

*Special Feature on Groundwater Management and Policy***Freshwater under Pressure**László Somlyódy<sup>a</sup> and Olli Varis<sup>b</sup>

Most parts of the world are facing escalating difficulties in meeting the growing demand for freshwater, while at the same time they are confronted by a deteriorating supply of this precious resource. Decisions and attitudes concerning human development, institutional frameworks, water and wastewater infrastructure, and other technological issues—given economic and social constraints and environmental and social imperatives—present challenges with no simple answers. The water issue involves much more than just irrigation, hydropower, the environment, water supply, and sanitation. Besides science and engineering, it encompasses political, social, environmental, economic, and institutional dimensions. Therefore, more of a focus is needed on the multidisciplinary and integrated nature of the water sector, and freshwater should be considered in closer connection to these many dimensions for more effective policymaking. In order to do so, comparative, cross-sectoral work is essential. Coping with these interdisciplinary issues and the accompanying uncertainty and complexity presents methodological challenges. This paper discusses major freshwater-related challenges such as availability and vulnerability, water quality and groundwater impacts on various scales, extremes, and shared water resource issues. Also, driving forces such as economic underdevelopment, poverty, low human development, food insecurity, unbalanced globalization, and others are analyzed. Some of the important tools of integrated and sustainable policies are discussed, and recommendations are made from the perspective of recent international agreements, with a focus on opportunities as well as the many shortcomings and barriers involved.

*Keywords:* Sustainable development, Environment, Water, Groundwater, Integrated management, Poverty, Population growth, Climate change.

**1. Introduction**

Water is one of the most strategic of natural resources. It is intertwined in the everyday life of human beings in myriad ways, and its importance as a driver of health, food security, and quality of life, and as a pillar for economic development is unique. As water affects all human lives, we are also affecting our planet's hydrological cycle in all dimensions, from the very local to the global scale. For instance, the production of one kilogram of grain consumes 1,000–4,000 liters of water, and food production (although still not enough to feed all of humanity) already accounts for 90 percent of water use in developing countries. And while electricity produced through hydropower by damming rivers evokes grand emotions, sustainable energy production remains among the cornerstones of economic development. At the same time, the damage caused by floods and droughts continues to escalate—a small demonstration that human impact on ecosystems can be catastrophic. Besides its other intrinsic

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values, water is also largely a political good, since the bulk of humanity lives in river basins shared by two or more nations.

Water is the backbone of the economy of many countries of the world. Water resources provide the foundation of the agricultural sector, much of the energy sector, an important part of urban infrastructure, health care, and in many other functions of society. But while economic growth is desperately needed in poverty reduction, growth alone is not sufficient. The poor must benefit; otherwise, growth only polarizes economies. Water's role is crucial in this complex interplay. Besides being an important fundament to many economic sectors, water is also key to meeting many basic human needs that are, in turn, instrumental in poverty reduction.

The objective of this analysis is to elaborate, analyze, and discuss systematically the global and local connections between water and development. While doing so, water's many roles are echoed in achieving the concurrent development paradigms such as the Johannesburg Plan of Implementation and the United Nations Millennium Development Goals (MDGs), which both came out of the 2002 World Summit on Sustainable Development (WSSD). Of particular interest is the crosscutting role of water in development.

Water is often considered a sector by itself, but this view provides only a very limited appreciation of water, as it is also a crucial component in several other sectors. For instance, the theme of water flows fluently through all the MDGs, not just in the one that implicitly mentions water.

The structure of this paper is as follows: First, an outline of the water problem on this planet is presented with an emphasis on the scale, complexity, and multidisciplinary nature of the issue. Then the major global-scale driving forces of water management are summarized. A description follows of major, internationally agreed management and policy principles, as well as technologies available for more sustainable management of water resources. Finally, a set of concluding remarks is presented.

## **2. The water problem on various scales**

### ***2.1. Freshwater availability and vulnerability***

The root of the problem of water availability in a broad sense is population growth, which is associated with the over-consumption of resources, including both renewable and non-renewable ones. This is driven by the growth of the human population of the Earth, which has increased by five billion over the last century and may exceed nine billion by the year 2050. This growth characterizes the developing world and is increasing the economic and social disparity between North and South. For example, in 1991, the richest one-fifth of the world produced 84 percent of the global gross domestic product (GDP), while the poorest one-fifth produced only 1.4 percent (UNDP 1992).

Water use has grown almost two times as fast as the population in the past several decades; freshwater consumption grew at a rate of around 80 percent between 1980 and 2000. The population of the Earth now struggles to different extents with problems related to an insufficient amount of water. As a rule of thumb, it may be said that if per capita water supply is less than 1,000 cubic meters (m<sup>3</sup>) annually and

use exceeds 60 percent,<sup>1</sup> then effective water management is extremely difficult due to the physical constraint of water availability called scarcity.<sup>2</sup> In the early 1990s, only 4–6 percent of the total population lived under such circumstances (but, for example, 20 percent could not access safe drinking water for economic reasons), primarily in North Africa and the Arabian Peninsula (Kulshreshtha 1993) where availability may not reach 200–300 m<sup>3</sup> per year (Shiklomanov 1999). Availability is also very low in North China and South Asia, and the observed trend of the past fifty years is alarming. According to analyses based on national and regional data, the already large unevenness of water availability distribution over the Earth increases with time, and by 2025 in poor African and Asian regions, where population doubles in many countries in about 20 years, this ratio may increase almost ten-fold (Kulshreshtha 1993; Shiklomanov 1999). Estimation depends greatly on scenario assumptions, including socioeconomic development and climate change impacts on supply and demand. They all show a strong spatial variability and can be calculated only with high uncertainty.

The problem occurs more and more seriously as a result of accelerated urbanization, which is epidemic in most developing countries (Varis and Somlyódy 1997). The number of inhabitants living in towns doubled between 1970 and 1990. By 2025 it could reach the total global population of 1995,<sup>3</sup> while the number of people living in rural areas seems to have stabilized.

Managing the infrastructure of fast-growing urban areas is chaotic, making it a challenge to design and difficult to respond quickly to demand. The consequences are commonly the over-exploitation of groundwater (e.g., China), a high number of epidemics (e.g., Africa and the Middle East), lack of adequate storm water drainage, and exposure to floods (e.g., Southeast Asia). Another frequent impact of this “urban pull and rural push” is the impoverishment of the countryside and increasing soil salinity, groundwater contamination, and need for irrigation. Presently, more than one billion people rely on unsafe water supplies and 2.6 billion live without proper sanitation (WHO 2004). About half of the population in the developing world suffers from diseases such as diarrhea, schistosomiasis, and trachoma. Malaria alone kills one million people each year, most of them in Africa. About 1.4 million children die annually before the age of five, primarily in Africa and Southeast Asia (WHO and UNICEF 2004), and poor water and sanitation is the biggest killer. According to the World Health Organization, in Asia, Latin America, and Sub-Saharan Africa, 65 percent, 86 percent, and 100 percent, respectively, of wastewater goes untreated (WHO 2004).<sup>4</sup> This number can grow significantly unless the MDG initiative is able to halt and reverse this negative trend.<sup>5</sup>

Estimations of water availability rarely deal with the question of what share of the resources will become “hopelessly” unusable as a result of pollution.<sup>6</sup> According to analyses, the cost of satisfying water quality-related development needs (which mostly appear in developing countries) might be as

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1. Often 40 percent or an even smaller value is also applied.

