wetlands for agriculture (50 percent lost in the last century) and the appropriation of evapotranspiration (by land clearance) lead to further perturbation of natural systems and will cause profound impacts on the future availability of water. And it is yet again the poor who are most affected by such impacts – they live in marginal areas, those afflicted by floods, pollution and scarce water supplies as well as the loss of valuable natural sources of food.

We have come to accept two important concepts in the past decade: firstly, that ecosystems not only have their own intrinsic value, but also provide humankind with essential services; secondly, that the sustainability of water resources requires participatory, ecosystem-based management. Table 1 summarizes the pressures to which freshwater ecosystems are subjected and the potential impacts on systems at risk.

Measures of ecosystem health include: water quality indicators (physico-chemical and biological), hydrological information and biological assessment, including the degree of biodiversity.

Although there are various problems in

acquiring the relevant data, it is clear that inland aquatic ecosystems have problems. The stream flows of around 60 percent of the world's largest rivers have been interrupted by hydraulic structures. Well-studied commercial fisheries have declined dramatically, through habitat degradation, invasive species and over-harvesting. Worldwide, of the creatures associated with inland waters, 24 percent of mammals and 12 percent of birds are threatened, as are a third of the 10 percent of fish species studied in detail so far. Inland water biodiversity is widely in decline, mainly from habitat disturbance, which can be taken as evidence of declining ecosystem condition.

Measures to protect ecosystems include: policy and strategy initiatives to set targets and standards, and to promote integrated land/water use management; environmental education; regular reporting of environmental quality and changes; flow maintenance in rivers; site protection and water source protection; species protection programmes, etc.

Recognition of these environmental challenges has increased interest in and momentum towards ecological restoration by government institutions and non-governmental organizations (NGOs). Available data points to some progress in aspects of biodiversity conservation and use in inland waters, including progress in strategic planning and target setting. It is expected that restoration of ecosystems will become a central activity in environmental management in the future, including assisting system recovery by alleviating pollution, and by restoring and reconnecting wetlands and marshes.

Table 1: Pressures of freshwater ecosystems.

Human activity	Potential impact	Function at risk
Population and consumption growth	Increases water abstraction and acquisition of cultivated land through wetland drainage; increases requirement for all other activities with consequent risks	Virtually all ecosystem functions including habitat, production and regulation functions
Infrastructure development (dams, dikes, levees, diversions etc.)	Loss of integrity alters timing and quantity of river flows, water temperature, nutrient and sediment transport and thus delta replenishment, blocks fish migrations	Water quantity and quality, habitats, floodplain fertility, fisheries, delta economies
Land conversion	Eliminates key components of aquatic environment; loss of functions; integrity; habitat and biodiversity; alters runoff patterns; inhibits natural recharge, fills water bodies with silt	Natural flood control, habitats for fisheries and waterfowl, recreation, water supply, water quantity and quality
Overharvesting and exploitation	Depletes living resources, ecosystem functions and biodiversity (groundwater depletion, collapse of fisheries)	Food production, water supply, water quality and water quantity
Introduction of exotic species	Competition from introduced species; alters production and nutrient cycling; and causes loss of biodiversity among native species	Food production, wildlife habitat, recreation
Release of pollutants to land, air or water	Pollution of water bodies alters chemistry and ecology of rivers, lakes and wetlands; greenhouse gas emissions produce dramatic changes in runoff and rainfall patterns	Water supply, habitat, water quality, food production; climate change may also impact hydropower, dilution capacity, transport, flood control

A wide range of human uses and transformations of freshwater or terrestrial environments have the potential to alter, sometimes irreversibly, the integrity of freshwater ecosystems. Source: IUCN, 2000.

of wastewater, the management of rainfall runoff (including stormwater) and prevention of flooding, and the sustainable use of water resources. To the above must be added cooperation with other administrations that share the river basin or groundwater source.

Cities often take water from outside their administrative boundaries and discharge their waste downstream, thereby affecting other users.

Challenge 3
Cities: Competing Needs in an Urban Environment

Presently 48 percent of the world's population lives in towns and cities; by 2030 this will rise to about 60 percent. The logic of urbanization is clear – those countries that urbanized most in the past forty years are generally those with the largest economic growth. Urban areas, generally, provide the economic resources to install water supply and sanitation, but they also concentrate wastes. Where good waste management is lacking, urban areas are among the world's most life-threatening environments.

Good city water management is complex. It requires the integrated management of water supplies for domestic and industrial needs, the control of pollution and the treatment

For monitoring purposes, the World Health Organization/United Nations Children's Fund (WHO/UNICEF) *Global Water Supply and Sanitation Assessment 2000 Report* specifies reasonable access to water as at least 20 litres per person per day, from an improved source within 1 km of a user's dwelling. This does not, however, represent a definition of adequacy of access, but rather a benchmark for monitoring purposes. For example, in a densely populated squatter community with 100,000 inhabitants, it certainly is not reasonable. The reliability and regularity of many urban water supplies in lower-income countries is a big problem, with poor quality water and the high price of water when bought from street water vendors. On the sanitation front, shared toilets and pit latrines are not really adequate in urban areas. They are often badly maintained and not cleaned. Children find them hard to use and the cost of use for a poor family may be prohibitive. So, many urban dwellers resort to open defecation or defecation in a bag or wrapping, which is then dumped.

Accurate data is limited on the quality and availability of water supply and sanitation provision in cities in many lower-income countries. It appears that official national data provided for various studies may overstate the provision of improved water supplies and improved sanitation, and the actual situation may be worse than present figures indicate. What is clear is that the health gains from the provision of improved water supply and sanitation are like quantum leaps, with the biggest gains in the transition from no service at all to basic services, and then service extended to individual households.

To provide better water supplies, sanitation and flood management for cities, a range of actions is needed. Competent water utilities are foremost among these, whether public ones that have been corporatized or private ones, both of which must be subject to good regulation. The application of sound city planning and zoning regulations to control industrial and housing developments, together with the control of water abstractions and polluting effluents, is also essential. Good watershed management, to minimize ecological disturbance and make better use of water resources, is vital. Creating an enabling environment for communities and NGOs to make their own water supply and sanitation provision, with the proviso that these do not cause problems elsewhere in the system, will make a big contribution in peri-urban areas. However, problems of weak local government and the low incomes of many urban dwellers will complicate the achievement of these objectives.

