



Report of the World Commission on Water

1. Introduction

Water is life. Every human being, now and in the future, should have access to safe water for drinking, appropriate sanitation, and enough food and energy at reasonable cost. Providing adequate water to meet these basic needs must be done in an equitable manner that works in harmony with nature. For water is the basis for all living ecosystems and habitats and part of an immutable hydrological cycle that must be respected if the development of human activity and well-being is to be sustainable.

We are not achieving these goals today, and we are also on a path leading to crisis and to future problems for a large part of humanity and many parts of the planet's ecosystems. Business as usual leads us on an unsustainable and inequitable path.

To achieve these goals drastic changes in the manner in which water is managed will be needed. Namely:

A holistic, systemic approach relying on Integrated Water Resource Management (IWRM) must replace the fragmentation that currently exists in managing water

There are those who would see water only by use: water for municipal use, for industry, for irrigation, for environmental needs, as if the latter was a competing use, not an inherent part of maintaining the entire ecological system on which all water services depend. Or those who look at political and administrative boundaries as the basis of decision making when these seldom conform to the catchment and basin areas that nature prescribes as the management units for water.

But it is as much by activities on land that we impact on the quality and availability of usable fresh water as by the direct withdrawals that humans make. A holistic approach means taking these issues into account, and linking the quality and quantity aspects of water management. Water is affected by everything, and water affects everything and everyone.

Participatory institutional mechanisms must be put in place to involve all sectors of society in decision making

The old model of 'this is government's business' must be replaced by a model in which stakeholders participate at all levels. At the local level, community groups and users' associations have a major role—sometimes in self-providing and managing their local sewerage or irrigation works, sometimes in monitoring the performance of public and private service providers, sometimes in managing land use in their local watershed. At more aggregate levels, water users have a major role in 'users' parliaments' which work with government in managing aquifers and river basins. Experience shows that this participation must be real

and not symbolic, and shows that these users' associations and parliaments must have a decisive role in deciding what is done, how it is done, and who pays for it. Experience also shows that what works is partnerships between governments and stakeholders, with governments playing a vital role in creating the enabling environment, and in providing technical and enforcement support. Empowering women's groups, the poor, youth and the community-based groups to have an adequate voice in participatory decision making is a necessary pillar of this approach.

Fresh water must be recognized as a scarce commodity and managed accordingly

Full-cost pricing of water services with equity will be needed to promote conservation, and to attract the very large investments that are needed. The polluter pays and user pays principles must be enforced. And mechanisms must be found whereby those who use water inefficiently have incentives to desist and transfer that water to higher-valued uses, including environmental purposes.

Fresh water must be recognized as a basic need and adequate access to it must be ensured for the poor

Water is a fundamental need. All human beings must have access to water, including the poor and the marginalized. To ensure access for all with full-cost pricing of water will often require financial assistance to help poor communities develop and manage their own water supply. The level and breadth of subsidies will obviously have to take account of the overall level of resource availability to governments in different settings. Subsidies should be delivered directly to the people themselves, not to service organizations. They must be delivered in a manner that is transparent and well targeted. It is essential to separate the welfare task (which is the task of government) and the business task (which is what service organizations should be asked to do).

The public goods nature of the needs of future generations, of nature, of people outside the political and administrative units where decisions are being made, must be recognized. Governments must not shirk their responsibilities in protecting the public goods nature of wetlands and groundwater, or the needs of ensuring the water-related services necessary for the health needs of all the people at all times.

Incentives for resource mobilization and technology change are needed

Incentives must be found to (1) mobilize resources for water-related investments, (2) promote new science and technology to address water issues, and (3) harness the traditional wisdom of the people who have lived with nature for centuries, as well as to promote the deployment of new environmentally friendly technologies. Existing knowledge and technology that are often not applied need to be used more extensively from rainwater harvesting to biotechnology; traditional wisdom should be tapped along with the newest cutting edge of science and technology.

Resources will be required to provide greater protection of the environment, to undertake the needed investments and to ensure that the interests of the poor are addressed. These resources will be partly financial coming from government funds, international agencies and private sources. They will come partly from

community-based labour and energy, which can greatly reduce investment costs. They will come partly from scientific and technological ingenuity. The financial demands far outstrip the limited capacity of government budgets. Scarce public funds must increasingly be targeted to ensure that public responsibilities—the needs of the poor and the environment—are adequately funded. Investment for services must come increasingly from the private sector. Experience over the last decade has given a glimpse of the potential of the private sector in mobilizing the huge resources which are required, and has shown that a transparent, predictable regulatory regime is essential to protect the interests of consumers and investors. Experience has also shown that the insertion of the private sector means new and highly productive pressures on public service providers, who often operate without competition, regulation or accountability.

Political will is needed

Difficult decisions and complex tradeoffs can be minimized by seeking win—win solutions, but will not be eliminated. A technically and scientifically informed participatory, transparent process of decision making at all levels (from the community to the river basin) must be put in place as the action arm of the integrated water resources management approach.