2. Different authors use different criteria for classifying the range from abundance to scarcity to illustrate the magnitude of the problem in the frame of regional and global assessments (e.g., Kulshreshtha 1993; Shiklomanov 1999). The real issue on the national scale is more severe due to seasonal and spatial variabilities (floods, droughts, and uneven distribution).

3. It is estimated that 60 percent of the world’s population will live in urban areas by 2030 (United Nations 2002).

4. The percentage of population with a flush toilet connected to a sewer is 14 percent in Asia, 50 percent in Latin America, and 8 percent in Sub-Saharan Africa.

5. See section 4 for more details.

6. The availability of water quality data for the developing world is alarmingly poor (UNEP 2003).

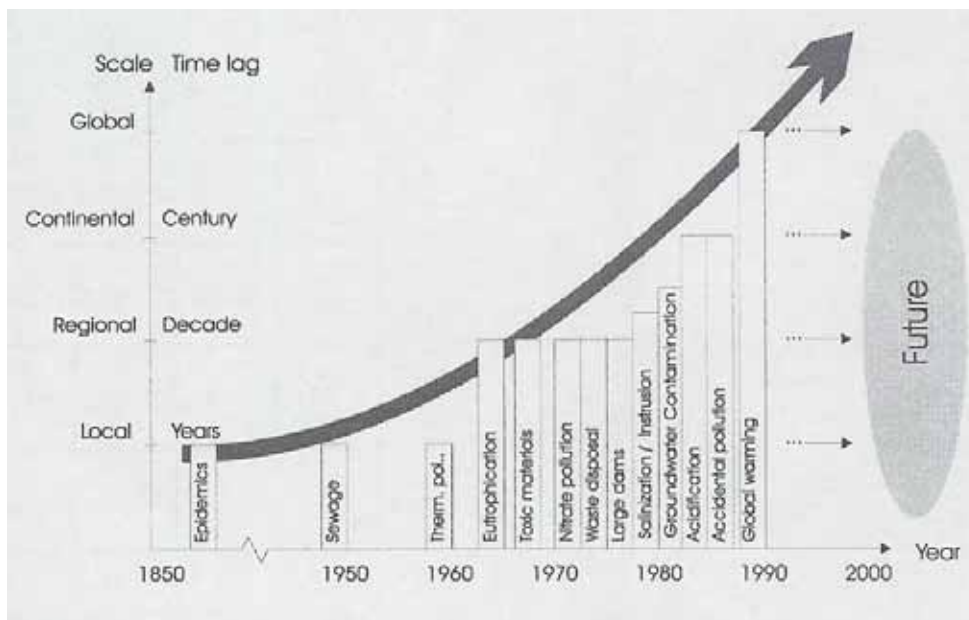
high as US\$2 trillion. And the total investment cost associated with water management needs (industry, agriculture, flood control, etc.) is approximately three times higher. Assuming a 30-year implementation period, \$200 billion in aid would be needed annually for the developing world (Cosgrove and Rijsberman 2000). The interrelated question is dual: From where can this huge budget be gathered? And how can the institutional and other conditions of efficient financing be created within such a short period of time?

Also, considering that great bulks of money have been spent on water and sanitation over the past three decades—with far too little progress—there are even more important interrelated questions to answer (WSSC 2004). How to proceed with education, capacity building, and institutional reforms? How to follow new approaches? How to work more closely with local communities and meet their needs?

Recognition of the global challenge to effectively manage water resources is reflected in the efforts of international organizations, various initiatives, agreements, and declarations (some milestones are discussed in section 4). In 2000, broad concern within the United Nations on severe interrelated global problems led to the formulation of the MDGs in which the main water-related target is to halve the proportion of people without sustainable access to safe drinking water and sanitation by 2015 (with 1990 as the reference year).

## 2.2. Water quality

Figure 1 is a simplified illustration of a broad range of water quality problems.



**Figure 1.** Trends in water quality issues

Source: Somlyódy 1995 and Somlyódy et al. 2001.

Note: Ther. pol. = thermal pollution.

The following trends involving water are now more or less evident:

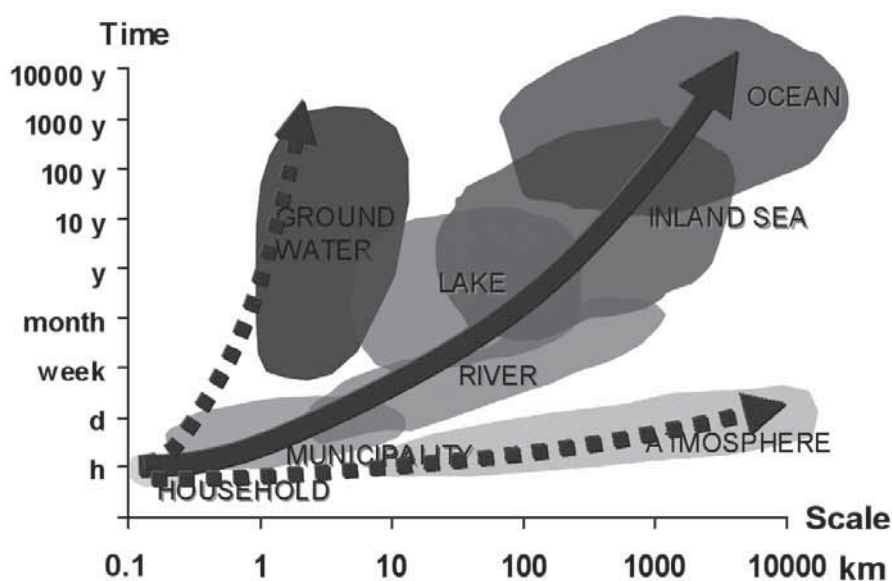
- The scale of problems is increasing from local to global.
- As a consequence of pollution of sediment, soil, and groundwater, the impacts as well as results of possible remediation appear after a significant delay.
- At any given location several superimposed problems have to be addressed, which is not an easy task—especially if unforeseen effects are considered.
- Newly emerging issues must be constantly faced, such as the cryptosporidium outbreak in Milwaukee in 1993, potential epidemics as a result of long-distance flights, surprising transmission of certain blue-green algae (see box 1), unforeseen climate change impacts, and others. While first-generation health problems maintain a high mortality rate in the developing world (see section 2.1), second-generation health hazards in the developed world must be addressed, such as those caused by blue-green algae toxins, the effects of the several thousand organic compounds synthesized annually, persistent organic pollutants (POPs) and natural organic matter (NOM), synthetic steroids, remains of medical components such as simple pain killers, and other materials containing endocrine disrupter substances (EDS).
- Here several difficulties exist. Many of the “modern” pollutants occur in such a small quantity and unknown composition that they cannot be monitored. Health impacts and ecological risks are rarely known. Many of these pollutants are neutral to wastewater treatment and traditional water treatment. Moreover, they are often spread via food products.