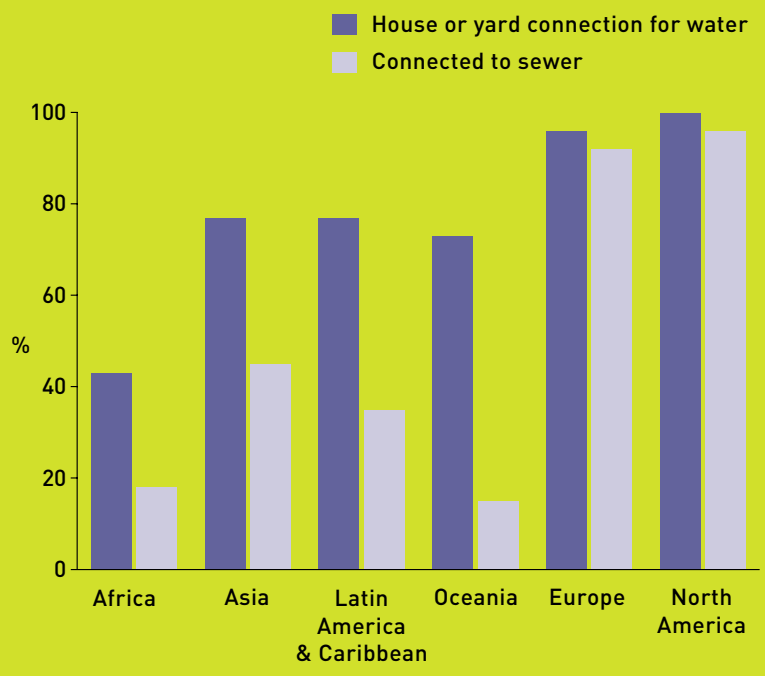


Figure 3:
The proportion of households in major cities connected to piped water and sewers.
These are based on information provided by 116 cities. In no region was there a representative sample of large cities, although the figures for each region are likely to be indicative of average levels of provision for major cities in that region.

If adequate provision for sanitation in large cities is taken to mean a toilet connected to a sewer, then this figure indicates there is a significant lack of adequate provision in cities throughout Africa, Asia, Latin America and the Caribbean and Oceania.

Source: WHO and UNICEF, 2000.

Challenge 4
Securing Food for a Growing World Population

The main source of the world's food supply is agriculture, which includes crops, livestock, aquaculture and forestry. Unmanaged earth systems can feed some 500 million people, so systematic agriculture is needed for the current world population of 6 billion. In addition, at the local level, agriculture is the mainstay of many rural economies. Providing the 2,800 calories per person per day needed for adequate nourishment requires an average of 1,000 cubic metres (m^3) of water.

Most agriculture is rainfed, but irrigated land accounts for about one fifth of the total arable area in developing countries. Some 15 percent of agricultural water is used by irrigation, totalling about 2,000-2,500 cubic kilometres (km^3) per year. In 1998, in developing countries, irrigated land produced two fifths of all crops and three fifths of all cereals. Cereals are the most important crop, providing 56 percent of calories consumed. Oil crops are the next most important. Developed countries account for about 25 percent of the world's irrigated areas. Since populations there grow slowly, most irrigation development will be in the developing world where population growth is strong. The WWDR provides a country-by-country breakdown of key indicators of national food supply.

Presently, irrigation accounts for 70 percent of all water withdrawals. Amounts will increase by 14 percent in the next thirty years as the area of irrigated land expands by a further 20 percent. By 2030, 60 percent of all land with irrigation potential will be in use. Of the ninety-three developing countries surveyed by FAO, ten are already using 40 percent of their renewable freshwater for irrigation, the level at which difficult choices can arise between agriculture and other users. By 2030, South Asia will have reached this 40 percent level, and Near East/North Africa will be using about 58 percent. However, for sub-Saharan Africa, Latin America and East Asia, irrigation water demand will be below the critical threshold although at local level serious problems may arise. Shallow groundwater is an important source of irrigation water but over-pumping of aquifers, pollution from agro-chemicals and the mining of fossil groundwaters are all problem areas. Agricultural chemicals (fertilizers and pesticides) are a major cause of water pollution generally, the nutrients from fertilizers causing severe problems of eutrophication in surface waters worldwide.

An important source of irrigation water is wastewater, with some 10 percent of total irrigated land in developing countries using

Table 2: Water requirement equivalent of main food production.

Product	Unit	Equivalent water in cubic metres
Bovine, cattle	head	4,000
Sheeps and goats	head	500
Meat bovine fresh	kilogram	15
Meat sheep fresh	kilogram	10
Meat poultry fresh	kilogram	6
Cereals	kilogram	1.5
Citrus fruit	kilogram	1
Palm oil	kilogram	2
Pulses, roots and tubers	kilogram	1

Source: FAO, 1997b.

This table gives examples of water required per unit of major food products, including livestock, which consume the most water per unit. Cereals, oil crops and pulses, roots and tubers consume far less water.

this resource. It provides direct benefits to farmers who are short of water, it can improve soil fertility and reduce contamination of what would otherwise be the downstream receiving waters. For irrigation use, wastewater should receive treatment, but in lower-income countries, raw sewage is often used directly, for which the associated risks include the exposure of irrigation workers and food consumers to bacterial, amoebic, viral and nematode parasites, as well as organic, chemical and heavy metal contaminants. Crops grown using untreated wastewater cannot be exported and access to local markets, at least partially, is restricted. The use of treated wastewaters in urban areas is expected to grow in the future, for irrigating trees, parks and golf courses.

Trade remains marginal compared to overall domestic production in the food sector but is growing. Developing countries imported 39 million tons of cereals in the mid-1970s. This is expected to rise to 198 million tons in 2015 and 265 million tons in 2030. Access to export markets is one key to sustainable development for agriculturally dominated economies.