Governments are key actors

Governments, both national and local, are the sovereign and legitimate decision-making bodies, and they will be the key actors who must make all this happen. Not by undertaking the tasks themselves, although they must act responsibly in the budget decisions that are made for investments, but by setting the enabling framework for local community-based action and for a properly motivated and regulated private sector. Such a framework would promote the adoption of environmentally friendly and socially responsible technologies and investments. Government agencies must also be involved in protecting the long-term interest of all by acting as the custodians for and champions of the environmental and social dimensions of water management, even when it goes beyond their borders. Cooperative mechanisms and consultative processes for settlement of competing claims across administrative and sovereign borders are part of this overall framework.

Behavioural change is needed by all

We are all involved in the management of water, by what we choose to do or not to do. Unless human behaviour changes dramatically, technological solutions will be for naught. Public awareness, education, identification and dissemination of best practices, and incentives for action are all part of realizing this vision of a sustainable, equitable future where all human beings, everywhere, will have access to enough clean water, sanitation, food and energy. A sustainable future where not only equity for humans in the use of water is assured, but one where all species and habitats shall flourish, and humans will treat the earth not as something that we inherited from our parents, but something that we borrowed from our children.

Going beyond Dublin and Rio

Many parts of the world are already experiencing water stress. In Dublin and Rio the international community adopted sound principles for dealing with this challenge. These 'holistic', 'institutional', 'gender' and 'economic' principles have been part of a broad global consensus on how water should be managed, at least since the Dublin Conference on Water and the Environment in 1992 and the Rio Earth Summit of 1992, which devoted Chapter 18 of Agenda 21 to water. The goal of the Commission is to build on the Dublin/Rio principles and identify critical priority actions that will result in more effective and rapid progress. This report extends Dublin/Rio in three critical ways. First, it shows that the arithmetic of water in coming decades does not add up. To ensure that environmental quality is improved and people's needs are met there must be a redoubled effort at technological, financial and institutional innovation. With regard to technological innovation this means mobilizing the knowledge and investment capacity of the private sector, and supplementing it with strategic public investments. With regard to institutional innovation, the core challenges are stimulating new forms for the involvement of citizens in managing water, and providing incentives for private sector involvement. None of these will succeed, the Commission emphasizes, unless full-cost pricing for water services becomes accepted practice.

The gloomy 'arithmetic of water'

Considerable progress has been made in many countries, and yet at a macro level the arithmetic of water still does not add up. In the next two decades it is estimated that water use by humans will increase by about 40%, and that 17% more water will be needed to grow the food for the growing populations. In addition the water demands for industry and energy will grow rapidly. We know that aquatic ecosystems throughout the world have been degraded, and will need greater protection and that water quality is deteriorating in poor countries. In short, with current institutional arrangements and current technologies, the arithmetic of water simply does not add up. Rapid and imaginative institutional and technological innovations are required. 'Business as usual' will not do. With the commitment of all, however, the problems can be overcome; a water-secure world is possible, but we must change the way we manage water, starting now!

This is the message that the World Commission for Water in the 21st Century has tried to encapsulate on the occasion of the Millennial World Forum on Water held at the Hague in March 2000. It is but a small part of an unprecedented participatory effort that has involved literally thousands of persons and hundreds of organizations all over the world in preparing a vision for the future.

This enormous participatory exercise has produced many sector visions, for water and sanitation, for food and agriculture, for water and nature. It has also explored many themes, from institutions to biotechnology, from the information revolution to the energy future. Many sources of data, models and forecasts were woven together in various scenarios for discussion. All these were confronted with the local realities, as national and regional vision exercises were launched in more than 30 regions and nations. More than 100 meetings were held.

The results of all these efforts are being published with each group signing its

own effort. The synthesis of many of these findings is given in a separate staff report prepared by the Secretariat to the Commission with the support and guidance of the Chairman of the Commission. While the Commission has carefully reviewed and considered these findings and exercises, this report does not constitute a summary of these efforts. It is the independent view of the Commission.

The Commission sees the launch of the World Water Council-led vision as a continuing process. The Hague 2000 meeting is only a milestone on an ongoing journey as we move from vision to action. The Global Water Partnership-led effort entitled 'Framework for Action' is intended to help lay out a path for bringing some measure of cooperation and coordination to the implementation of the vision.

The Hague 2000 events are to be seen as both a capstone of one stage and a launching pad for another greater effort. This is a broad-based, inclusive movement to bring the issues in water management to the fore, and to ensure that the vision and all the other exercises given birth to are implemented in this participatory, technically and scientifically informed and consistent manner.

2. The Water Crisis: Where We Are Today and How We Got There

2.1 The Setting

In a world beset by financial and political challenges, the fragility of the key ingredient in our ecosystem is not getting enough attention. The water system on which we depend for our survival is at risk.

Fresh water is a precious resource. Only 2.5% of the world's water is not salty, and of that two-thirds is locked up in the icecaps and glaciers. Of the remaining amount, subject to the continuous hydrological cycle, some 20% is in areas too remote for human access, and of the remaining 80% about three-quarters comes at the wrong time and place, in monsoons and floods, and is not captured for use by people. The remainder is less than 0.08 of 1% of the total water on the planet. It is precious indeed.