From figure 1 it is obvious that when global water problems are discussed, in fact, two classes should be distinguished. The first is caused by globally transported pollutants. Here, greenhouse gases, their quantity and quality impacts (see also later), as well as global transportation, should be mentioned. The second can be called “universal” issues that have scales smaller than global. Most of the problems described in figure 1 belong to this category, which may occur similarly everywhere, depending on site-specific conditions.

### Box 1. Globalization and the dominating algae of Lake Balaton

Lake Balaton is one of the largest shallow lakes in Europe. It is the most important recreational site and national asset in Hungary. From the late seventies to the mid-nineties, the dominant algae was *Cylindrospermopsis raciborskii*, a nitrogen-fixing blue-green species originating in deep lakes of tropical Africa. This invasive species then migrated to Indonesia and Central America. Australian rivers of extreme water regimes might have been the second evolutionary area of the cyanobacteria, which survives by generating spores. This latter capability multiplied its resistance. Subsequent transmission probably took place via birds to India and the Caspian Sea, then leading to the lower Danube River and Hungarian waters. *Cylindrospermopsis* became suddenly and surprisingly a vast problem in the eutrophicated Lake Balaton in 1982. This was appropriately handled by reducing phosphorus loads by about 50 percent, which led to a low trophic status similar to that of the early seventies. At present, *Cylindrospermopsis raciborskii* is surprisingly going on a rampage in Germany under significantly cooler conditions than in the tropics, and the impression is that, again, via birds it is moving to south. (Perhaps back to Kenya?)

One of the major reasons for the tendencies observed in figure 1 is the escalating trend of opening up of material cycles of nutrients, heavy metals, and several other compounds. This tendency leads to transport and accumulation of these compounds to locations where they do not belong and where they cause increasingly more harm to humans and ecosystems at a larger and larger scale. A classic example is the flush toilet. Its typical timescale is a few seconds, but its impact can appear via rivers, lakes, and inland seas or the oceans over hundreds of years or may even cause permanent changes. The following three transport paths are possible: (1) via surface runoff; (2) towards groundwater with potentially huge residence times; and (3) through the hydrologic cycle via the atmosphere, often on continental scales (figure 2) (Somlyódy 2004). These three paths are obviously in interaction with each other; originally very local water quality issues grow to complex, large-scale environmental problems.



**Figure 2.** Transfer paths of pollutants due to opening up of material cycles

*Notes:* (1) Closing water and material cycles are preconditions of sustainability. (2) Logarithmic scale is used.

Some of the trends observed today are likely to continue (Somlyódy et al. 2001); however, many features of future freshwater issues are unknown and uncertain, as was the case in the past. Could we have foreseen the present state of freshwater management 20 or 30 years ago?

Learning from the past may help us to think and act in a more precautionary manner and more innovatively and cautiously. The major lesson is that in the future an even larger number of problems of often-unknown nature may appear jointly, and there is no uniform strategy to follow. What is certain is that end-of-the-pipe actions and traditional methods alone will not lead to effective solutions. If we consider nano- and micro-pollutants such as POPs and NOMs, synthetic steroids, and other EDS materials, we do not believe that the development of sensitive analytical techniques, fate assessments,

and treatment methods will solely lead to feasible solutions. On the contrary, it is likely that many related processes will remain unexplored scientifically. Thus, there is a definite need for a new era of clean production technologies, source and consumption control, and land-use management, as well as advanced legislation, including the use of extended environmental management systems on various embedded scales. In a somewhat broader sense, the tendency to move outside the scope of traditional water management should be continued in order to tackle the many emerging issues.

### **2.3. Groundwater**

Groundwater is one of the major freshwater resources serving domestic and municipal supplies and irrigation. Groundwater accounts for 20 percent of global withdrawals and supplies about 1.5 billion people with drinking water (UNEP 2003).<sup>7</sup> The importance of groundwater as a reliable water source can only increase, given forecasted future demands. In many locations, demand is already outpacing supply, and groundwater aquifers are being over-pumped (Somlyódy et al. 2001).

There are many examples that could be cited,<sup>8</sup> but take Beijing, China. In the 1950s the water table was within five meters of the earth's surface in many locations, but nowadays more than 40,000 wells draw from depths of more than 50 meters. Another example is the Middle East region. Israel draws a major portion of its water from just two aquifers, a controversial issue as they are now stretched to their limits and experiencing pollution problems (Shuval 1992). Israel was over-drafting groundwater aquifers by 200 million m<sup>3</sup>, but it realized the non-sustainability of this practice and has struggled since 1991 to halt the practice of over-pumping. The third example comes from India, where the use of groundwater for irrigation has been booming in past decades. The number of tubewells used for this purpose has grown over twenty-fold in 40 years. Besides economic growth and poverty reduction, this has led to wide-reaching environmental problems, comparable to those mentioned above in the cases of North China and Israel (Mukherji and Shah 2004).

One alarming water pollution problem is the worldwide contamination of fragile groundwater resources. Groundwater has proven to be a clean and reliable water source, but it is often threatened due to the careless disposal of organic and chemical wastes. This not only ruins water quality but also reduces the long-term filtering capacity of the soils through which it travels. Although it has been the topic of intensive research during the last few decades, groundwater continues to be contaminated through both point and non-point pollution sources worldwide. As attention is drawn to groundwater contamination in the industrializing and developing countries, the astronomically high-cost remediation schemes of the West are probably not transferable to these financially strapped regions (Simons 1994). Are there alternatives or will contaminated aquifers simply have to be abandoned in the future?

Another big groundwater problem occurs in the vadose (unsaturated) zone, which traps contaminants in the soil matrix and reduces their flux to the groundwater below. Soil-buffering capacities are high, and toxins can be suspended within the soil for long time periods without their effects being observed. Biological, physical, and chemical processes act on contaminants within the unsaturated zone to create a

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7. For instance, in the former USSR, 60 percent of the towns are supplied exclusively with groundwater. In Hungary, 95 percent of the drinking water supply comes from groundwater.

8. Texas, California, Mexico, Saudi Arabia, India, Indonesia, the Bangkok region, Vietnam, Africa, etc.

continual source of contamination to the saturated water below (Elgersma et al. 1991). One example is the toxic heavy metal, cadmium (Piotrowski and Coleman 1980).<sup>9</sup> It is often found bound within the soil matrix of irrigated croplands that have seen years of cadmium-laced phosphate fertilizer application. Cadmium's leaching rate (downward movement to groundwater) is reduced at higher pH values, which is often the case in agricultural lands where fertilizers with high pH values are used. If agricultural practices are halted and fertilizers are no longer applied, the pH within the upper soil layer will begin to decrease. This increases cadmium's leaching rate and groundwater contamination is inevitable.

Thus, a positive environmental action within one system (reducing the impact of agriculture on the environment) becomes negative for another (cadmium contamination of groundwater). An expensive alternative to this dilemma is the artificial application of lime to maintain high pH values within the upper soil layers. The land remains inactive from an agricultural standpoint and the cadmium remains bound in the upper soil matrix (Stigliani 1994), but what is the best alternative for protection of all components of the ecosystem in this case?