Irrigation development costs range typically between US$1,000 and US$10,000 per hectare. Future total annual investment costs worldwide are estimated at US$25-30 billion, including expansion of irrigated areas, rehabilitation and modernization of existing systems, and provision of extra water storage.

There is a strong positive link between investment in irrigation, poverty alleviation and food security. In India, 69 percent of people in non-irrigated areas are poor; in irrigated areas this figure falls to 26 percent.

Irrigation water use efficiency, presently about 38 percent worldwide, is expected to improve slowly to an average of 42 percent by 2030, using technology and improved irrigation water management practice. This will also help to alleviate the problems of vector-borne disease associated with irrigation. Much needed reform of the management of irrigation water to improve performances, equity of allocation, involvement of stakeholders and water use efficiency, is underway in many countries like Mexico, China and Turkey. The process includes structural and managerial changes aiming at improving service to irrigation water users, including in many cases elements of transfer of authority to water users' associations. Progress is slow, however, and results have been somewhat mixed.

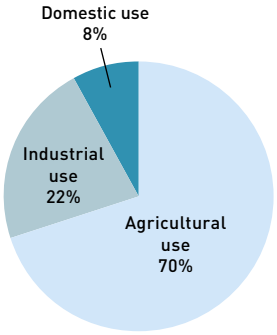
Despite all the foregoing, 777 million people in developing countries are under-nourished and the target of halving this will not be met before 2030. This situation has arisen more from national conflict than from water insecurity. In the last decades, agricultural production has grown faster than the world's population and there is no evidence that this should change. Overall, the message from agriculture is cautiously optimistic.

Challenge 5
Promoting Cleaner Industry for Everyone's Benefit

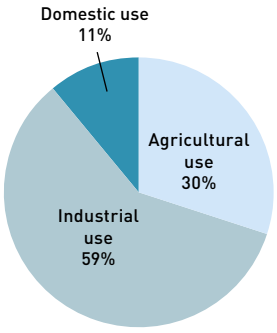
Industry, an essential engine of economic growth and critical to the achievement of the UN Millennium Development Goals, requires adequate resources of good quality water as a key raw material. Global annual water use by industry is expected to rise from an estimated 725 km^3 in 1995 to about 1,170 km^3 by 2025, by which time industrial water usage will represent 24 percent of all water abstractions. Much of this increase will be in developing countries now experiencing rapid industrial development. Figure 4 shows industrial water usage per region, compared with other main uses.

Indicators of industry impacts on water are not well developed, often relying on incomplete, indirect or inconsistent data. In order to encourage the proper valuation of water by industry, an attempt is made in the WWDR to link industrial water consumption to the manufacturing value addition achieved.

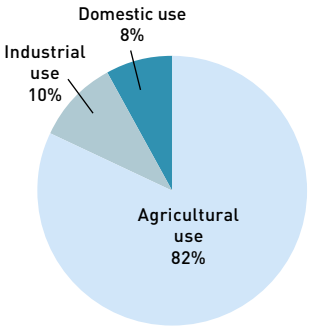
The projected growth in industrial demand for water can only be met by integrating improved supply-side considerations with enhanced demand-side management at government and enterprise levels. Demand-side initiatives play an important role in increasing the water efficiency of industrial processes, and lowering the pollutant load of effluents discharged by industry.



Competing water uses (world)



Competing water uses (high-income countries)



Competing water uses (low- and middle-income countries)

Figure 4:
Competing water uses for main income groups of countries.
Industrial use of water increases with country income, going from 10 percent for low- and middle-income countries to 59 percent for high-income countries.
Source: World Bank, 2001.

Training and education in demand-side management, combined with technology transfer, can provide both environmental benefits and the improved economic performance of enterprises.

Within industry, water, often in large quantities, is most commonly used in the manufacturing process – for washing, cooking, cooling, etc. – and then returned to local water systems. Water discharged by industries may be of poor quality and, unless adequately treated, threatens the surface and groundwater resources into which it is discharged. Industry may pose a chronic threat to resources by the continuous discharge of effluents, or an acute threat when a catastrophic failure generates an intense pollution event over a short period.

Damage to water resources by industry activity is not restricted to 'local' freshwater resources. The increasing concentration of population and industry in coastal zones is resulting in the impoverishment of coastal habitats and the people that depend on them. In addition, air emissions of, for example, persistent organic pollutants, may pollute waters far removed from industrial centres.

Many countries have adopted the polluter pays and precautionary principles to address these issues but they may be unwilling to hinder industrial and economic performance or lack the resources to monitor and enforce regulations. This is coupled, in many middle- and lower-income countries, with a lack of awareness among industry managers of how water is used in their enterprise and with the use of obsolete, inefficient or inappropriate technology. These factors represent barriers to efficient water use management at enterprise level. In many industries, the bulk of effluent discharge represents excess raw material that can be captured for re-use thereby reducing new production inputs and costs. This encourages industry participation and breaks the prevailing paradigm linking industrial growth to environmental damage. To promote such initiatives at local and regional levels, the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP) have established a network of more than twenty National Cleaner Production Centres providing technical assistance to enterprises in developing countries around the world.

Further action is required at the global level to develop and refine appropriate and robust indicators of water consumption and quality, and to support the continuing collection of reliable data. Assistance is needed to build these indicators into regional and local water management and to integrate this with industrial, economic and investment planning. The promotion of demand-side initiatives at enterprise level is needed to provide positive incentives for industry engagement in efforts to meet targets set at the 2nd World Water Forum and the Millennium Development Goals.

Challenge 6
Developing Energy to Meet Development Needs

Water is not the only source of energy; in some parts of the world significant energy is supplied by fossil fuels, nuclear power and wind power. Water is vital for energy production in many areas, but its two foremost applications are the generation of hydroelectricity and use for cooling purposes in thermal electrical power stations. Other uses, excluding hydropower, include tidal power, wave energy and geothermal sources. Despite the large amounts of electricity generated worldwide and the crucial role of energy in sustainable development, access to electricity is very uneven worldwide. Some 2 billion people have no electricity at all, 1 billion people use uneconomic electricity supplies (dry cell batteries) or candles or kerosene, and 2.5 billion people in developing countries have little access to commercial electricity services.

