11

Coping with the global fresh water dilemma: The state, market forces, and global governance

Peter H. Gleick

Over the past hundred years, growing populations and growing economic development have led to the need to regularize and tame the highly variable hydrologic cycle. The goals have been to reduce the impacts on humans of droughts and floods, to move water from water-rich areas to arid regions, to capture water in wet periods for use in dry periods, and to create the institutions necessary for addressing water-related problems. Enormous progress has been made in harnessing water resources to meet human needs. But this progress has come at a high economic and environmental price, and there still remain serious unmet needs.

Despite the billions of dollars spent on water supply systems worldwide, we are failing to keep up with the basic needs of much of the world's population. Others have documented the state of the world's fresh water resources and the problems caused by underuse, overuse, or misuse of water (Gleick 1993; 1998; Postel 1993; Clarke 1991; UNCNR 1996). The world faces many serious water problems. Among the greatest concerns are the inability to provide basic clean drinking water and sanitation services to billions of people, the risk that food production will fail to grow as fast as global population because of insufficient or inadequate water availability or quality, the possibility of inter-state or intrastate conflict over shared water resources, and the likelihood that global climatic changes will significantly affect water supply, demand, and quality in unpredictable ways.

The paradigm of development that has guided water resources plan-

ning and management during the twentieth century needs to be rethought in the light of these problems. Discussions about the need to develop new principles for addressing fresh water problems began 20 years ago at the ground-breaking conference on water at Mar del Plata, Argentina, and they have been further developed and refined at several important meetings since that time. Significant advances were made at the 1992 Dublin Conference in preparation for the Earth Summit in Rio de Janeiro. These principles were further discussed in the recent Comprehensive Assessment of the Freshwater Resources of the World (UNCFA 1997; Lundkvist and Gleick 1997).

One of those principles is that water must be considered an economic good. By giving water a price, and by better understanding the total (economic and non-monetary) costs of water supply and demand, decisions about investments and water policies can, theoretically, become more rational. In reality, however, including economic principles in water decision-making is necessary but not sufficient, and many water-related problems cannot be solved in this way. This chapter summarizes and elaborates on the major water issues facing the world and offers principles related to international and national governance and the role of market and non-market forces relevant for guiding water decisions into the next century.

Projections of future supply and demand

There is no such thing as a global water problem – all problems manifest themselves on smaller scales. For example, at the global average level, there is sufficient water to meet the needs and wants of every human being. At the continental level, per capita water availability still seems more than adequate, though large regional disparities appear. In Europe, each million cubic metres of water available per year is ''shared'' by over 150 people, on the average, while in South America only 25 people must share that much water (see Table 11.1).

At the national level, the differences are even more marked, with variations of several orders of magnitude. For example, one of the richest countries in Europe, measured by water availability, is Norway, with 10 persons per million cubic metres per year. At the other extreme is Turkey with nearly 1,000 persons per million cubic metres per year. Yet Turkey, compared to some of its Middle East neighbours, could be considered water rich (Gleick 1993; 1998; Engelman and LeRoy 1993; World Resources Institute 1996; Kelman 1996). And within countries, still larger variations in water availability, water distribution, water quality, and water use occur.

Table 11.1 Availability of fresh water by continent

Continent	Area (10^3 km^2)	Population (millions)	Runoff (km^3/year)	Availability (people/10^6 m^3/year)	Availability (m^3/person/day)
Europe	10,500	498	3,210	152	18
Asia	43,475	3,108	14,410	211	13
Africa	30,120	648	4,570	144	19
North and Central America	24,200	426	8,200	52	53
South America	17,800	297	11,760	25	108
Oceania	8,950	26	2,388	11	252
Total	135,045	5,003	44,540	114	24

Source: Shiklomanov 1993

Growing scarcity at the regional and local levels indicates imbalances between overall availability and growth in need and demand. These imbalances will have implications far outside the areas under stress. An important example is the issue of food production. If more and more countries do not have sufficient amounts of water to grow the food that they need, the deficit must be covered from somewhere else. And there must be arrangements, agreements, and institutions capable of creating a surplus big enough to cover the growing regional and local deficits, providing logistical capacity and procedures for the actual transfer of food and other essentials from surplus to deficit regions, and guaranteeing a political commitment to transfer food to deficit areas and the poor, even if people in these areas do not have the means to provide their own supply.

If these three preconditions are not at hand or met, the likely result in a growing number of areas is hunger and starvation, political and social instability, tension and conflict, serious ecological disruptions, and the mass exodus of people from depressed regions. In any case, the growing dependence on imports of food may soon begin to put upward pressure on market prices of many staples. Already now there are signs of a reverse in the trend of decreasing or stable food prices as compared to other commodities in international trade. Whether or not these trends continue depends in part on how regional and local water problems are addressed. Below, four critical water issues are discussed in more detail.