About 70% of this water is used in agriculture to grow the food and fibre on which human society depends. About 10% is used for municipal water use, for households and industry. Water is also used to generate electricity (hydropower and cooling for thermal power), for navigation and leisure. Finally, water is also required to sustain rivers and wetlands, to dilute pollution, and to wash away salts that would otherwise destroy farmlands.

These figures are global estimates. The lack of consistent and reliable data on both the supply and use of fresh water presents serious problems in efforts to manage this precious resource.

2.2 What Has Been Achieved, and What Problems Loom

In many ways there have been striking gains from water management in recent decades. Over a generation ago the world was haunted by the spectre of widespread famine. Not only has this not materialized, but the opposite has happened—food has been produced in such abundance that food-grain prices have been cut in half, with incalculable benefits to consumers, especially poor people. The principal driving force behind this abundance has been a huge

expansion in irrigated area, the use of high-yielding varieties of crops and the application of fertilizers and pesticides and improved management practices. In terms of water and sanitation, too, there have been impressive gains—over the last 20 years over 2.4 billion people have gained access to water supply and 600 million to sanitation. The glass is indeed half full.

Despite these achievements, there is growing recognition that the world is now beginning to feel the first pangs of a more chronic and systematic water crisis.

First, there are the unsolved 'old problems': more than a billion people do not have access to a water supply and three billion do not have adequate sanitation. And there is evidence of a slow-down in both the growth of irrigated land and the productivity of that land. Then there are the 'new problems' of environmental degradation: For example:

- Aquifers are being mined at an unprecedented rate—10% of the world's agricultural food production depends on using mined groundwater. Water tables are dropping in fossil aquifers, including in the western United States, and water tables are falling as much as a metre a year in many parts of Mexico, India, Yemen, China and elsewhere.
- Water diversions for irrigation have had devastating effects in Central Asia, with the Aral Sea shrinking to a fraction of its original size.
- Urbanization and agricultural practices have reduced the size of the Everglades to less than half of its original size, with corresponding losses in environmental functions.
- Lack of attention to maintenance of vegetation in catchments has contributed to flooding, as in the Chang Jiang (Yangtze) in 1998.
- The Huang He (Yellow River) did not run into the sea for more than 220 days in 1997.
- There is poor water quality in rivers and lakes.
- The rate of fresh water fish species extinction is five times that of salt water species.
- Deforestation/land degradation (impacts on flooding and siltation of reservoirs), salinization/waterlogging, and water contamination by chemicals, fertilizers and human waste are all serious issues in many parts of the world.

The United Nations Water Conference in Mar del Plata in 1977, the International Conference on Water and the Environment in Dublin, and the Earth Summit in Rio de Janeiro in 1992 articulated and subsequently affirmed a set of principles for good water resource management. These are often referred to as the Dublin Principles. The first of these principles is the 'ecological principle', which requires that water be treated as a unitary resource within river basins, with particular attention to ecosystems. The second is the 'institutional principle', which recognizes that water management requires the involvement of government, civil society and the private sector, and that the principle of subsidiarity be respected. It also gives special emphasis to the role of women in water management. The third principle is the 'instrument principle', which requires that water be recognized as a scarce economic good, and that greater use be made of 'user pays', 'polluter pays' and other market-friendly instruments.

In short, the water experts have stressed that the combination of demand management, reduced waste and proper management of claims against the water supplies would make a major contribution to the sustainability of the resource.

2.3 The Gloomy Arithmetic of Water

It is useful to examine the aggregate balances of supply and demand, with due recognition of the fact that the issues of water are specific to time and place.

First, on the demand side of the equation. Assume close to two billion more people on the planet, mostly in the developing countries. Assume further that food consumption per person does not increase, a very conservative assumption as all models forecast a growth in consumption with rising income and changes in diets. Assume further that the contribution of irrigation to that increment in food production is equivalent to the contribution of irrigation to all food production (about 40%), another very conservative assumption, since in the last spurt of agricultural production, the green revolution, irrigation accounted for about 80% of the increment. Assume further that all irrigation systems achieve water-use efficiency of 70% at the basin level, a remarkable achievement if it were come to pass. The International Water Management Institute (IWMI) shows in 2025 an increase of 17% in the demand for water for irrigation. (Relaxing any of these assumptions results in concomitant forecast increases in the size of the deficit.)

If this additional water for irrigation is not forthcoming, then the increases in rain-fed agriculture to meet the demand in food for nearly eight billion people will be enormous and would have very detrimental environmental impacts. It would require that far more land be cleared for agriculture with losses of forests and habitats, and biodiversity on a massive scale.

These increases in the demand for irrigation water are likely to be matched by increases of 20% and 70% in the demand for water for industry and municipal use.