Yet electricity contributes to poverty alleviation in many ways. It is essential for livelihoods that involve small-scale enterprises, for improving medical services, including

Table 3: Deployment of hydropower

Location	Market area	Current deployment in 1995 (TWh/year)	Estimated deployment in 2010 (TWh/year)
World	Large hydro Small hydro Total hydro	2,265 115 2,380	3,990 220 4,210
EU + EFTA	Large hydro Small hydro Total hydro	401.5 40 441.5	443 50 493
CEE	Large hydro Small hydro Total hydro	57.5 4.5 62	83 16 99
CIS	Large hydro Small hydro Total hydro	160 4 164	388 12 400
NAFTA	Large hydro Small hydro Total hydro	635 18 653	685 25 710
OECD Pacific	Large hydro Small hydro Total hydro	131 0.7 131.7	138 3 141
Mediterranean	Large hydro Small hydro Total hydro	35.5 0.5 36	72 0.7 72.7
Africa	Large hydro Small hydro Total hydro	65.4 1.6 67	147 3 150
Middle East	Large hydro Small hydro Total hydro	24.8 0.2 25	49 1 50
Asia	Large hydro Small hydro Total hydro	291 42 333	1,000 100 1,100
Latin America	Large hydro Small hydro Total hydro	461.5 3.5 465	990 10 1,000

Source: Water Power and Dam Construction, 1995 and International Journal on Hydropower and Dams, 1997.

EU + EFTA → European Union & European Free Trade Association
CEE → Central and Eastern Europe
CIS → Ex-USSR countries
NAFTA → United States, Canada, Mexico
OECD Pacific → Australia, Japan, New Zealand
Mediterranean → Turkey, Cyprus, Gibraltar, Malta
Asia → All Asia excluding former USSR

This table shows the current and projected deployment of hydropower throughout the world. It is set to expand in all regions, in particular in Africa, Asia and Latin America, where the potential for development is greatest.



powering equipment and the refrigeration of vaccines and medicines. It can extend the length of the working day, providing lighting for study and business activities. It provides power to pump water for domestic, agricultural and small industrial functions, and for water treatment. It substitutes for solid fuels used for cooking and eating (currently 80 percent of all household fuel consumption in developing countries is from biomass), making for a cleaner, healthier, domestic environment.

For thermal electricity generation, the greatest use of water is for cooling the turbines in power plants. Thermal power plants are the most efficient users of cooling water (they re-use the cooling water several times) and produce much less thermal pollution than 'once-through' generating plants. Although large quantities of water are used in power station cooling, most is returned to the watershed, with little contamination or evaporation.

Hydroelectric power provided 19 percent of total electricity production in 2001 (2,740 tera watt per hour [Twh]), with a further 377 Twh under construction or at the planning stage. There still remains between 4,000 and 7,500 Twh of untapped hydroelectric potential. Only one third of the total sites deemed economically feasible have so far been developed.

The use of hydropower can reduce the emissions of greenhouse gases and other atmospheric pollutants from thermal power plants, as well as minimize the pollution associated with the mining of the fossil fuels needed for them.

Presently, hydropower supplies at least 50 percent of electricity production in sixty-six countries, and at least 19 percent in twenty-four countries.

Small-scale stand-alone (not connected to the grid) hydropower schemes, defined as generating less than 10 megawatts, with fewer of the problems of large schemes but without the benefit of bulk power, can be of great benefit in the more rural and remote areas. China alone has an estimated 60,000 small hydropower schemes. Worldwide, small hydropower development is expected to grow by a further 60 percent by 2010.

In some highly arid regions of the world, for example the states of the Persian Gulf, energy is needed for water production. In this region there is high reliance on water produced by desalination. In addition, especially in arid zones, there is reliance on groundwater that requires energy for its extraction.

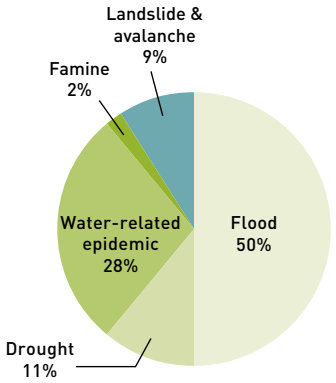
To date, developed countries are exploiting about 70 percent of their electricity potential, whereas in developing countries, the figure is only 15 percent.

Management Challenges: Stewardship and Governance

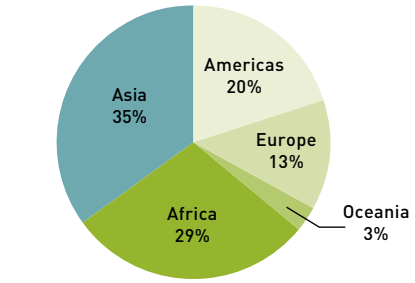
Challenge 7
Mitigating Risk and Coping with Uncertainty

Between 1991 and 2000, the number of people affected by natural disasters rose from 147 million per year to 211 million per year. In the same period, more than 665,000 people died in 2,557 natural disasters, of which 90 percent were water-related. Of these water-related disasters, floods represented about 50 percent, water-borne and vector-borne diseases about 28 percent, and droughts 11 percent. Floods caused 15 percent of deaths and droughts 42 percent of all deaths from all natural disasters. Recorded economic losses from natural catastrophes have grown from US$30 billion in 1990 to US$70 billion in 1999. These figures understate the true scale of loss, which is believed to be double or more than the recorded figures. While the figures indicate the economic impact of disasters today, they understate the impact on future social costs, e.g. loss of livelihood, etc.

The above indicates a trend of increasing natural disasters that disproportionately affect



Type of water-related natural disasters



Distribution of water-related natural disasters

Figure 5:
Types and distribution of water-related natural disasters, 1990–2001.
More than 2,200 major and minor water-related disasters occurred in the world between 1990 and 2001. Asia and Africa were the most affected continents, with floods accounting for half of these disasters.