Unmet needs: Critical problems in water resources supply and demand

Water, basic needs, and human health

The ugly reality is that billions of people around the globe lack access to the most fundamental foundation of a decent civilized world: basic sanitation services and clean drinking water. As Akhtar Khan said, ''Access to safe water and adequate sanitation is the foundation of development. For when you have a medieval level of sanitation, you have a medieval level of disease, and no country can advance without a healthy population'' (Khan 1997, 5). For nearly 3 billion people, access to a sanitation system comparable to that of ancient Rome would be a significant improvement in their quality of life.

The failure to provide basic sanitation services and clean water to so many people is taking a serious toll on human health. In many developing countries, cholera, pneumonic and bubonic plague, dysentery, and other water-related diseases are on the upswing. Nearly 250 million cases are

reported every year, with between 5 million and 10 million deaths. Diarrhoeal diseases leave millions of children underweight, mentally or physically handicapped, and vulnerable to other diseases. Yet the world is falling further and further behind in the efforts to provide these basic services. Between 1990 and 1997, an additional 300 million people were added to the rolls of those unserved by adequate sanitation services, a clear indication that the world community is failing to meet the most basic of needs.

In 1980, the United Nations launched the International Drinking Water Supply and Sanitation Decade, with the goal of providing clean drinking water and sanitation services to those without them. At that time, the UN estimated that 1.7 billion people did not have access to adequate sanitation services. Ten years later, at the end of the decade and after enormous effort, expense, and progress, 750 million of these underserved people had received new sanitation services, albeit at a pretty minimal level. During that same period, however, the population needing these services grew by almost exactly the same amount: 750 million people. In other words, population growth entirely wiped out the progress achieved in this area, and the official estimate in 1990 was that 1.75 billion people were still without access to adequate sanitation services. Unfortunately, the situation was even worse than that. Because of better data, more complete surveys, and population growth, current estimates are that more than 2.8 billion people are now without adequate sanitation services – half the world's population (Gleick 1998).

According to the United Nations there are also 1 billion people without access to clean drinking water, including nearly half of the population of Africa. Moreover, these global numbers hide some ugly regional problems. For example, the total populations in urban areas needing both clean water and sanitation grew over the decade, reflecting the massive and continuing migration to large urban centres in developing countries and the inability to provide necessary services there.

What are the implications of this inability to provide these services? Directly associated with poor sanitation services and unclean drinking water are the severe waterborne diseases: malaria, dysentery, cholera, and the many parasitic diseases found in Africa and Asia, such as schistosomiasis and guinea worm. Cholera is a good example. In all the years of the century up to 1990, there were rarely more than 100,000 cases of cholera reported annually, and usually between 30,000 and 70,000 cases a year. None of these was in Latin America, which had been free of cholera for over 100 years. In 1991, cholera exploded in the region: over 390,000 new cases were reported in 14 countries there, directly attributable to the failure to provide clean drinking water and adequate sanitation services. That same year there were over 590,000 cases worldwide, including over

100,000 cases in Africa alone, and tens of thousands caused by a new strain of epidemic cholera in Asia (Gleick 1998).

Food and water

The water ''crisis,'' as described in the recent summary of the Committee on Natural Resources of the UN Economic and Social Council (UNCNR 1996), also includes serious concern over global and regional food security and sufficiency. Despite the massive development of irrigation infrastructure worldwide, nearly 1 billion people are still considered undernourished by the UN FAO, and there remain serious worries about the ability of the world community to meet future needs as well. In particular, finite water supplies and escalating demands, together with degradation of soil conditions and water quality, are contributing to concerns that society will fall further behind in the race to feed the earth's growing populations.

The 1992 Dublin Conference acknowledged the importance of food security concerns and suggested alternative approaches to ensure that future food goals are met:

> Achieving food security is a high priority in many countries, and agriculture must not only provide food for rising populations, but also save water for other uses. The challenge is to develop and apply water-saving technology and management methods, and, through capacity building, enable communities to introduce institutions and incentives for the rural population to adopt new approaches, for both rainfed and irrigated agriculture (ICWE 1992).

In September 1997, a special session on food security at the Ninth World Water Congress in Montreal released a position statement that read in part:

> The magnitude of the problem is enormous. Today some one billion people in the world do not have access to enough food. It now appears that half of the world's population by the year 2025 will live in water scarce regions, where food self sufficiency will be extremely difficult to achieve. A substantial food gap seems unavoidable in these regions ... Water tables are falling and rivers are running dry in many food-producing regions ... Despite uncertainties in both estimates of available fresh water due to deficiencies in global hydrological data, and in estimates of future water needs for food production, we know enough to be deeply concerned. Action is needed now (IWRA 1997).