What of the supply side? Our supplies of fresh water are not evenly distributed in space or time. Our ability to use these supplies depends in part on the frequency and magnitude of floods and droughts that, according to the Intergovernmental Panel on Climate Change, are both likely to become more severe. What are the possibilities of increasing the proportion of rainfall that is captured? The traditional approach has been to build more dams or tap groundwater. As with all other aspects of water management, local circumstances vary widely. For example, while about 70% of hydroelectric potential is tapped in developed countries, in developing countries the figure is less than 20%.

Dam construction may continue to play an important role in some developing countries, but only if there is much greater attention to options assessment, social and environmental impacts and participatory decision-making processes. About 300 new large dams (higher than 15 metres) are being added each year to the more than 45 000 in existence. The recommendations of the World Commission on Dams, due in November 2000, are expected to provide clearer guidelines on when dams are appropriate, and on how they should be planned, designed, built and operated.

In many settings there is also scope for increasing rainfall capture through traditional water-harvesting methods, and through groundwater storage. These environmentally friendly approaches need to be better known and more widely used. But there are also losses on the supply side—an estimated 1% of dam capacity is lost annually due to silting.

Desalination is sometimes seen as *the* supply-side solution. In recent years,

driven by technological advances and declining energy prices and better management, the cost of desalination has declined sharply. All indications are that this technology will play a major role in providing water to coastal cities and industries, but it is unlikely that it will be cheap enough to provide water for the cultivation of most food crops. Treated wastewater can be used for agricultural purposes, and new technologies can reduce the cost of this treatment, but the bulk of water for agriculture will come from elsewhere.

In short, it is obvious that under current trends the arithmetic of water does not add up. Already our aquatic ecosystems are severely stressed—witness the Aral Sea and the Florida Everglades. Increasing withdrawals by the amounts described above would impose intolerable stresses on the environment, leading not only to loss of biodiversity, but to a vicious circle in which the stressed ecosystems could no longer provide the services for plants and for people. Unfortunately, only in very limited regions do we have precise figures on how much fresh water is available and a good knowledge of its quality. Systematically obtaining and updating such information is a necessity for sound water-management decisions in the future.

2.4 Building on Past Efforts, but Going Beyond

Experience also shows that major improvements can and have been made in the way in which water is managed. In recent decades many industrialized countries have made tremendous progress. Water quality has improved, as witnessed by such 'showcases' as salmon returning to the River Rhine. Participatory river basin management has become a reality in France and elsewhere, and the quantity of water used, both in absolute and per capita terms, has actually declined in the United States over the past decade. While serious water problems persist in rich countries, the situation is far more challenging in developing countries. On almost all counts—service coverage, scarcity and water quality—poor countries have much worse starting conditions, and they have rapid growth in demand not only for people but for food, for industry and for the generation of electricity. And since three billion people in developing countries still live on less than two dollars a day, these countries have only a fraction of the financial resources available compared with industrialized countries.

What is obvious is that progress, especially in developing countries, is much too slow and that, unless there are drastic changes, water shortages and environmental degradation will become the norm. More people than ever will be added to some of the areas of the planet that are already most vulnerable socially, economically and environmentally.

This Commission pinpointed two areas that need to be given immediate and high priority if the world is to escape the doom of the current water arithmetic. These two areas are full-cost pricing coupled with innovative approaches to subsidies, and technological innovation. We believe that these will be the instruments that make the overall approach of holistic IWRM and participatory governance yield their hoped-for results. Implementing these measures will require political will, and does imply changes from current practices. But if more people are to achieve higher standards of living we need to make some hard choices. The future is not for more of the same. It cannot be. But the future can be bright only if we are ready to act. And act we must.

3. A Holistic Vision: Articulating the Vision as Seen by the Commission

3.1 Inspiring but Difficult Goals

Every human being should have access to safe water for drinking, appropriate sanitation, and enough food and energy at reasonable cost. Providing adequate water to meet these basic needs must be done in a manner that works in harmony with nature.

Such is the vision. What does it mean in terms of technology, institutions, incentives, behaviour change and investments, in order to bring it about in the next 25 years or so?

Four key points have to be made. First, it is essential to take a holistic approach to integrated water resources management (IWRM). Decisions on IWRM must be participatory, technically and scientifically informed, and taken at the lowest appropriate level but within a framework at the catchment, basin and aquifer level, the natural units by which nature manages water.

Second, technology must, can and will change radically in order to adapt to the needs of the more water-conscious world. Less wasteful, more sensitive to the environmental and social dimensions of decisions, these technologies will draw on traditional wisdom as much as they will harness the revolutionary changes taking place in the biological, information and energy fields. But technology alone will not bring about the more desirable future. It will require behavioural change at all levels of society, everywhere. And, indeed, technological change is not exogenous, but will happen only if society provides stimulation and incentives for this innovation.

It is important to underline that this Commission does not believe that technological changes alone are enough, nor does it believe that just by changing institutional arrangements we can achieve the desired outcomes. The future of hope that we sketched out in that vision can come about only if there is wide adoption of the best existing technologies and practices, and rapid innovation and adoption of both institutional arrangements and new technologies.