#### **2.4. Extremes**

Too much water and too little water (i.e., extreme events such as floods and droughts) cause fundamental problems of water resources management. They are a result of the variability of the hydrologic cycle as influenced by climate change and alterations in land-use patterns. Floods belong to the natural disasters category. They are considered a severe risk factor and can cause tremendous economic losses. Droughts limit water use, primarily irrigation, and can result in serious damages in agriculture, energy production, tourism, and other sectors. Both appear in interaction with many other water- and environment-related issues.

According to data provided by insurance agencies, about 6,000 natural catastrophes were registered in the world between 1988 and 1997, of which 35 percent were floods with more than 200,000 victims (IFRC 2002).<sup>10</sup> Damage from natural disasters is estimated at about \$700 billion, one-third of which stems from floods. Severe, often record floods characterized the last decade of the twentieth century in about twenty countries, including Australia, Bangladesh, India, Canada, China, Somalia, the United States, and many European countries. In Europe, about 100 significant devastating floods occurred, resulting in 4,000 deaths and close to \$100 billion in losses (Szlávik 2001). The number of flood (and drought) disasters appears to be growing (IFRC 2002). This is also suggested by the first few years of this century, which have witnessed extreme floods in Central and Eastern Europe. In 2003, many Latin American countries suffered from floods and/or droughts (UNEP 2003). In West Asia, seven years of drought were followed by record rainfalls in 2002 and 2003, which caused heavy flooding.

A major challenge is due to climate and land-use change impacts. As suggested by hydrological studies, global warming would lead to more significant alterations in extreme events than in average and seasonal conditions (Shiklomanov 1999). In other words, increasing floods and more frequent

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9. Mercury is recently being considered as an increasing global threat, having a larger worldwide risk than earlier assumed (UNEP 2003).

10. According to the International Federation of Red Cross and Red Crescent Societies, the number of affected people may reach two billion (IFRC 2002).



occurrence of severe droughts simultaneously should be anticipated. At the same time, the critical use/availability ratio would also negatively change. These impacts can have serious economic and ecological consequences, and subsequently require re-thinking of future flood control, river regulation, reservoir planning, and the identification of irrigation areas. The complexity of the broad range of the possible problems is illustrated by the case study of Lake Balaton (box 2).

### Box 2. Droughts and Lake Balaton

In spite of an unchanged and insignificant water consumption pattern, a severe water shortage was experienced at Lake Balaton early 2000 due to a series of extremely dry years, which caused the water level to drop by more than half a meter (close to 20 percent of the average depth). Unpleasant consequences included degradation of beaches, a proliferation of macrophytes and attached algae in the near shore zone, and difficult access to harbors for sailboats. It was felt that the transfer of water from another watershed was necessary. A comprehensive assessment made in 2003 drew the following conclusions (Somlyódy and Honti 2005):

- The present ecological status of the lake is good and does not justify any interventions.
- Large water level fluctuation due to natural variability in rainfall, runoff, and evaporation has occurred in the past. Nonetheless, the long-term average water balance of the lake is positive and thus the water level will be rehabilitated.
- An examination of meteorological and hydrological data revealed that no climate change impacts could be detected.
- The stochastic hydrologic generator developed on the basis of observations for the past hundred years indicated that water level recovery needs a time period of between four months and three years. The lake will fill up even if the climate change impact is twice as large as assumed by climatologists.
- The present extreme event occurs, say, once in two hundred years. If climate change is assumed, this may happen once in about thirty years.
- Water transfer may seem to be a good idea to prevent future negative changes; however, the detailed assessment shows that it would result in ecological risks (change of the chemical composition of the lake's water, increase of the external and internal nutrient loads, enhanced algal growth, proliferation of invasive species, etc.) and no benefits. Thus, it is wiser not to interfere and to adjust human needs to the lake's condition.

Nearly two years have passed since the completion of the study. Monitoring data have verified that the conclusions of the assessment were correct; the lake has even filled up a little faster than suggested by the "average" hydrological scenario.

## 2.5. Shared water resources

Water has historically been the source of many well-known social, economic, and human conflicts; this will likely escalate further in the foreseeable future. Disputes over water can lead to wars, and water in wars plays an important, strategic role.<sup>11</sup> International conflicts are primarily connected to shared river basins. Well over half of the world's population lives in such areas (Jordan, Ganges, Nile, Zambezi, Amazon, Rhine, Danube, Black Sea, and Baltic Sea, etc.). Therefore, it is envisaged that water management in shared basins is one of the key challenges of the twenty-first century. Similar to many other areas of resource management, however, the implementation of relevant conventions is often

11. In the Iraq war, for example, the most important logistical task was to solve the problem of supplying water to half a million soldiers in the desert.

missing; political, institutional, and enforcement conditions are rarely agreed upon internationally. Recently, however, Europe has shown significant progress in this respect with the approval of the EU Water Framework Directive (EU WFD) in 2000, which provides a unified future water policy for EU member states and accession countries. It defines (now for 25 member countries) many specific actions and their scheduling—together with supporting directives—which include measures related to transboundary basins. Unlike with many environmental agreements, there is a strong political will to implement the EU WFD (see section 4).

### 3. The broader picture: Driving forces

Until now in this paper, water problems were primarily dealt with as they arose. The purpose of this section is to look for the causes in a broad sense and to frame the water resources challenges at the global level by reviewing the major trends in critical external forces that drive development (figure 3). They will be discussed one by one, with special reference to their contemporary and future impact on freshwater management.



**Figure 3.** Critical externalities of water resources development in South Asia

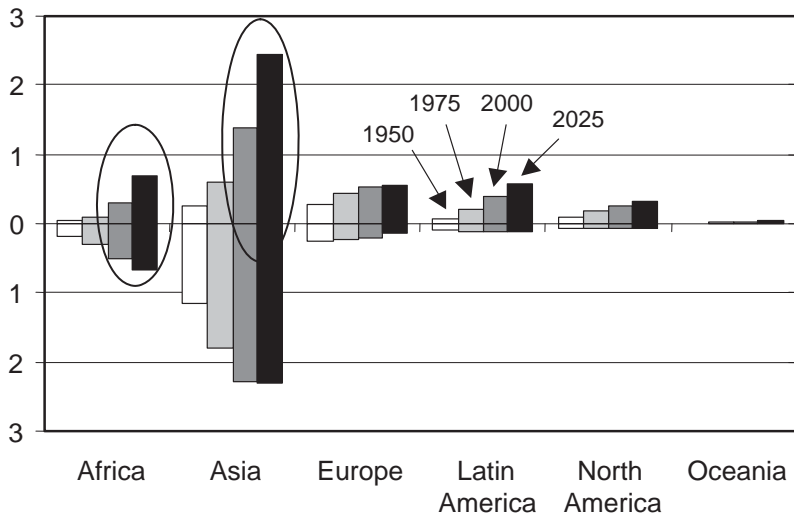
Source: Varis 2005.

#### 3.1. Population growth and urbanization

High population growth is a fundamental cause of the growing pressure on natural resources. Fertile land, clean water, and most other natural resources are becoming increasingly scarce. Excessive population densities in large parts of Asia and, to a certain extent, in other continents place unique stress on the environment. The associated poverty problem implies that many of those regions are bound and will continue to be bound to relying very much on local solutions in meeting their basic needs such as

food supply. For the purpose of comparison, consider that 90 percent of Chinese live in areas with a population density of over 350 persons per square kilometer (km<sup>2</sup>), while the density in Bangladesh is 935 persons per km<sup>2</sup>, on the island of Java in Indonesia it is 870, and in the Netherlands it is 457 inhabitants per km<sup>2</sup> (World Bank 1999). Obviously, extremely land-scarce areas must be able to keep their mushrooming cities alive.