The ultimate goal must be to grow sufficient food to meet the world's needs, somewhere, and to deliver that food where it is needed. Thus ''global food security'' is absolutely vital, while the goal of ''national food

self-sufficiency,'' where countries seek to produce all their food needs domestically, is increasingly unattainable and unnecessary. The view that every country must be largely responsible for its own food production hinders rational solutions to the problem of true food security.

Truly water-short regions cannot reliably depend on internal water resources to produce sufficient food to meet all domestic consumption. Water and agricultural experts in Israel, the western United States, and elsewhere have already acknowledged that increasing urban and industrial demands will continue to take water from the agricultural sector. Israel, for example, is beginning to assume that the only reliable long-term source of irrigation water may be water reclaimed from urban and industrial uses (Shuval 1996). The countries of the Persian Gulf that today depend on non-renewable fossil fuels to pump non-renewable fossil groundwater are already moving away from large-scale grain production and will be forced to shift more heavily to dependence on world grain markets.

Even countries formerly independent in food production, like China, are beginning to meet part of their food needs with purchases on the world market. As a result, a growing trade in water embodied in the purchase of foods and products produced elsewhere will continue to be seen. This embodied water – also called ''virtual water'' (Allen 1995) – represents the large-scale transfer of water from regions of water surplus to regions of water scarcity.

Several problems face developing countries wanting to meet significant food needs on the world market. First, availability of funds for use in purchasing food on the world market is often limited, because of the economic structure of developing countries, debt burdens, and lack of infrastructure. Second, growing pressure on global food markets has been predicted by some analysts, which may in turn raise market prices and increase competition for limited surpluses (see, for example, Brown and Kane 1994; Carruthers 1993; Kendall and Pimentel 1994; Postel 1993). These problems, in turn, force countries back toward national food self-reliance, at a high cost in both water and economic resources. Concerns about the risks of relying on foreign trading partners who may impose conditions on trade or food embargoes for political reasons must also be satisfactorily resolved. At the same time, others believe that there is substantial room to do better than we are doing today, and that continuing to provide all necessary food needs can be done with appropriate and achievable efforts (Mitchell and Ingco 1993; FAO 1993; Rosegrant and Agcaoili 1994).

Another fundamental shift in the global food situation is likely to be necessary from the point of view of water availability – a shift in diet away from water-intensive meat consumption in the more affluent na-

tions. Diets that depend on meat for a significant proportion of protein and calories are far more water-intensive than diets higher in vegetable proteins. At present, nearly 40 per cent of all grain grown worldwide is used to feed animals. Eighty per cent of all corn production goes to animals. Reductions in livestock grain consumption in regions where irrigation is necessary would permit a shift in grain – and the water used to grow it – to direct human use. Current trends, however, are in the other direction, with more and more grain going to provide meat, at a high cost in water.

Water and ecosystems

A third component of the global water crisis is the ecological impact of human manipulation of the hydrological cycle. In part because of the lack of clearly defined legal water rights or firm guarantees for the environment, many aquatic ecosystems and individual species have become severely threatened or endangered. The recent disasters to the natural fisheries of Lake Victoria and the Aral Sea are but two examples. Overall, more than 700 species of fish have been recognized by international organizations as threatened or endangered. In just the last couple of years, many more have been added to the list, including several anadromous species, because of increasing pressures on water resources. Anadromous fisheries, in particular, are extremely vulnerable to changes in water supply and quality and to modifications in habitat (Covich 1993; Nash 1993).

While efforts are being made to identify basic ecosystem water requirements, there is little agreement about minimum water needs for the environment and few legal guarantees for environmental water have been set. Some limited efforts have been made to establish minimum requirements for certain threatened or high-priority ecosystems, but few criteria have been set, particularly in the developing world.

The ecosystems for which water is necessary include both natural ecosystems where there is minimal human interference and ecosystems that are already highly managed by humans. Societal decisions will have to be made regarding the degree to which these ecosystems should be maintained or restored and the indicators by which to measure their health. Examples of such decisions include identifying stretches of undisturbed rivers to protect, establishing minimum flow requirements in some river stretches, reallocating water from major water projects to the environment, and developing standards to protect wetlands and riparian habitats. Protecting natural aquatic ecosystems is not only vital for maintaining environmental health, but there are important feedbacks between these systems and both water quality and availability as well. The recent deci-

sion to place a cap on further development and diversions in the Murray-Darling river system in Australia (MDBMC 1996) and the complete revision of South African water law to include water for ecosystems as a fundamental priority (MWAF 1996) are two important examples of this new focus.