Source: CRED, 2002.

lower-income countries. Some 97 percent of all natural disaster deaths occurred in developing countries. The number of hydrometeorological disasters (floods and droughts) has more than doubled since 1996. The very poor, the elderly, women and children are worst affected. As more and more people live on marginal land, there is increasingly greater risk from flooding or drought.

Worldwide, there is a shortage of effective disaster preparedness and mitigation methods, due to the fact that risk reduction is not an integral part of water resource management, as it has mainly been viewed as a technical problem, unrelated to the factors that force people to live in risky areas. Lack of political will has also been a factor. However, appropriate risk-mitigation investment, and the redirection of resources into prevention, offers significant economic benefits, as well as reduction in loss of life, improvements in welfare and social stability. A range of economic, institutional, legal and commercial factors are constraining more effective risk management. There is a clear link between water resources, variability and risk, and investment is needed to mitigate the risks, not least because risk constrains willingness to invest; and there are large opportunity costs of countries adapting to the effects of water-induced shocks on their economies.

Risk management has three aspects: assessing the risks, implementing both structural and non-structural measures to reduce risks, sharing risk via insurance programmes and other risk transfer mechanisms.

In the case of floods, the hazard potential is related to the magnitude and frequency of floods. It is possible to predict the probability of occurrence and to forecast flood events in real time. Mitigation measures include structural means (dams, dikes, etc.) and non-structural means (land-use planning, flood forecasting, response plans, etc.). But because floods like other disasters are not preventable, there has been real progress in the proactive and reactive strength of the emergency response communities.

Droughts, for which the onset is slow, are also associated with significant human and socio-economic losses. They are often claimed to be a result of lack of distribution, know-how, and human and capital resources in poorer regions. Mitigation can include: changing land-use practices, irrigation from reservoirs or wells, crop insurance, relief programmes, protecting priority users, etc. Longer-term measures include changing crop types, building reservoirs, building security at local and family level, and maybe even population relocation. Recent years have seen improvements in seasonal and long-term climate prediction, which facilitates drought-management practices.

Challenge 8
Sharing Water: Defining a Common Interest

Water has to be shared in two ways: between its different uses (energy, cities, food, environment, etc.), and between users (administrative regions or countries sharing a river basin or aquifer). Many regions, cities and countries rely on upstream users for water flow and any downstream user will be dependent on the action of the upstream users. Conversely, certain countries may be constrained by the demands by downstream countries. Equitable and sustainable management of shared water resources requires flexible, holistic institutions, able to respond to hydrological variations, changes in socio-economic needs, societal values, and, particularly in the case of international watercourses, political regime changes. The strategic response to the above scenario is known as Integrated Water Resources Management (IWRM) and the integration can be considered in two ways: the natural system and the human system. Integration has to occur both within and between these two categories, taking account of variability in time and space. It is understood that the watershed is the unit of management in IWRM, where surface water and groundwater are inextricably linked and related to land use and management.

Measures used to allocate water between competing uses include: national strategy and/or legislation on intersectoral allocations, tariff disincentives and targeted subsidies, abstraction management, application and enforcement of water-quality objectives, reservoir operating rules, multi-use reservoir management, multireservoir system management and reservoir compensation flow releases.

There are presently 261 international river basins, and 145 nations have territory in shared basins. Rarely do the boundaries of the watersheds coincide with existing administrative boundaries. Progress is being made through appropriate legislation and institutions. Despite the potential problem, experience suggests that cooperation, rather than conflict, is likely in shared basins. Figure 6, based on an analysis over fifty years, shows that 1,200 cooperative interactions have occurred in shared basins, versus 500 conflictual ones, and there were no formal wars. This study has pinpointed the following indicators of potential conflict:

1. internationalized basins that include the management structures of newly independent states;
2. basins that include unilateral project developments and the absence of cooperative regimes;
3. basins where states show hostility over non-water issues.

In the past fifty years, 200 non-navigation treaties for international watercourses have been signed, but remain weak for the following reasons: lack of water allocations, poor water quality provision, lack of monitoring/enforcement/conflict resolution mechanisms, and failure to include all riparian states. Recent thinking has focused on sharing the benefits of the water, rather than the water itself.

Progress in managing transboundary aquifers lags far behind, despite the massive volumes of often high-quality water involved (estimated at 23,400,000 km^3 compared with the 42,800 km^3 in rivers). A lack of international will and finance to collect the