Urbanization is actually seen today as an even more problematic issue than population growth, particularly with respect to freshwater. Almost all population growth is now occurring in cities (figures 4 and 5). This will be a big issue for most individuals in coming decades, as well as when considered as a driving force in any aspect of humans and their environment—be it nature, social development, or the economy. Globally, rural and urban populations are now equal in size. It is estimated that by 2025, the rural population will no longer be growing. In China alone, the urban population will likely grow from 500 to 850 million from 2000 to 2025 (United Nations 2002).



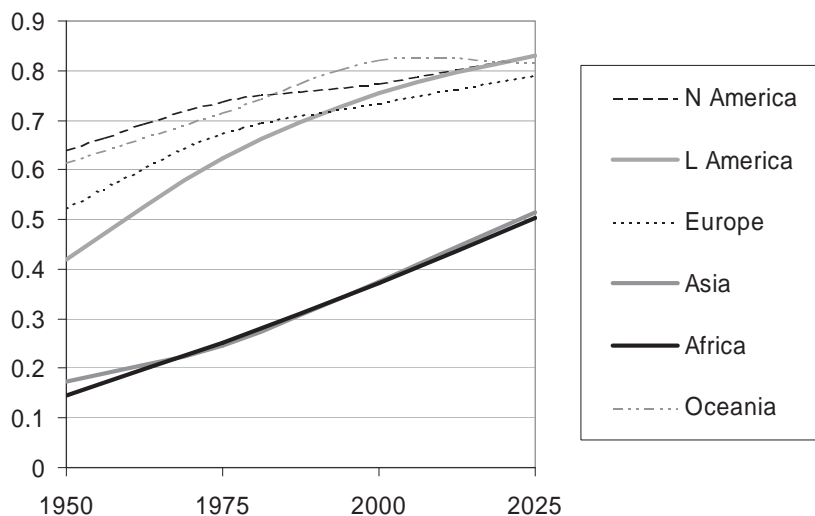
**Figure 4.** Rural (below) and urban (above) population (in billions), by continent

Source: United Nations 2002.

The growth of cities’ immense needs for water and food is rapidly challenging all aspects of the water sector, and agricultural productivity must grow sharply. This cannot take place without massive improvement in irrigation efficiency and infrastructure; however, arable land area as well as the rural labor force will remain very much on the same level as before (according to all projected future scenarios).

Growing urban centers will face enormous problems in ensuring adequate water supply and sanitation for their inhabitants, and thus urban water infrastructure should be prioritized more than ever. Whatever comes to progress in the sanitation situation, most developing countries have a long way to go until their

citizens can enjoy safe sanitation. Obviously, the water supply and sanitation situations should be developed hand-in-hand in order to achieve the best results in public health and environmental protection, but too often development has not been in balance.



**Figure 5.** Urbanization by continent (proportion)

Source: United Nations 2002.

### **3.2. Economic underdevelopment, poverty, and low human development**

Poverty reduction has found its way onto almost all national and international development agendas. Although the definition and estimates of the number of those living in poverty vary greatly, roughly one-fifth of mankind is typically classified as being poor.<sup>12</sup>

A simple thing to a layman (but not so obvious to the experts) is the fact that many water problems go hand-in-hand with the poverty problem. Those exposed to malnutrition, inappropriate water and sanitation services, and so forth are very often the same individuals who have been classified as poor under various indicators. Another dimension is the ability of nations to finance the huge needed investments to improve water infrastructure to an adequate level.

Private-sector involvement has been debated and proposed as one solution to the financial problem, yet who would invest massively in a sector with such a low rate of return? In India, for example, the rate of cost recovery in multi-purpose river valley and irrigation projects is only around 13 percent, whereas it is not higher than 2 percent in small-scale irrigation schemes (SASTAC 2000).

It is often argued that people-centered development provides many solutions that cannot be realized using contemporary resource-based approaches. Empowering people to help themselves, raising public

12. One of the eight MDGs is to halve the incidence of poverty from the 1990 level by 2015. Poverty has many definitions, but the MDG comparisons most often use the definition of earning less than one dollar per day.

awareness, and enhancing public participation are all important keys to overcoming limited financial capability vis-à-vis requirements. But the limits of people-centered development become rapidly apparent if insufficient systematic education of the people is provided. Education has been shown many times to be the real booster to both economy and people-centered development, and it links in myriad ways to the management of water and the solution of water sector challenges.

### **3.3. Food insecurity**

Approximately one out of every six human beings suffers from food insecurity. Although global food security projections suggest better days to come, the optimism is largely based on the assumption that low-income countries will increase their food imports, their economies will grow steadily, and their food markets will remain stable (IFPRI 1997).

As mentioned earlier, around 90 percent of all water withdrawals in developing countries go to agriculture, yet arable land area does not grow in any part of the world. The required increase in food production must take place by increasing unit yields and water management, including irrigation—by far the main factor in this respect (Vakkilainen and Varis 1999).

In many developing parts of the world, although food production systems have been improved remarkably in the past decades, malnutrition is still widespread, and part of the progress is eroded by rapid population growth. Rapid urbanization, climatic effects such as droughts, and many social disparities continue to cause food security problems for one-sixth of the world's population, which is an alarming number. In the early 1990s, more than 800 million people were undernourished, among which 180 million were children. In South Asia, more than 50 percent of children are still undernourished despite excessive improvements in food production since the Green Revolution of the 1960s.

### **3.4. Unbalanced globalization and regional integration**

Globalization is one of the most hated and beloved concepts these days. In the broad sense, it means opening of the economic gates and breaking down boundaries between nations. While the basic idea is grand and the underlying tendency is inevitable in the contemporary world, plenty of contradictions and side effects are obvious. Whatever the attitude for or against globalization, most people agree that regional cooperation is ultimately beneficial.

Arguments often used to back the benefits of international trade include the comparative benefits of the international division of labor and the substitution of commodities. Tariff barriers have come down almost everywhere, allowing enhanced conditions for trade across borders.<sup>13</sup> Yet the protection of the world's poorest economies is highly justified, given the still-existing extreme disparities in the global economy. Besides this, the wealthiest economies such as the United States and European Union are anything but tolerant in allowing foreign products to enter their markets.

It is expected that developing countries will have to be self-sufficient in many basic commodities for a long time ahead. This has important implications for freshwater, since in many countries over 90 percent of all water consumed goes to agriculture. Along with urbanization and population growth, the amount

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13. World trade doubled in only ten years between 1987 and 1997 (World Bank 1999). The ratio of world trade to the world's total purchasing power parity (PPP) adjusted gross national income (GNI) grew from 20.6 percent to 29.6 percent.

of water used by agriculture is expected to grow unless water conservation becomes far more efficient. Too rapid exposure of agriculture to globalization, particularly traditional livelihoods, has many times been shown to increase the vulnerability of these livelihoods, which has caused immense human suffering. The situation is different in the modern industrial sector (which is far more buffered against this exposure), where water management often improves as a consequence of globalization.