Traditional market mechanisms fail to address these problems and many of the proposed market solutions to water allocation problems will continue to fail in this area. Ultimately, allocations of water for the basic needs of ecosystems will have to be made on a governmental or regional level, with specific guarantees and protections accounting for climatic variability, seasonal fluctuations, basic human needs, and other factors. Management will have to follow an adaptive model where decisions are reviewed frequently based on the latest information and special efforts are made to avoid irreversible environmental consequences.

Water and security: Inter- and intrastate conflicts

As the twenty-first century approaches, water and water supply systems are increasingly likely to be both the objectives of military action and the instruments of war as human populations grow, as improving standards of living increase the demand for fresh water, and as global climatic changes make water supply and demand more problematic and uncertain (Gleick 1993; 1998). Where water is scarce, competition for limited supplies can lead nations to see access to water as a matter of national security. History is replete with examples of competition and disputes over shared fresh water resources: water resources have historically been both the objectives of inter-state conflict and the instruments of war.

Many rivers, lakes, and groundwater aquifers are shared by two or more nations. This geographical fact has led to the geopolitical reality of disputes over shared waters, including the Nile, Jordan, and Euphrates Rivers in the Middle East, the Indus, Ganges, and Brahmaputra in southern Asia, and the Colorado, Rio Grande, and Paraná in the Americas. Water and water supply systems have been the roots and instruments of war. Access to shared water supplies has been cut off for political and military reasons. Sources of water supply have been among the goals of military expansionism. And inequities in water use have been the source of regional and international frictions and tensions. These conflicts will continue – and in some places grow more intense – as growing populations demand more water for agricultural, industrial, and economic development (Gleick 1993).

Inter-state conflicts are caused by many factors, including religious animosities, ideological disputes, arguments over borders, and economic competition. Although resource and environmental factors are playing an

increasing role in such disputes, it is difficult to disentangle the many intertwined causes of conflict. Identifying potential trouble areas does little good if there are no tools for mitigating the problem. International law for resolving water-related disputes must play an important role.

While various regional and international legal mechanisms, such as specific treaties and the new Convention on Non-Navigational Use of Shared International Watercourses (UN 1997), exist for reducing water-related tensions, these mechanisms have never received the international support or attention necessary to resolve many conflicts over water. Indeed, there is growing evidence that existing international water law may be unable to handle the strains of ongoing and future problems. In addition to improving international law in this area, efforts by the United Nations, international aid agencies, and local communities to ensure access to clean drinking water and adequate sanitation can reduce the competition for limited water supplies and the economic and social impacts of widespread waterborne diseases. In regions with shared water supplies, third-party participation in resolving water disputes, either through UN agencies or regional commissions, can also effectively end conflicts.

Not all water resources disputes will lead to violent conflict; indeed, most lead to negotiations, discussions, and non-violent resolutions. But in certain regions of the world water is a scarce resource that has become increasingly important for economic and agricultural development. In these regions, water is evolving into an issue of ''high politics,'' and the probability of water-related conflict is increasing. Policy-makers and the military should be alert to the likelihood of conflicts over water resources, and to the possible changes in both international water law and regional water treaties that could minimize the risk of such conflicts.

Meeting basic needs for water

A distinction must be made between basic human and environmental ''needs'' for water and the much larger set of ''wants'' for water to provide additional goods and services. The overall demand for water includes a combination of basic ''needs'' and this larger set of ''wants.'' ''Need'' for water exists independently of economic or political status and, in principle, it cannot be manipulated. More generally, ''demand'' typically refers to the economic and political demand that is expressed in terms of human desire, purchasing power, and degree of political empowerment and claims.

The goal of providing for basic human needs was officially recognized as early as the 1977 Mar del Plata Conference and continues to be an important unmet concern (UN 1978; 1992; ICWE 1992). The basic

Table 11.2 Water requirements for basic human needs

Purpose[1]	Basic water requirement (litres per person per day)
Drinking water[2]	5
Sanitation services	20
Bathing	15
Food preparation	10

Source: Gleick 1996
[1] Excluding water required to grow food.
[2] This is a true minimum to sustain life in moderate climatic conditions and average activity levels.

water requirement (BWR) described below and in Table 11.2 was designed to address the ''need'' part of this problem. Minimum needs have long been recognized by policy-makers in the form of the ''lifeline tariff'' being advocated in parts of the United States, some countries in Europe and Southern Africa, and elsewhere.