Third, these institutional and technological innovations and changes will not come about unless water's economic and social, environmental and political dimensions are adequately taken into account. This means full-cost pricing complemented by targeted subsidies, thus freeing the public sector to focus on what only it can do better (make decisions on welfare and the provision of public goods), freeing the private sector to do what it does best (provide cost-effective services in an accountable and transparent way, and mobilize investment).

Fourth, to bring about changes of the magnitude required (see Table 1) will require enormous funding, appropriately mobilized and targeted. The Commission has estimated that in order to reduce the number of people without water and sanitation services to about 330 million (reductions of 75% and 87% respectively), and to increase average caloric intake in developing countries from the current levels to no less than 2750 calories/per capita/day (c/pc/d) and where possible to 3000 c/pc/d or better, will require more than doubling of investment levels from the current level of about US\$70–80 billion a year to about US\$180 billion a year. This will not come about without the systematic adoption of integrated water resources management, full-cost pricing, targeted subsidies to the poor and marginalized, and the mobilization of the vast labour inputs available in poor rural communities. This will require an unremitting

Table 1. The vision of what is possible and what it will take to get there

Country/region	1995	2025 vision
China:		
Population (billion)	1.20	1.52
Lacking access to safe water (billion)	0.40	0.08
Lacking access to sanitation (billion)	0.93	0.08
Average calorie consumption (cal/cap/d)	2800	>2750
India:		
Population (billion)	0.93	1.30
Lacking access to safe water (billion)	0.18	0.07
Lacking access to sanitation (billion)	0.72	0.07
Average calorie consumption (cal/cap/d)	2400	>2750
Sub-Saharan Africa:		
Population (billion)	0.58	1.13
Lacking access to safe water (billion)	0.29	0.06
Lacking access to sanitation (billion)	0.33	0.06
Average calorie consumption (cal/cap/d)	2200	>2750
OECD:		
Population (billion)	0.87	0.93
Average calorie consumption (cal/cap/d)	3300	3550
Total developing countries:		
Population (billion)	4.76	6.53
Lacking access to safe water (billion)	1.3	0.33
Lacking access to sanitation (billion)	2.6	0.33
Average calorie consumption (cal/cap/d)	2600	>2750
Annual investment in water (billions \$)	70–80	180

Note: All estimates by the Vision Secretariat.

effort at public awareness, at engaging all parties everywhere on water issues, and ensuring that the institutional fragmentation that has hampered past endeavours at holistic approaches to water management will be overcome.

Even if the changes brought about are not sufficient to meet the desired targets set out in consonance with the goals of the vision, the processes for meeting them are those indicated here. If the processes suggested above are followed we are sure that most of the poorest populations will be able to meet their water needs by 2025. But the main need is to get started now, and to launch the new approaches, where the best practices of the few will become the standard practices of all. This will generate the necessary investments from the private sector and community resources, but we must ensure that governments will provide the enabling environment and the requisite targeted and transparent subsidies, which would run in the tens of billions of dollars, to ensure adequate access for the poor. This would be far less than public spending in the conventional mode that would simply perpetuate 'business as usual' approaches.

In the following sections we spell out in more detail these various recommendations which we consider as all mutually reinforcing and certainly needed. If we have devoted less space to some (e.g. participation) than to others (e.g.

pricing), it is because we believe the former is better known and understood than the latter, not that it is less important.

3.2 Why Integrated Water Resources Management?

Arguably the biggest task is going to be manage the allocation of water for direct use of water to meet human needs and protect the ecosystem. Arbitration of claims among competing users is needed, and it cannot be done in a vacuum. It requires that we shift the framework of analysis from the narrow views of sector users or the artificial boundaries of administrative and political units to the natural boundaries of the catchments, basins and aquifers. Only thus will the quantity and quality issues be adequately addressed in a coherent framework. This framework incorporates the intersection of three complex and rapidly changing systems: the environment, of which water is a vital part for all living things; the hydrological cycle, which governs the flow and regeneration of water; and the human socioeconomic system of activities.

In an increasing number of river basins and aquifers around the world, water is already fully or over-allocated. A vital task is that of simultaneously reducing (or capping) abstractions and allowing new, high-valued claimants access to water, while protecting the needs of the poor and the environment. This problem is, of course, most acute in arid areas of the world. In many of these arid countries—including the Western United States, Australia, Chile, Mexico and Brazil—the phenomenon of formal water markets is being established and maturing. Formal water markets are a central part of a solution to the classic common-property-resource problem. This involves restricting access by potential new claimants, and creating incentives for existing claimants to manage the resource instead of overexploiting it, usually by assigning rights to the resource. In this government plays several vital roles, namely in facilitating and sanctioning the organization of users into basin and aquifer associations, in protecting the legitimate interests of third parties, and acting as partners by providing information, and helping monitor and enforce agreements.