Along with the wave of globalization in trade, finance, and environmental issues, another worldwide force—decentralization—is reshaping development efforts everywhere. One of the basic ideas behind localization and decentralization is to enhance people's participation in politics and increase local autonomy in decision-making. This tendency is welcomed, and progress in decentralization is necessary. Also, in many parts of the world, water sector planning is changing gradually from employing the top-down technocratic approach to being bottom-up grassroots driven. These approaches are developing towards being more participatory than before, and partnerships between public and private operators are called for. But will this work without massive, large-scale public investment?

Empowerment should be far more emphasized than it is at the moment. Civil society organizations are functioning increasingly better in most developing regions and, in fact, civil society might continue to become more functional worldwide. However, the masses are still beyond having the appropriate control over their own living conditions. The disparities in gender, education, economy, and, consequently, empowerment and many other aspects are enormous.

## **4. Towards integrated and sustainable policies**

### ***4.1. Principles: From Dublin to Johannesburg***

Recent years have witnessed many high-profile international events related to development and water. Like the 1987 Brundtland Report, the 1992 Rio Summit did not put water high on the international agenda and, therefore, pressure on the sector to develop started to build. After the mid-1990s, international pressure on addressing water issues grew and, consequently, we have seen a series of high-level events with very strong recommendations on water. The three World Water Forums, the 2001 Bonn Freshwater Conference, the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, and many other events have all highlighted water's role in the sustainable development of societies, environmental sustainability, and poverty reduction. The outcomes of the three most influential of these events are summarized in box 3.

As can be seen from box 3, the first two items stemming from the WSSD (the Johannesburg Principles) define clear operational targets for the implementation of integrated water resources management (IWRM) both in the river basin context as well as at the jurisdictional level. How realistic these targets are is another question (cf. Biswas 2005), but what is important is that IWRM was very high on the Johannesburg agenda. The recommendations of the above-mentioned events are not completely consistent, but certain aspects are clearly visible in all of them. Obviously, the most pronounced one is the concept of IWRM (see box 4).

Compared to the past, these international events clearly indicate progress, but the reality does not offer many reasons for optimism (we list here only a few reasons). First, principles are still changing, are rather general, often contradictory,<sup>14</sup> and are difficult to translate into practice via actual governance systems. Second, political will is often missing. Third, as is often said, actions are usually characterized by “too little, too late.” Fourth, the crucially important process view of planning and implementing actions is missing. Fifth, there are many shortcomings in education, capacity building, local involvement, empowerment, and ownership.

### Box 3. Basic principles of three influential international events

#### 1992 UN Conference on Environment and Development in Dublin and Rio de Janeiro

1. Fresh water is a finite, vulnerable, and essential resource that should be managed *in an integrated manner*.
2. Water development and management should be based on a participatory approach, involving users, planners, and policymakers at all levels.
3. Women play a central role in the provision, management, and safeguarding of water.
4. Water has an economic value and should be recognized as an economic good, taking into account affordability and equity criteria.

#### 2001 International Conference on Freshwater in Bonn

1. The first key is to meet the water security needs of the poor.
2. Decentralization is the key in water security. National policies meet communities at the local level.
3. The key to better water outreach is developing new partnerships.
4. The key to long-term harmony with nature and neighbors is cooperative arrangements at the water basin level, including water that touches many shores. Thus, integrated water resources management (IWRM) is needed to bring all water users to the table for information sharing and decision-making.
5. The essential keys are stronger, better-performing governance arrangements.

#### 2002 World Summit on Sustainable Development (WSSD) in Johannesburg and beyond

1. Develop *IWRM and water efficiency plans* by 2005 for all major river basins of the world.
2. Develop and implement *national/regional strategies, plans, and programs with regard to IWRM*.
3. Improve the efficiency of water use.
4. Facilitate public-private partnerships.
5. Develop gender-sensitive policies and programs.
6. Involve stakeholders, especially women, in decision-making, management, and implementation processes.

Source: Rahaman and Varis 2005.

14. For instance, how can a solution be sustainable, integrative, preventive, precautionary, efficient, cost-effective, beneficial, participatory, affordable, financially viable, characterized by cost recovery, equitable, ethical, etc., all at the same time?

**Box 4. Integrated water resources management**

Integrated water resources management (IWRM) in a broad sense is understood as being based on the so-called 3E principle: Water should be used to provide economic well being to the people without compromising social equity or environmental sustainability. Water should be managed in a basin-wide context, with stakeholder participation, and under the prevalence of good governance. Thereby, IWRM aims to *develop democratic governance and promote balanced development in poverty reduction, social equity, economic growth, and environmental sustainability*.

The fundament of the IWRM process in any basin is the institutional set-up. In international basins the task of implementing IWRM is usually assigned to a basin organization that coordinates activities and is often an active body in planning and other activities.

There are myriad challenges in the implementation of IWRM. For instance, the gulf between centralized, international river basin agencies and local villages and communities seems to be very large. Geographically, this is unavoidable if a basin is large—yet this is not the point. In terms of institutions and communication, the remoteness is often excessive—and a far more serious problem than geographical distance. Problems occurring in the opposite direction—from villages to agencies—apply as well, but perhaps the detachment in this direction is still larger in all ways due to many practical and capacity-related issues. These gaps should—and definitely could—be lessened one way or another.

**4.2. EU Water Framework Directive**

The new unified water policy of the European Union, the Water Framework Directive (EU WFD), approved at the end of 2000, established a framework for the protection of surface waters, groundwater, and others, regardless of national borders, and included a long-term view. It builds on already existing, so-called daughter directives (since 1975 nearly 30 were created) and decisions related to drinking water quality, bathing waters, dangerous substances and pollutants (mercury, cadmium), environmental impact assessment, information exchange, wastewater sludge, municipal wastewater treatment, pesticides, nitrates, integrated pollution prevention and control (IPPC), larger accidents, and others.

The basic unit of the EU WFD is the *river basin*, which is defined as “the area of land from which all surface runoff flows through a sequence of streams, rivers and possibly lakes into the sea at a single river mouth, estuary or delta.” Thus, the whole Danube catchment forms a basin, but its largest tributary, the Tisza River (a catchment of about 200,000 km<sup>2</sup>) is only considered a sub-basin.

The principal concept of the EU WFD is—in the light of *sustainability*—to ensure the “*good status*” of waters (box 5). The purpose is to protect and, where possible, to enhance the state of ecosystems, the aquatic environment, water quality, and groundwater through a number of various measures, to promote sustainable water use, and to mitigate the effects of floods and droughts. The law is characterized by a strong intention towards *integration*, covering quantity and quality, different water bodies, combined water quality control approaches, point- and diffuse-sources, as well as interactions with other elements of the biosphere. It is based on the principle of *subsidiarity*; incorporating interventions that have to be controlled at the EU level. In other words, it deals only with a portion of water resources management, and this is done systematically under a strong environmental “umbrella.” Many issues were left open for national regulation that can properly take into account local conditions.