Recent efforts to integrate environmental issues and concerns with sustainable economic and social development have returned to the concept of meeting basic human needs first proposed nearly two decades ago. One of the most fundamental of those needs is access to clean water. Efforts to identify basic human needs for water have been made by UN agencies and international organizations in the past. More recently, a comprehensive definition of the BWR for domestic activities was put forth by the author (Gleick 1996). This definition recommends that 50 litres per person per day be provided to meet basic domestic water needs for drinking, sanitation, bathing, and food preparation. As part of this recommendation, international organizations, national and local governments, and water providers must play the leading role in meeting basic needs and should guarantee access to the BWR independently of an individual's economic, social, or political status.

Hundreds of millions of people, especially in developing countries, currently lack access to this BWR. Furthermore, rapid population growth and inadequate efforts to improve access to water ensure that this problem will grow worse before it grows better. A first step towards sustainable water use would be to guarantee all humans the water needed to satisfy their basic needs.

The broader level of demand for water – ''wants'' – can be changed and even reduced without necessarily diminishing the overall utility for the individual user of water. If users reduce their water demands, for instance through increased price or improved technology, well-being may nevertheless remain the same. The potential to increase efficiency – to

reduce the volume of water used per unit of output – is quite significant in most productive uses of water, notably irrigated agriculture and industry. If the ''freed'' water can be used beneficially by others, this implies improved opportunities and increased utility for society at large.

Market and non-market solutions

The problems described above are very complicated, involving many different actors and driving forces. The solutions to those problems will, therefore, also be very complicated, and different approaches will apply to different actors and driving forces in myriad ways.

One of the principles to come out of each of the major water meetings, including the Mar del Plata and Dublin Conferences, is that effective water resource management requires treating water as an economic good. The Dublin statement, for example, says ''water has an economic value in all its competing uses and should be recognized as an economic good.''

Despite the call for water to be recognized as an economic good, there is little agreement about what this means or how the principle should be applied. At the most basic level, water should not be considered a free good – it should have a price, people should pay for it, and the price should reflect its true value, including environmental values. There are many examples worldwide where water has no price or is not paid for, and this leads to misuse of the resource. Ironically, there are also many examples where people in the developing world already pay far more for poor-quality water provided by vendors or private sellers than they would pay if they were supplied by more conventional municipal systems.

The largest single consumer of water is the agricultural sector, and water for agriculture is often heavily subsidized or even free. There are good reasons for this, including the desire of countries to maintain levels of rural employment and provide access to local markets for food, and for other social reasons. But too often, subsidies for agricultural water lead to inefficient and wasteful use of water, groundwater overdraft and contamination, and ecological destruction. Examples of the adverse impacts of cheap agricultural water can be seen in the devastation in the Aral Sea, the Colorado River delta in Mexico, the Nile Delta, and elsewhere. Groundwater overdraft is occurring in the Middle East, north China, India, and parts of the western United States – in large part because of market failures in properly pricing water.

The prevailing notion that provision of water should be free or subsidized and that water can be used without concern about the growing need and demand for water in other sectors is no longer acceptable. As long as precipitation, streamflow, or groundwater are plentiful in relation

to overall demand, there is little reason to focus on complex allocation schemes or innovative market mechanisms for water management. Under such circumstances, the infrastructure needed to provide water might be comparatively simple and the necessary expenditure modest. When water is scarce, however, the social and environmental costs of greater and greater levels of water development rise. More and more of the world faces just such development constraints. When the ratio of use to overall availability increases, careful and rational water management, planning, and allocation become crucial.

Today, the construction of new water infrastructure requires increasingly expensive investment to produce an additional unit of water supply. This is partly due to the fact that the ratio of use to availability is high in most regions of the world and because most of the economically and environmentally appropriate sites for dams and storage facilities have already been developed (as have many uneconomic or environmentally inappropriate sites). Over time, therefore, distance from new water sources to users increases or the water requires increasingly expensive treatment.

More and more of the water used in the world, including water for food production, is provided through some kind of physical and institutional infrastructure that must be developed and reimbursed. Charges for that water need not be the same for every user – indeed, there is a long history of political support for various water-related subsidies, including cross-subsidies between various users and across different sectors – but the lesson of past developments is that some price must be paid and it is better if users pay the true costs.

There is thus a need to define better the different kinds of value (economic, health, social, etc.) that water use generates and to identify the various kinds of cost associated with water development, distribution, use, and treatment, including direct costs, opportunity costs, and hard-to-quantify environmental costs.