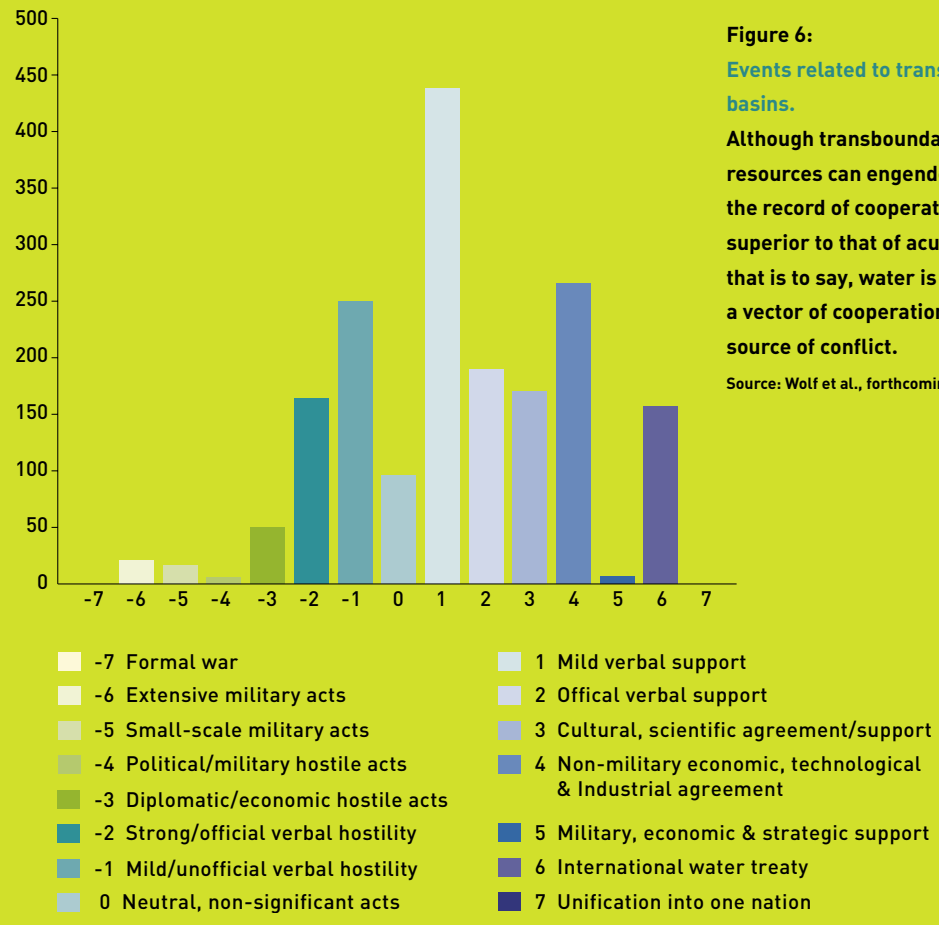


Figure 6:
Events related to transboundary basins.
Although transboundary water resources can engender hostility, the record of cooperation is vastly superior to that of acute conflict, that is to say, water is much more a vector of cooperation than a source of conflict.
Source: Wolf et al., forthcoming.

necessary information means that progress in evaluating groundwater resources and producing appropriate systems for collective management is at a very early stage.

Some established basin management structures have proved to be resilient over time and they provide us with valuable lessons on the management of transboundary waters. More likely than violent conflict is the worsening water quality or water quantity (or both), which can damage the internal stability of a nation or region and increase riparian tension. There is a need to ensure adaptable management structures, with equitable distribution of benefits and a detailed conflict resolution mechanism.

Challenge 9
Recognizing and Valuing the Many Faces of Water

Much progress has been made in the last decade in understanding that water has not only an economic value, but social, religious, cultural and environmental values as well, and that these are often interdependent. The equity concept in water use and management is well established, as is acceptance of maximizing its value among many uses, while promoting equitable access and adequate supplies. It is understood that the needs of vulnerable groups, children, local communities, people living in poverty and the environment must be fully considered when using economic instruments for allocating water. We have learned to distinguish between the value of water (benefit to beneficiaries), the price of water (charges to consumers) and the cost of supplying water (capital and operating costs of water delivery systems).

Water valuation, as an integral component of water resource management, has roles in water allocation, demand management and financing investments. However complications arise because economic tools cannot accurately estimate social/religious values, economic and environmental externalities, or the intrinsic economic value of water: most current valuation methods are too complex, there is little operational application of valuation methods, and water services are heavily subsidized even in developed countries.

The water sector's investment needs and funding requirements for water and sanitation have been estimated to range from US$20-60 billion, a lot more than is currently available. Although it is considered essential to involve the private sector in water resource management, it should be seen as a financial

Table 4:
Comparison of water pricing in developed countries.

Country	$/M³
Germany	$1.91
Denmark	$1.64
Belgium	$1.54
Netherlands	$1.25
France	$1.23
United Kingdom of Great Britain and Northern Ireland	$1.18
Italy	$0.76
Finland	$0.69
Ireland	$0.63
Sweden	$0.58
Spain	$0.57
U.S.A	$0.51
Australia	$0.50
South Africa	$0.47
Canada	$0.40

Source: Watertech Online, 2001.

Note: These figures are based on supply for consumers in offices occupying 4,180 square metres of city space and using 10,000 m³/year.

Developed countries show a wide range of variation in water pricing, ranging from the lowest cost in Canada to costs five times as high in Germany.

catalyst – not so much a precondition – for project development. Because valuing water includes social and environmental priorities as well as cost recovery, control of the assets should remain in the hands of the government and users.

In North America and Europe, water charges are widely based on full cost recovery, whereas in the lower-income countries charges are often based on running costs alone, for both water supply and irrigation. The problem of irrigation water cost recovery is often caused by poor market prices for produce and variations in these prices between different crops.

Problems in the pricing of water reflect those encountered in valuing water as listed above, in addition to the fact that:

- the different economic sectors of water use (food, cities, industry, etc.) may all be valued differently;
- the tradition of paying for water is not well established everywhere;
- it is not always practicable or economically feasible to measure actual consumption, making pricing approximate;
- the polluter pays principle often cannot be applied because of uncontrollable (legal or illegal) water pollution.

Providing financial subsidies to aid access of the poor to water is considered a 'pro-poor' strategy. Although not always successful, some of the better water tariff structures can aid the poor, as can the initial amount of free water and social security initiatives, such as the distribution of water stamps.

Challenge 10
Ensuring the Knowledge Base: a Collective Responsibility

Knowledge is accepted as one of the keys to development, improved livelihoods, environmental participation and stronger democracies. Generating and disseminating knowledge – to expand education, facilitate research, build capacity and bridge the gap between the rich and the poor – needs political will, investment and international cooperation. The knowledge base for the water industry is exceptionally broad, embracing health, agriculture/aquaculture, industry, energy and ecosystem issues. It covers the following sectors: education, medical, legal, economic, scientific, technological and management disciplines, as well as a wide range of business issues. It includes grassroots communities, industrial and business leaders, health specialists, educators, lawyers, economists,

scientists and engineers of all types, and government.

There is a huge body of information and knowledge on water, but language problems, limited access to Information and Communication Technologies (ICT) facilities and limited finances deny many people especially in lower-income countries access to such information. Much of the knowledge relates to advanced country problems and there is a marked lack of indigenous knowledge and expertise relevant to local problems, and an equal lack of appropriate research on lower-income country problems. Science education at post-secondary level is facing a severe crisis in many developing countries, and there is a growing perception that science is failing to tackle acute problems associated with water supply, sanitation, food security and the environment. Research on effective institutional structures and management techniques for lower-income countries is badly needed. Privatization is focusing research more on industrial requirements than basic holistic research.