**Box 5.** About the EU Water Framework Directive: Good status of waters and institutions

Defining “good status” is not simple. For surface waters, status refers to the worst ecological and chemical quality, where the first depends on biological quality, hydrology, morphology, physical, and general chemical elements, as well as other chemical compounds influencing the biological state. Reference conditions or waters for each water body should be prioritized, characterizing the natural state as the objective. For subsurface waters, chemical quality and quantity relations play the determining role.

There is not yet a unified system for the specification of “good status” or ecological quality (and due to site-specific conditions it is unlikely there will be a single methodology), but many EU-funded research activities are ongoing. Also, within the implementation of the EU WFD, working groups were created to develop a harmonized approach.

Proper administration and a competent authority should also be identified to implement the EU WFD, but no further guidelines are given on how to proceed. The EU WFD specifies goals, some of the governance principles, tasks, etc., but no particular institutional setting for the purpose of implementation. This should be developed by EU member states depending on existing structures, problems, local conditions, history, culture, and many other factors.

The EU WFD incorporates a detailed schedule of implementation, with a realistic process view applied, with deadlines ranging between two and nineteen years. Major elements of the EU WFD incorporate, among others, (1) the identification of river basins within given national territories and river basin districts to which they belong (box 5); (2) definition of programs of measures to ensure the “good status” of waters; (3) characterization of natural conditions and man-made activities; (4) determination of point- and non-point sources, water abstractions, and impacts of man-made activities on the state of waters; (5) development of proper pricing policies and *recovery of costs* of services from various sectors; (6) establishment of a combined approach to point- and diffuse-source management; (7) preparation of river basin management plans for river basins; (8) public information and consultation; and (9) reporting.

In addition to sustainability, subsidiarity, ecological quality, and integrated river basin strategies, cost recovery is the main additional pillar of the EU WFD. In this respect, it is not yet clear on how it will be used in fields where user groups and beneficiaries are not well defined (e.g., flood control). A crucial vehicle of the implementation of the EU WFD is the river basin management plan. This should define the program of measures (the deadline for the latter is 2015), which is followed by reviews and updating every six years thereafter. The procedure to be applied is rather sophisticated, with little practical experience at present. Nevertheless, the EU WFD offers a unique opportunity in a large part of the European continent to introduce a common strategy at the same time. The effort is huge and expensive in terms of the need to understand many new concepts and definitions, make institutional changes, coordinate activities on various levels (from local to continental), and finance all the desired measures.

Whereas the EU WFD does not fully comply with the IWRM paradigm (cf. Rahaman et al. 2004), it represents an ambitious attempt to integrate and harmonize water sector policies on one hand over a vast geographic area and with environmental policies on the other hand.

### **4.3. Millennium Development Goals and progress in implementation**

As already can be seen, the water component of the MDG program is the most ambitious ongoing global effort in the area in question, the objective of which is to halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation (in comparison to the 1990 baseline level [see earlier]). The program has far-reaching implications not only for health but also for poverty, hunger, child mortality, and gender issues. The question is where the undertaking stood at halfway in 2002. The answer is rather mixed, if not alarming.<sup>15</sup>

Positive news is that the present improved water supply coverage globally is 83 percent (the developed world is characterized practically by full service).<sup>16</sup> The increase since 1990 is 90 million people yearly. Significant progress has been achieved in Northern Africa, Latin America, and Southern and Western Asia in the past decades (e.g., WHO and UNICEF 2004). But, for instance, Sub-Saharan Africa lags seriously behind meeting the MDG target. On the negative side, however, 1.1 billion inhabitants are still presently lacking safe service, and in fact, due to population growth, the absolute number of people without improved coverage decreased since 1990 by only about ten million annually.

The progress in sanitation is far beyond meeting the original target of moving from 49 percent coverage in 1990 to 75 percent in 2015 (WHO and UNICEF 2004). The 2002 level is only 58 percent compared to the planned 62 percent (progress was made mostly in the same regions as water supply) and the population without coverage declined by only 100 million. Today 2.6 billion people still live without adequate sanitation, more than half of which live in India and China. If the 1990–2002 trend continues, the world will significantly miss the sanitation target and in 2015 almost as many people will be without improved sanitation as today—a not too promising future.

### **4.4. Sanitation strategies**

Sanitation represents an immense problem that appears differently in various parts of the world. In developing countries and many rural areas of the developed ones, its lack or inadequacy is the major issue. In urban areas of industrialized countries, huge reconstruction needs and the development of suburban districts raise the question of whether or not we insist on employing traditional water-borne solutions that have many recognized deficiencies or follow a modified development path. Cost implications are huge everywhere. The choice among technology alternatives has never been easy, since there are many to choose from (“high-tech,” “low-tech,” “eco-tech,” “alternative,” and “novel” ones, etc. [see, for instance, Matthew and Ho 2005]). Besides, their systematic classification and evaluation are missing, their use depends a lot on local conditions, and some of them may be advocated too aggressively without having scientific proof of their operation and sustainability.

It should not be forgotten that sanitation options basically depend on the type of water supply, management of wastes, receiving water quality, and environment. For instance, public water supply and the flush toilet principle automatically entail expensive sewerage and wastewater treatment that need to

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15. Evaluation depends on the interpretation of data monitored (see WHO and UNICEF 2004).

16. Water and sanitation improvements are achieved, depending on local conditions, by house connection, standpost, borehole, dug well, rainwater disinfection at point of use and sewer connection, small bore sewer, septic tank, ventilated improved pit, pour-flush, and simple pit latrine, respectively.

be constantly upgraded due to the recognition of emerging problems (such as EDS). Thus, it is evident that sanitation is not only a health and technology issue but much more; environmental, sustainability, social, institutional, and legislative implications are also crucial, and a broad approach is looked for that takes into account all these aspects when selecting from the various existing alternatives.

Schertenleib (2005) recommends the household-centered environmental sanitation (HCES) model, which has the household at the center of the planning process. In harmony with the flows shown in figure 2, zones of differing scales are visualized that follow political borders (household, community, local government, national government, etc.) or common interests (e.g., river basins). Stakeholders are representatives of zones; decisions are reached by consultation with them. Problems are solved as close to their source as possible, and only the portion that cannot be handled is transferred to the next “circle.” The process is bottom-up in a top-down regulatory framework. The procedure minimizes waste flows across zone borders, and thus, returning to figure 2, stops the linear shift of problems from small scale to larger ones while conserving resources such as nutrients. The key is how successfully the participatory approach can be implemented in practice.

The advantage of this model is that it offers space to choose the “best” solution at all levels, from low to high tech, depending on local conditions. At the household scale, for instance, source control, urine separation (Larsen and Guijer 1996), and the design of the composition of wastewater (Matsui et al. 2001) can be performed by keeping in mind treatment and re-use options as well as conditions of overall water management on the same scale.

Clearly, sanitation is a field where, irrespective of plenty of ongoing research on alternative approaches, there are still at least two key weaknesses. First, it tends to focus at the device level or on small-scale pilot projects—large-scale and especially urban projects are conspicuously missing. Second, there is a lack of coherence in thinking on the subject, especially in relation to the most appropriate technology to use, depending on site-specific conditions, and the most effective forms of organizing service provision. This lack of consensus between proponents of different technologies and the divergence of approaches to management of service provision has hindered the development of rational “decision-narrowing” mechanisms.