The failure of market forces in meeting water needs

As hinted above, markets for water are often limited and always incomplete. This raises the basic question: where is economics not enough? The application of economic principles alone fails in the areas of protecting ecosystems and environmental goods and services, in providing for basic human needs for water, and in resolving international disputes over shared water resources. Each of these problems also requires some form of government intervention, such as local or regional protections or policies.

But other questions also arise related to basic water needs and the role of markets. To what extent does a state have an obligation to provide its

citizens with a basic water requirement? Is this obligation independent of ability to pay or other economic constraints? Should the international legal community consider the right to a certain level of fresh water to be a basic human right? How can the ''environment'' participate in water markets? What are appropriate subsidies, if any? For meeting basic human rights, international declarations made at Mar del Plata and the Earth Summit also suggest that states have the obligation to develop in such a way as to ensure that their use of fresh water is sustainable and adequate to meet the basic needs of its people, independent of ability to pay (Gleick 1996).

Water sufficient to meet basic needs should thus be an obligation of governments, water management institutions, or local communities. While in some regions governmental intervention may be necessary to provide for basic water needs, many areas will be able to use traditional water providers, municipal systems, or private purveyors within the context of market approaches. In some cases, however, governments or water providers may be unable to provide this amount of water using economic markets, because of rapid population growth or migration, the economic cost of water supply infrastructure in regions where capital is scarce, inadequate human resources and training, or even simple political incompetence. In such cases, the failure to provide this basic need must be considered a major human tragedy, and non-market intervention will be necessary. In particular, this means community or government direct action.

Institutional issues: Regional versus global governance

Water resources must now be recognized as a major determining factor for socio-economic development (UNCNR 1996). When human demands for water were low and when hydrological cycle behaviour and the climate were thought to be fairly predictable, water was one of the last things to be considered in the development decision-making process, if it was considered at all. Hydrologists and water managers tended to concentrate on gathering scientific knowledge about the hydrological cycle, paying little attention to socio-economic and environmental aspects or values, to the point that most development activities simply assumed that there would always be water available for growing needs.

Today, due to the increasing pressures on water resources and the recognized variability of the hydrological cycle and the climate, the position of water in the decision-making process has risen. Now, water must be considered in the context of development and security objectives, including the day-to-day management of water allocation for socio-economic activities and the preservation of natural ecosystems. It is now imperative that decision-makers in all sectors, and particularly those re-

sponsible for planning, make development decisions with explicit attention to water resources (Lundkvist and Gleick 1997).

Apart from increased concern within the policy domain, influential segments of society are showing a new interest in resource and environmental issues. Private and commercial sector interest in water affairs is growing. Environmental interests play an important role and community groups are increasingly seeking a say in water resource decisions (Gomez and Wong 1997). The new mix of partners concerned about water management and the new consensus about the myriad roles of water in development and for security represent an opportunity to address water problems in a more flexible and realistic manner.

Conclusions: Steps toward more sustainable water management and use

Identify and meet basic human and ecosystem water needs

Among the concepts raised nearly 20 years ago during the 1977 Mar del Plata Conference was that of meeting ''basic needs.'' The 1992 Dublin Conference statement reiterated that principle, which was then strongly reaffirmed during the 1992 UNCED in Rio de Janeiro. International organizations, national and local governments, and water providers should adopt a BWR standard to meet basic needs, and guarantee access to it. Unless this basic resource need is met, large-scale human misery and suffering will continue and grow in the future, contributing to the risk of social and military conflict. Priority should be given to the unserved and underserved poor, who are at greatest risk. While these needs can be met in a market context, they must also be met where traditional markets fail.

National food policies must acknowledge water limitations

The view that all countries must be responsible for their own food production hinders rational solutions to the problem of true food security and leads to unsustainable use of water. By the late 1990s there were already many countries with insufficient water to grow all their own food and this situation will only get worse, not better. These countries go to world markets to meet their needs. The ultimate goal must be a world that grows sufficient food to meet the world's needs, somewhere, and the institutions and mechanisms to deliver that food where it is needed. Thus, countries without sufficient water resources realistically and dependably to produce sufficient food domestically must be able to meet needs through alternative reliable avenues. This requires a flexible combination of market and non-market institutions and a shift in the functioning of

global trade, agricultural markets, and import-export policies. In particular, mechanisms to help shift poor water-short countries away from water-intensive agricultural production must be coupled with the development of robust trade or aid programmes. Some of the needed changes, like political guarantees against food embargoes and the development of adequate transportation and distribution systems, will not be produced through traditional market mechanisms. Over time, changes in diets and new forms for food production like ''urban agriculture'' can also play an important role in boosting global food security.