Water education is recognized as a strategic entry point to developing a new ethic for water governance and, in Africa for example, many countries are introducing water topics to their school curricula. Overall the challenges in ensuring the knowledge base involve: expanding the capacity of lower-income countries to develop their own relevant expertise, a big expansion in the exchange of knowledge and experience among developing countries themselves (south-south cooperation), and, at the same time, ensuring the full access of lower-income countries to the global body of water knowledge.

Box 1:

The World Water Portal: a model for water information sharing and cooperation

■ The World Water Assessment Programme (WWAP), together with other water programmes and organizations, is developing the 'World Water Portal', a model for water information sharing and cooperation. This Internet portal will integrate various regional networks with the WWAP global water portal using common structures, protocols, and standards to provide seamless access to a wide body of water information. Current priorities for the development of the World Water Portal include:

- → Development of a network of reliable water information providers;
- → Development of an organizational structure that will provide technical support (metadata assistance/standards, "good practice" guidance for database and web-page development, search and database integration software, development of processes for data acquisition, etc.) ensure information quality through peer review processes (coordination/support of peer review process, discussion lists, etc.) and promote the adherence to sound information management standards;
- → Capacity-building in the area of information management and website development for partners and contributing organizations, education and training for both managers and technicians enabling them to make more efficient use of the Internet;
- → Facilitation of working partnerships via a physical and virtual network, the use of reliable information, and the improvement of integrated water resource management decisions. By accurately and consistently describing information resources, and linking to other information partners, the Portal aims to provide a valuable and self-perpetuating water information source for use by decision-makers, resource managers, researchers, students and the public at large.

■ In preparation for going global, a prototype water portal is now being developed for the Americas. If appropriate, its techniques for sharing and integrating information will provide a basis for the World Water Portal. This model will allow local, national and regional water organizations to develop the relationships and pursue the water information issues that are most important to them while contributing to the world's body of water knowledge. Other regions can then easily implement the prototype tools and technologies to rapidly expand the content and scope of the World Water Portal.

http://www.waterportal-americas.org

Challenge 11
Governing Water Wisely for Sustainable Development

The water crisis is essentially a crisis of governance. The symptoms of this crisis have been set out earlier but the causes include: lack of adequate water institutions, fragmented institutional structures (a sector-by-sector management approach and overlapping and/or conflicting decision-making structures), upstream and downstream conflicting interests regarding riparian rights and access to water, diversion of public resources for private gain, and unpredictability in the application of laws, regulations and licensing practices, which impede markets.

The governance of water occurs in situations of high complexity and uncertainty, with managers functioning in situations characterized by rapid shifts and that often necessitate them acting as agents of positive change. They have to deal with competing demands due to the many different interests related to water. Weaknesses in governance systems have greatly impeded progress towards sustainable development and the balancing of socio-economic needs with ecological sustainability.

As yet there is no agreed definition of water governance – ethical implications and political dimensions are still under discussion – although there are many water governance issues that need to be addressed (as listed in box 2). However, it is agreed that the basic principles of effective governance include: participation by all stakeholders, transparency, equity, accountability, coherence, responsiveness, integration and ethical issues. The reasons for slow progress include preoccupation with debt and deficit reduction, reduced expenditure on environment-related infrastructure services (i.e. concentration on economic growth involving devolvement of responsibility for water to lower levels of government that lack the resources and capacity to act), and government adoption of a private-sector-type business approach, without consultation with water users, and without appropriate mechanisms for public participation in decision-making. Although progress is slow, there are encouraging trends in the needed reforms, and in three areas in particular:

1. recognition of the need for sound water governance and of certain required reforms of policy and institution, plus enforcement of laws and regulation, that are essential to sustainable water development;
2. reform of water institutions and policies is now taking place in many countries, but progress is slow and limited;
3. the IWRM approach is accepted in principle, but implementation is partial in both developed and developing countries.

Water rights are a contentious issue and require more attention, possibly including decoupling water rights from land-use rights, to include equity and access to water for all. Reform in this area will be challenging. Various forms of public-private partnerships exist, and involvement of the private sector is likely to grow. To support this there needs to be a large increase in national and local private company capacity in the water sector in developing countries. There is the need, too, for good regulation and for the required investment to provide for it. Community-based delivery systems – including user associations, NGOs and local communities – have considerable potential. Their local knowledge and networks are key assets for effective and equitable service delivery, but they often lack funds, institutional capacity and have limited membership. In addition, they face difficulties of replicability and scaling up of good practice.

Reforms of water governance typically take place following power-sector reform, and frequently take advantage of the synergy of political and economic liberalization. Correct selectivity and sequencing of the reform is important, and reform can only be made when there is demonstrated national and local political leadership.

The achievement of more effective water governance requires the reform and implementation of water policies and institutions. Issues to be addressed include conflicting property rights and fragmentation of institutions, and the facilitation of efficient public- and private-sector initiatives and public participation. Regulatory regimes must allow clear and transparent transactions between stakeholders in a climate of trust, together with shared responsibility for safeguarding water resources. Reform in the water sector alone is not sufficient. Water resource issues are complex and transcend the water sector. Policies related to, for example, macro-economic development and demography, should take account of the impacts and effects on water resources and their uses.

Box 2:

Taiz water management planning: possibilities for rural/urban conflict resolution.

■ In recent years, efforts have been made by the National Water Resources Authority (NWRA) in Yemen to minimize these social and political conflicts by implementing a system of water transfers from rural to urban communities in the Taiz region within the context of IWRM. Key features of this system included both demand management measures (such as input taxation and raising of public awareness) and social measures (through definition of a regime of tradable water rights). It was felt that demand management measures would only make a meaningful contributions towards achieving the objective of sustainable water resources management if adopted in conjunction with these social measures.

■ Defining a system for rural-urban water transfers called for detailed consultations with the local rural communities, particularly farmers, who frequently have little faith in the institutions engaged in the consultative process. Discussions often led to heated arguments. Nevertheless, the process continued over more than three years. The process was considered as a valuable opportunity for confidence-building and special efforts were made to ensure that dialogue break down at any stage. There were many rounds of discussion, sometimes with large groups of farmers, at other times only with influential community leaders. Each round of discussion built upon the issues and concerns raised in the previous round.