The great benefit of water markets is that they provide users with clear signals on the opportunity cost of the resource, and strong incentives for water to be voluntarily transferred from low-value (often environmentally destructive) uses to high-value (often more environmentally responsible) uses. And in so doing they often negate the need for further construction of dams and other water control structures. The use of water markets has spread rapidly in the past decade and they undoubtedly will play a major role in the future. Water markets require the establishment of property or sharing rights for water. These must be established at the surface or groundwater basin level. They must take into account traditional rights. This process is complex and requires careful management in basins within a single sovereign country. And they are undoubtedly even more difficult to manage in the case of international waters.

Is the environment a claimant for water competing with human uses? Clearly not. The environment (broadly defined) is the foundation on which the entire ecological and hydrological systems function and thus must be seen as part of the reality we are dealing with. Human uses are the ones to be arbitrated but in a context that ensures the maintenance of the robustness of the underlying ecological and hydrological systems, their ability to regenerate from the vagaries

of seasonal or long-cycle fluctuations, and continues to sustain the growing human and biological populations that will rely on them for its existence.

To understand the boundaries of the acceptable levels of human interference with the environment will require both more data and research than are now available, and data which are publicly available in forms that can create awareness and guide decision making. This is an area that requires priority research. But ensuring attention to environmental concerns can be helped by making decisions at the basin level.

So what can be done to increase the adoption of basin- and aquifer-level management?

3.3 How to Do IWRM: Basin- and Aquifer-level Associations

If the IWRM principle is adopted, then basin-level systemic management is clearly needed. Every river basin system should be managed holistically. Accordingly, governments should set up management agencies at the basin and aquifer levels, and international funding agencies should be willing to support and help finance the setting up and strengthening of such agencies.

For this recommendation to be operational in each case, some clarifications are needed. There is clearly a hierarchy in space: catchment, basin, sub-basin, etc. Each is nested within the larger one. They are part of an organic whole. The functions of the basin agencies must also reflect that hierarchy, with decision making pushed down to the lowest appropriate level, known as the principle of subsidiarity. But clarification is needed for how a geographic-based agency relates to the mandate of the sectoral agencies and the administrative/political units that do not generally correspond to the basin boundaries. This clarification will be needed and codified in each case for effective action to flow from the institutional arrangements and to avoid these new agencies becoming only another bureaucratic layer that contributes to the current and ongoing fragmentation of decision making in water.

There must also be clarification of the decision-making processes within the basin organization and accountability arrangements for those making the decisions. The experience of water parliaments needs to be generalized, so that all stakeholders have a voice in the decision making.

The creation of such agencies is consistent with two global trends: the demand from stakeholders to play a role in managing their resources, and the related trend towards greater devolution in all countries. Going back to the historic experience in the Ruhr Basin in Germany at the beginning of the twentieth century, a model for participatory basin management has developed. The German model was adapted and scaled up by France in the 1960s. In recent years many countries, including Mexico, Brazil, South Africa and Zimbabwe, have adopted somewhat similar approaches to basin management. A central feature is the integration of participation and the use of economic instruments. It is not by accident that the French basins are governed by 'parliaments', and that they are known as River Basin *Financing Agencies*. For it is money that is the lubricant of accountability in these systems, which raise most of their revenues from user fees and polluter fees, and apply these to priority public works, many for environmental improvement, in the basins.

It is equally imperative that decision making must be informed and scientifically and technically sound. Effective river basin management thus walks

on two legs: (1) parliaments where users make policies and decide on the raising and spending of money; and (2) excellent technical agencies which provide the parliaments and users with the raw and processed information necessary for management.

3.4 International Waters and National Sovereignty

If we accept the principles of integrated water resource management, we must recognize that some 260 rivers are shared by two or more countries and that we need to promote ways of minimizing conflicts between riparians and advocating best use of the water at the basin level. Actually, many of these rivers have brought countries together and promoted collaboration between countries, though not always on issues of water. Transport, trade and many other issues have been actively managed by various mechanisms, and the experiences of the USA and Canada, the riparians of the Rhine and the Southern African countries shows that riparian states do not have to define their relationships exclusively around the sharing of water. In fact, the effective management of water could become a vehicle for collaboration as much as its absence could be a potential source of conflict.

A distinguished group of statesmen—honorary members of this Commission—have looked at the issues of national sovereignty and international waters and produced an independent report as part of this overall vision exercise. It is published separately, but many of its recommendations deserve the attention of the decision makers in riparian states.

Among the helpful ways of thinking about this problem is to note that issues of quantity of water—sharing the total resource—can be a cause of competing claims and possible conflict. Thus dealing with conflict avoidance and possible appointment of an ombudsman or the use of mediation panels should be considered in mature relationships between riparians, relationships that usually involve many other facets beyond water sharing. In limited relationships, it may well be necessary to conceive of confidence-building measures and postpone any firm decisions on the long-term issues as the relationship matures.

On the other hand, the quality issues can more readily be the basis of collaboration, if only at the level of getting the parties together, sharing information and developing action plans. There is valuable experience gained by the Global Environment Facility (GEF), the sole existing global mechanism to help with international waters issues (Box 1). The GEF can help finance the necessary actions and promote cooperation.