Water as an economic resource

Growing scarcity and water competition implies that water must be treated as an economic resource. Liberal provision of heavily subsidized water services is an invitation to waste and also means a significant drain on limited public funds and other resources. In order to meet basic human and environmental needs and stimulate long-term sustainable economic development, it is imperative that the notion of water as a free good be changed. The recognition of water as an economic resource, which was one of the cornerstones of the Dublin and Rio statements, implies that planners and users recognize the true value of water in all its competing uses and functions. Responsible and proper use requires, among other things, that charges and fees reflect the various costs for water with recognition of non-market values. Even modest steps in this direction have the potential to reduce and eliminate wasteful water use and allocations.

Water planning and decision-making

Water planning and decision-making should ensure representation of all affected parties and foster direct participation of affected interests. The principle that water planning and decision-making should involve the fullest participation by affected parties has been enunciated by international organizations and official water conference statements for nearly 20 years, going back to the 1977 Mar del Plata Conference. The goal was also one of the prime recommendations from the Dublin meeting.

> Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels. The participatory approach ... means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects (ICWE 1992).

Sustainable water planning and use should ensure comprehensive public representation, open and equitable access to information about the

resources, and direct participation of affected interests in decisions about allocating those resources. The success of policies and programmes for water management, planning, and use now strongly depends on the extent to which the public becomes actively involved. Ways must also be found to incorporate and protect the interests of future generations – a fundamental criteria of sustainability as defined by the United Nations in Agenda 21.

Part of the idea of participatory decision-making must be the inclusion of mechanisms and institutions for dispute resolution. There has been progress on the international front in setting standards and principles for resolving conflicts over shared fresh water resources peacefully. In April 1997, the UN General Assembly approved the final Convention on the Law of the Non-Navigational Uses of International Watercourses – an international convention that had been negotiated over the past 30 years (UN 1997).

Article 7 of the Convention obliges states to take all appropriate measures to prevent harm to other states from their use of water. Article 8 obliges watercourse states to cooperate on the basis of equality, integrity, mutual benefit, and good faith in order to use and protect shared watercourses optimally. Article 33 offers provisions for guiding peaceful settlement of disputes by negotiation, mediation, arbitration, or appeal to the International Court of Justice. At the same time there are acknowledged limits to the ability of these standards to help settle disputes, and attention must continue to be focused here.

Management of the earth's water and other natural resources has increasingly been recognized by senior international policy-makers as inextricably linked with community prosperity and social and political stability. A wide range of both market and non-market solutions exist for many problems of misallocated or misused water, but insufficient attention has been paid to the proper application of these solutions. In the past, inadequate attention to the role of markets has caused significant misallocations and misuses of water. At the same time, application of market approaches in situations where non-economic values are high or where certain types of water needs or uses cannot be quantified also fails to resolve problems, and may often create more. These issues deserve more attention as the world moves into the twenty-first century.

REFERENCES

Allen, J. A. 1995. ''Water in the Middle East and in Israel-Palestine: Some Local and Global Issues.'' In *Joint Management of Shared Aquifers*, eds M. Haddad and E. Feitelson. Jerusalem: Palestine Consultancy Group and the Truman Research Institute of Hebrew University: 31–44.

Brown, L. R. and H. Kane. 1994. *Full House: Reassessing the Earth's Population*

Carrying Capacity. Worldwatch Institute Environmental Alert Series. New York: W. W. Norton.

Carruthers, I. 1993. ''Going, Going. Gone! Tropical Agriculture As We Know It.'' *Tropical Agriculture Association Newsletter* 13(3): 1–5, cited in A. F. McCalla. 1994. *Agriculture and Food Needs to 2025: Why We Should be Concerned*. Washington: Consultative Group on International Agricultural Research.

Clarke, R. 1991. *Water: The International Crisis*. London: Earthscan.

Covich, A. 1993. ''Water and Ecosystems.'' In *Water in Crisis: A Guide to the World's Fresh Water Resources*, ed. P. H. Gleick. New York: Oxford University Press.

Engelman, R. and P. LeRoy. 1993. *Sustaining Water*. Washington: Population Action International.

FAO (Food and Agricultural Organization). 1993. ''Agriculture: Towards 2010.'' Conference Paper C-93/24.

Gleick, P. H. 1993. *Water in Crisis: A Guide to the World's Fresh Water Resources*. New York: Oxford University Press.

Gleick, P. H. 1996. ''Basic Water Requirement for Human Activities: Meeting Basic Needs.'' *Water International* 21(June): 83–92.

Gleick, P. H. 1998. *The World's Water 1998–99*. Washington: Island Press.