In order to influence policy and decision-making on this subject more effectively, the following tasks should be addressed:

- Classify the range of available sanitation technology options (including technical, social, financial, institutional issues, etc.), focusing primarily on existing technologies, with a review of innovative options.
- Identify a framework for evaluation of these technology options.
- Review selected case studies where such evaluation criteria can be applied.
- Identify a longer-term process as to how the issue of sanitation should be handled in the future.

To respond to these needs, in 2005, the International Water Association (IWA) established a task force and launched its Sanitation 21 program.

#### **4.5. Technology development**

Advances in science and technology have resulted in developments that would never have been believed earlier. New tools and the results of new information (such as computer and sensor technology, remote sensing, instrumentation, monitoring and control, nano- and bio-technology, modeling, decision support, expert systems, etc.) and their combination allow improved comprehension of the microscopic world and extend this knowledge to address large-scale, macroscopic planning and strategic issues. A number of advanced treatment technologies are now available, including a broad range of membrane methods, some of which operate on the nano scale and remove pollutants accordingly. Thus, we may say that by utilizing existing knowledge we can develop innovative solutions to various problems that are based on closed water and material cycles and reuse and recycling on the smallest possible scale (see figure 2). Accordingly, they are more sustainable (and not infrequently cheaper) than existing alternatives. For instance, today's technology is capable of offering innovative ways to deal with wastewater at the household level, cascade management, rainwater harvesting, different forms of irrigation, leakage control in networks, and others.

Thus, opportunities are tremendous; however, there are also problems and barriers. We list a few of them here. Often the focus is on high-tech solutions, which are rarely applicable in the developing world since costs are generally high (though significantly decreasing for many technologies, thus making particular solutions like desalination a viable alternative where freshwater scarcity is severe) and capacity is lacking to operate them.<sup>17</sup> At the same time, so-called appropriate technologies and the use of sciences to derive low-cost methods still do not receive sufficient attention.

The other barrier is caused by the type of technology transfer from developed donor countries to developing ones, which is often driven by the donors' self interest rather than the recipients' actual needs. Often institutional shortcomings at the national level lead to wasteful spending and unproductive programs, although developing countries are not rich enough to even buy the "cheap" stuff. Here we also mention the important role of tradition and technology acceptance. In summary, we are back to facing problems of education, capacity development, local ownership, affordability, and others.

#### **4.6. Governance and reality**

These problems materialize through many mechanisms in the shortcomings of governance. In a large number of the world's countries their governance system suffers from serious malfunctions. The institutional and legislative systems tend to be handicapped by overlaps, inconsistencies, lack of responsibilities, distorted patterns of centralization and decentralization, and other problems. Many laws and decrees are not implemented due to lack of enforcement. National water policies may exist but may not be very effective. On top of all these barriers, corruption often plays a significant role.

Policies and laws may exist but very often fail in effectiveness. Governments are often too heavily involved in controlling resources even at the micro level. Decentralization is seriously lagging behind,

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17. A positive example is Singapore, where there is a strong focus on implementing sustainable water resources management for more than four million inhabitants under conditions of extreme scarcity. There is practically no distinction between clean water and wastewater; the overall notion is "used" or processed water. Basic principles are conservation, source control, reuse, recycling, and cascade management. The technologies applied range from activated sludge to membrane, reverse osmosis, ultra filtration, and others. At the same time, there is a strong focus on public education, starting with children.

as is private-sector involvement. Water sector management is commonly far too fragmented within governments, and serious problems with public access to information prevail, hindering the development of transparent and democratic governance practices. Worldwide, a fair amount of capital-intensive water infrastructure investments have been made, but installations are typically deteriorating due to inadequate maintenance. Women's participation in water management also tends to be too low.

Institutions provide the rules for society. A crucial player that is largely missing from the water debate is the informal sector and thus informal institutions. Their various functions range from legislative, juridical, and administrative to different informal aspects such as culture, religion, and ethnicity. The former ones are often called formal institutions, whereas the latter are known as informal ones.

Along with rapid urbanization, economic liberalization, and other transitions, the various roles of informal institutions are increasingly emphasized in development programs, although not yet properly in water agendas or visions. Policies based on public awareness, grassroots activities, participation, etc., are often targeted at least partly by the informal sector, which (leaning largely on informal institutions) grows rapidly in developing and transitional countries and incorporates a majority of the world's people.

Varis (2001) analyzed the various roles of informal institutions in the water sector and related policy principles, and then drew the following important conclusions:

- The informal sector is growing in most nations.
- The same applies to informal institutions, since formal ones fail to reach the informal sector sufficiently. Thus, they should be more respected and integrated into water agendas.
- This is challenging since they are deeply interwoven into the local traditions and culture.
- Their positive aspects should be supported and their negative sides, such as corruption, bribery, etc., should be gotten under control.

To sum up, it is stated that effective governance in a broad sense is the single most important factor of adequately implementing plans and policies. Thus, the main task is to reduce the huge number of barriers and dilemmas we face in this domain.

## 5. Concluding remarks

Water has traditionally been considered a sector in its own right. This concept is understandable, but it entails a serious misunderstanding of the crosscutting role of water in environment, sustainability, economic development, social equity, and many other areas.

Besides being an "economic sector," water has a fundamental role in several other aspects of society, including the following:

- **Water.** The poorer the nation is, the more important water tends to be economically.
- **Environmental threats.** By far the most detrimental environmental catastrophes are floods and droughts. Water is a main carrier of environmental pollutants. It is also a major agent in worldwide erosion, desertification, biodiversity decline, and climate change problems.
- **Traditional societies and the traditional sector.** Their economies are tied to nature and very closely to the water cycle.

- **Informal sector.** Water is a key constraint to having a decent livelihood in the rapidly growing informal sector. The challenges are soaring, particularly in urban areas.
- **Agriculture.** It accounts for 70 percent of all water use by humanity. In most developing countries agriculture's share of water use is over 90 percent.
- **Industry.** In large parts of the world, industry is developing more rapidly than ever before (of particular note are China, Southeast Asia, and South Asia with their large populations). Many industrial sectors rely on water, so the challenge of dealing with pollution is enormous.
- **Energy.** The Johannesburg Plan of Implementation that came from the 2002 WSSD defined the increase in the share of renewable energy sources as the primary goal of the energy sector. It is fundamental to understand that 96 percent of contemporary renewable energy production comes from either biomass or hydropower. These both rely completely on effective water resources management.
- **Services.** For many service industries such as tourism—the fastest-growing industry sector in the world—water is an essential need.
- **Economic growth.** Although it is necessary in alleviating poverty, economic growth does not guarantee it. Distribution of wealth is also necessary. In economic terms, care must also be taken of not very profitable sectors such as food production.

Over and over again, many examples demonstrate that these connections have not been adequately comprehended and not integrated into policies, programs, or actions. This situation cannot continue. We should be much more insightful in understanding the fundamental role of water in life, nature, development, economies, human welfare, health, and, eventually, the future of the planet. We must reduce the pressure on our commonly shared freshwater. We must be much more efficient in utilizing our knowledge in implementing down-to-earth actions. It may not be an exaggeration to say that our work will only be complete once we no longer speak about the “water sector” as being a stand-alone sector. This would indicate that water has truly become an integral element of properly managing our lives.

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