Box 1. Cooperation in managing transboundary waters: role of GEF

With 50% of the earth's land surface consisting of transboundary basins and 70% of the surface in oceans, the majority of the world's water resources must be managed internationally as transboundary ecosystems. These waters are included as one of the four focal areas of the Global Environment Facility (GEF), which was created as a pilot programme in 1991 and restructured by the world community in 1994 as a permanent financial mechanism. GEF provides grant and concessional finance for the incremental cost of measures that generate global environment benefits in its four focal areas (climate change, biodiversity, international waters and

ozone depletion, as well as land degradation as it relates to the four focal areas) through its implementing agencies (UNDP, UNEP, and World Bank).

Approximately 55 international waters projects are under implementation or preparation with GEF funding as a result of requests from 113 countries. They range from familiar river basins such as the Danube, Mekong, Nile, Okavango, Niger, Senegal, and the Upper Paraguay River to shared lake basins such as Titicaca, Malawi, Victoria, and Ohrid and coastal oceans such as the South China Sea, Bay of Bengal, Gulf of Guinea, W. Indian Ocean, Black Sea, Red Sea, Yellow Sea, Mediterranean, Baltic, and the Caribbean. Of significance is that GEF does not just consider the basin or the ocean separately but seeks to integrate consideration of the impact of adjoining fresh water basins on coastal waters as part of its comprehensive approach to land and water resource management. This approach was adopted by the GEF Council in its 1995 Operational Strategy.

International law on shared waters is rather weak at present. It is remarkable that even the limited and relatively weak United Nations Convention on the Law of the Non-Navigational Uses of International Waters has taken twenty years to negotiate and is still at risk of not being ratified.

Surely, weak as it is, it deserves to be approved if only as a first step towards a greater appreciation of the international character of water in the future. In the meantime, the doctrine (embodied in the Convention) of no appreciable harm to other riparians and equitable and reasonable treatment of the precious resource must be the guide for pragmatic action in internationally shared river basins.

Beyond these issues, we specifically note that the issues of international groundwater are far less well known or understood than those of surface water. But management of international aquifers poses many of the same issues of traversing international political boundaries and issues of quantity and quality aspects of groundwater management will be as crucial as surface water management in the years ahead.

Experience shows that countries can and do work together to address international water issues. The experiences of cooperation on the Rhine and the Great Lakes are well known. The end of the Cold War, and the associated search for peaceful, cooperative international relations has had a profound and positive impact on international water management. Riparians are now working actively in many river basins—including the Mekong, the Danube, the Nile and the Zambezi—in trying to work out mutually agreeable management arrangements. And some countries have unilaterally ‘raised the bar’ for others. South Africa is a shining example, by acknowledging international law and obligations within its constitution thereby recognizing the rights of its neighbours to waters from rivers which originate in South African territory.

3.5 Participation is the Key

The key to make the IWRM-inspired institutional reforms work is the participation of all the actors in the decision-making process. This means governments, both national and local, the private and public sectors, the formal and the informal, the civil society, women’s groups, the NGOs, the community-based groups, the professional associations, the environmental groups and users’

associations. Only by the participation of these key actors at all these levels will it be possible to enunciate policies that will have broad support and put in place mechanisms of decision making that will have legitimacy. In this effort, it is essential to ensure that a special outreach effort is made to empower women, minorities and the poor to fully participate in the processes of decision making. It is essential to avoid tokenism in such efforts.

So central is the idea of participation that we consider it the second essential pillar along with IWRM. To make this happen, however, experience shows that exhortations alone are not enough, and that there will be transparency and accountability only when financial arrangements are consistent with participatory management. Accordingly, we now turn our attention to the issue of pricing.

3.6 Pricing

The Commission members agreed that the single most immediate and important measure that we can recommend is the systematic adoption of full-cost pricing for water services. This recommendation is based on the following observations:

- Far too few public resources are devoted to public goods, most especially environmental enhancement. Even in many middle-income countries of Latin America, for example, less than 10% of sewage is properly treated. Economic growth is an essential pre-condition for greater investment in these public goods. But it is also essential that a much greater proportion of available funds be used for public goods, rather than for subsidizing what are largely private urban water supply and irrigation services.
- Free water leads to wasted water. When water is metered, consumption drops. Where services are free, the result is inevitably politicization of the concerned agencies, inefficiency, lack of accountability, capture of the subsidies by influential groups, and a vicious cycle of poor quality services, insufficient resources for operation, maintenance and investment, and water rationing. In virtually all cases it is the poor who end up without access, who end up paying exorbitant prices for inferior and unreliable services provided by unregulated vendors, and who end up bearing the brunt of environmental degradation.
- This means that the considerable resources invested in the water and sanitation sectors in developing countries—estimated at US\$30 billion a year—are used inefficiently. In most urban water systems unaccounted-for water accounts for as much as 50% of total water production and in some instances even as high as 70%. In many public irrigation systems only 30% of water supplied is actually used by plants. This is unacceptable in a situation where half of the population of the developing world lives on less than US\$2 a day, where over one billion persons have no access to clean water and two billion lack adequate sanitation.
- Governments in developing countries cannot meet the investment demands for water services now, let alone in the future, even while they are under-investing in public goods. The main alternative is to attract private investment for urban water and sanitation and for irrigation services. But it is axiomatic that private parties will not invest unless they can be assured of a reasonable return on their investments and they can be assured that political risks are

acknowledged and managed. There is no rabbit to be pulled out of a hat—this return has to come from those who benefit from the service provided.