Gomez, S. V. and A. K. Wong. 1997. *Our Water, Our Future: The Need for New Voices in California Water Policy*. Oakland: Pacific Institute for Studies in Development, Environment, and Security.

ICWE (International Conference on Water and Environment). 1992. ''The Dublin Statement on Water and Sustainable Development.'' International Conference on Water and Environment, Dublin, Ireland.

IWRA (International Water Resources Association) 1997. ''Water Experts Express Grave Concerns about Future Global Food Security.'' Common position paper of the session Water Scarcity as a Key Factor in Food Security. Ninth World Water Congress of the IWRA, 1–6 September, Montreal, Canada.

Kelman, J. 1996. ''Freshwater Availability in Large Cities of Brazil.'' Background memo, Chapter 4 Meeting in New York for the Comprehensive Global Freshwater Assessment.

Kendall, H. W. and D. Pimentel. 1994. ''Constraints on the Expansion of the Global Food Supply.'' *Ambio* 23(3): 198–205.

Khan, A. H. 1997. ''The Sanitation Gap: Development's Deadly Menace.'' In *The Progress of Nations 1997*. New York: United Nations (UNICEF).

Lundkvist, J. and P. H. Gleick. 1997. ''Sustainable Water Strategies for the 21st Century.'' Policy paper for the Comprehensive Assessment of the Freshwater Resources of the World. Stockholm, Sweden: Stockholm Environment Institute.

MDBMC (Murray-Darling Basin Ministerial Council of Australia). 1996. ''Setting the Cap: Report of the Independent Audit Group.'' Murray-Darling Basin Ministerial Council (November).

Mitchell, D. O. and M. D. Ingco. 1993. ''The World Food Outlook.'' Draft paper, International Economics Department, World Bank, Washington.

MWAF (Ministry of Water Affairs and Forestry of South Africa). 1996. ''Fundamental Principles and Objectives for a New Water Law in South Africa.'' Report to the Minister of Water Affairs and Forestry of the Water Law Review Panel (January).

Nash, L. 1993. ''Environment and Drought in California 1987–1992: Impacts and Implications for Aquatic and Riparian Resources.'' Report, Pacific Institute for Studies in Development, Environment, and Security, Oakland, California.

Postel, S. L. 1993. *Last Oasis: Facing Water Scarcity*. New York: W. W. Norton.

Rosegrant, M. W. and M. Agcaoili. 1994. ''Global and Regional Food Demand, Supply, and Trade Prospects to 2010.'' Paper presented at Population and Food in the Early Twenty-first Century: Meeting Future Food Needs of an Increasing World Population. International Food Policy Research Institute, 14–16 February, Washington, DC.

Shiklomanov, I. A. 1993. ''World Fresh Water Resources.'' In *Water in Crisis: A Guide to the World's Fresh Water Resources*, ed. P. H. Gleick. New York: Oxford University Press.

Shuval, H. 1996. ''Sustainable Water Resources Versus Concepts of Food Security, Water Security, and Water Stress for Arid Countries.'' Background paper, Workshop on Chapter 4 of the Comprehensive Global Freshwater Assessment of the United Nations.

UN (United Nations). 1978. *Water Development and Management. Proceedings of the United Nations Water Conference Mar del Plata, Argentina*, Vol. 1, Part 1. Oxford: Pergamon Press.

UN (United Nations). 1992. *Agenda 21: Programme of Action for Sustainable Development.* New York: United Nations.

UN (United Nations). 1997. ''Convention on the Law of the Non-Navigational Uses of International Watercourses.'' Document A/51/869.

UNCFA (United Nations Comprehensive Freshwater Assessment). 1997. *Comprehensive Assessment of the Freshwater Resources of the World.* Stockholm: Stockholm Environment Institute.

UNCNR (United Nations Committee on Natural Resources). 1996. ''Future Water Resources Management Issues and the Strategies and Policies that the International Community Should be Considering in Response.'' Document E/C.7/1996/6.

WRI (World Resources Institute). 1996. *World Resources 1996–97, The Urban Environment*. New York: Oxford University Press.

FURTHER READING

MNHW (Minister of National Health and Welfare). 1992. *Guidelines for Canadian Drinking Water Quality.* 5th edn. Ottawa: Canadian Government Publishing Center.

UNDP (United Nations Development Programme). 1994. *Human Development Report 1994.* Oxford: Oxford University Press.

UNICEF (United Nations Children's Fund). 1997. *The Progress of Nations 1997.* New York: United Nations.

Watson, R. T., M. C. Zinyowera, and R. H. Moss, eds. 1996. *Climate Change 1995: Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analysis: Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press.