■ The end result was that communities agreed to the following main principles for rural-urban water transfers:

- → There should be clearly defined rights, taking into account ethical considerations such as priority for drinking water needs.
- → Except for water needed for drinking and basic needs, water should be allocated through market-like processes.
- → Water rights should be tradable and, to the extent possible, there should be direct compensation of individuals willing to transfer their water rights to others, which is commensurate with the rights transferred.
- → Water transfers should be verifiable. Those who agree to transfer their water rights must reduce their water use accordingly.
- → The local communities should participate in designing the rules and mechanisms to govern rural-urban transfers, including a mechanism for monitoring compliance and punishing violators.
- → NWRA should have an oversight role in rural-urban transfers to ensure resource sustainability and equity.

Source: UNDESA. Prepared for the WWAP.

Pilot Case Studies: a Focus on Real-world Examples

Seven case studies of river and lake basins have been used to illustrate the very different water scenarios that exist in the world today. These include examples from advanced, middle-income and lower-income countries, of transboundary basins, high-altitude and low-altitude situations, of densely populated and sparsely populated basin areas, as well as of locations in both tropical areas and a cold, northerly setting. Collectively these case studies provide a good overview of the range of water challenges confronting humankind as we begin to grasp the nettle of water-sector reform, improved water management, and possible solutions.

The pilot case studies appearing in this first WWDR are the Chao Phraya River basin (Thailand), the Lake Peipsi/Chudskoe basin (Estonia and Russia), the Ruhuna basins (Sri Lanka), the Seine-Normandy basin (France), the Senegal River basin (Guinea, Mali, Mauritania and Senegal), the Lake Titicaca basin (Bolivia and Peru) and Greater Tokyo (Japan). Each one faces very specific challenges.

- **The Chao Phraya River basin** faces the challenge of trying to unify a very fragmented water management system and is introducing a new water law.
- **Lake Peipsi/Chudskoe** is subject to eutrophication and other pressures, but is gearing up to meet new standards when Estonia enters the European Community.
- **The Ruhuna basins** are devising ways to cope with water stress due to seasonal variations and increased demands from irrigation and hydropower.
- **The Seine-Normandy basin**, despite many improvements in recent years, still suffers from nitrate pollution and the loss of valuable wetlands.
- In the **Senegal River basin**, construction of dams has proved a mixed blessing – providing year-round water for agriculture, but also bringing problems for health and aquatic ecosystems.
- In the case of **Lake Titicaca**, the challenge for Peru and Bolivia is the management of a basin area inhabited by very poor indigenous people whose traditional values and way of life must be accommodated within any water resource scheme.
- Lastly, in **Greater Tokyo**, the heavily populated metropolitan area is subject to floods and other natural disasters. Management challenges include risk mitigation and public awareness activities.

Fitting the Pieces Together

The eleven challenges that have shaped the structure of this first WWDR have a high level of political ownership. They were launched by the Ministerial Meeting at the 2nd World Water Forum. They have been embraced by WEHAB, the framework highlighted by the 2002 World Summit on Sustainable Development, as integral to a coherent international approach to sustainable development. And they coincide with the departmental responsibilities of many governments. They are, of course, of recent origin as a structure for analyzing the water sector and they can be linked together and viewed through different lenses, such as sustainable development, the Poverty and Action Framework, and others.

At the country level, the water situation varies enormously. Substantial water and other relevant information is available for many countries, from many sources, and

this has been used to make a country-by-country analysis of their key water sector characteristics, as well as their progress towards meeting the Millennium Development Goals.

Looking at the effects of the various challenge areas, it is plain that while the negative impacts of each challenge on the poor are bad enough in and of themselves, the brutal truth is that the really poor suffer a combination of most, and sometimes all, of the problems in the water sector. A moment's thought about this brings home the extent to which the water crisis is truly about the blighted lives of the world's poor.

A review of progress towards overcoming the problems of the water sector is not, so far, very encouraging. Yes, many actions have been started, but to take a charitable view, they have not yet yielded the needed results, although they may in the years to come.

Many targets have been set over the past thirty years and will continue to be set. However, experience over this period shows a consistent pattern of failure in achieving those targets. An analysis of the magnitude of the task, for example, shows just how enormous the challenge is: to meet the water supply and sanitation targets, 342,000 people will have to be provided with sanitation every day until 2015.

Will water availability be a constraint to target achievement? Maybe; we do not really know. One of the great unknowns is the extent of humankind's capacity to adapt. Note that the Jordanians, for example, can survive on a per capita water availability of a mere 176 m^3 per year, far below the minimum specified as absolute water scarcity. Reform and liberalization of the water sector, better valuation of water, and more private-sector involvement, could bring forward new technology and ways of operating, which, allied to our capacity to adapt, could enable us to muddle through.

This, however, is to take an optimistic view. The realist would have to say that, on the basis of the evidence put forth by this first WWDR, the prospects for many hundreds of millions of people in the lower-income countries, as well as for the natural environment, do not look good.

Afterword

This first edition of the WWDR has thus brought together twenty-three agencies in the UN system and other entities concerned with freshwater issues. In addition, many governments have participated, making valuable contributions to the report.

Future issues of the WWDR will build on the partnerships already forged between UN agencies and with governments. In addition, and increasingly, non-governmental and intergovernmental organizations will contribute, as will the private sector, regional financial institutions and academic organizations.

The WWDR will remain an integral part of the World Water Assessment Programme. This programme is scheduled to include the integration of relevant databases within the UN system and within countries. Furthermore, the WWDR will be incorporated into a major Water Portal on the worldwide web and become a 'living document', to be updated and expanded over the years ahead. Emphasis will be placed on the further development and application of indicators, and continued monitoring of progress towards the realization of targets will be vigorously pursued.

Above all, there will be an increased emphasis on building national capacities to make effective reporting of progress, at both country and local levels. For, when all is said and done, it is action at the local level, improving the lives of real people, which counts the most.

Let this first WWDR, then, be a rallying call for all of us to work together to make the world a better place for everyone, but especially for those who are most in need.

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