The situation is clear: without full-cost pricing the present vicious cycle of waste, inefficiency and lack of service for the poor will continue. There will be little investment from the private sector, services will be of poor quality and rationed, there will be little left for investing in water quality and other environmental improvement. The corollary is that there could be a 'virtuous cycle', too. This could be one in which users pay for the services they want, in which urban utilities and irrigation agencies provide these services efficiently and accountably, in which users pay the costs of these services, in which investors place their money, and in which public funds are used primarily for public purposes. Fortunately, there is evidence that such a virtuous cycle is possible, and that it is possible, with political leadership, to make the transition from vicious to virtuous cycle.

A reality in many developing countries is that many people are poor and cannot afford to pay the full costs of conventional water and sanitation services. Experience has shown that there are several core ingredients in addressing this central problem. First, it is necessary to recognize that it is a legitimate, indeed central, role of government to provide safety nets for poor people. Second, it is imperative that subsidies be provided to people, not to service providers. As shown in Box 2, this both ensures that service providers are accountable to poor people, and allows service providers to do what they should be doing, namely focusing their attention on providing the best service at the least cost.

Box 2. Water stamps in Chile

In Santiago, Chile, the government realized that it was inherently contradictory to require that an urban water utility function as a commercial entity and provide subsidized services to the poor, since each subsidized person served would represent a loss of revenue to the utility. Accordingly, the government decided to institute a targeted, means-tested, government-administered 'water stamps' programme, whereby poor people would get 'stamps' which would cover part of their water bill. The utility then not only strengthened its focus (getting out of the welfare business and focusing on becoming the most efficient utility it could), but now had a clear incentive to serve the poor, who became revenue-generating customers like all others. The system works well.

Third, it is imperative that poor people be offered choices from a menu of services, of different costs and qualities, and that this include the possibility that they reduce financial costs by mobilizing their own labour. The experience of the condominium sewerage system in Brazil and Orangi Pilot Projects in Pakistan (Box 3) shows how innovative approaches not only work properly but also offer choices to people.

Box 3. How users are involved in choosing and producing urban sanitation in Brazil and Pakistan

The condominium sewerage system in Brazil represents a remarkable tech-

nological and institutional innovation for dealing with the sanitation needs of poor people. The technological innovation was to recognize that the costs of the feeder sewers (within neighbourhoods) could be dramatically reduced by laying low-slope shallow sewers through the backyards of blocks of houses. The main elements of the accompanying institutional innovations were: (1) to give people choices of service level and cost, with the lowest-cost system costing about one-third of a conventional system; and (2) developing a system of 'co-management', whereby the utility is responsible for the trunk infrastructure and the community for the feeder infrastructure, thus involving the community in the management of their neighbourhood sewers. Finally, because of the greatly reduced responsibility of the utility, its operating costs are sharply reduced. The condominium system is now providing affordable service to millions of poor people and has become 'the method of choice' in many cities, including the national capital of Brasilia.

The Orangi Pilot Project in Karachi independently blazed a path which is similar in many ways. In this case an innovative NGO works with communities in building low-cost sewage-collection networks, the costs of which are fully paid by the communities themselves. These sewers now serve about one million people in a low-income area. This has freed the utility to concentrate its limited resources on constructing trunk sewers and treatment plants.

Full-cost pricing has long been advocated in the irrigation sector, and yet has seldom happened. It is clear that it cannot and will not happen unless it is preceded by a fundamental reform in the service agencies. Farmers, quite reasonably, resist paying for services when they have no say about what these are, and when they know that the irrigation agencies are inefficient and corrupt. As is demonstrated so clearly in the reform of irrigation in Mexico and Victoria, Australia, putting users in the driver's seat is a necessary condition for full-cost pricing in the irrigation sector (Box 4).

Box 4. Irrigation reform in Australia and Mexico

Australia

Farmers in Australia, as elsewhere, had long been accustomed to receiving government subsidies for their irrigation services. In the 1990s a series of events led to fundamental change in Australia in general and irrigation services in Victoria in particular. The precipitating factor was a state fiscal crisis, and the decision, *inter alia*, to eliminate all subsidies to irrigation. Farmers reacted strongly, but once it was clear that there was no going back on this decision, made several fundamental changes. First, if they were to be paying the full costs of irrigation services, then farmers insisted that the irrigation agencies in different districts become accountable to them. Although the previous agencies were considered to be good operators, this increased accountability led to cost reductions of about 40%, without any loss of service quality. Farmers are also responsible for all future replacement and investment costs, and have thus made sure that all large capital expenditure items are subject to the question: 'is it worth it?'.

In many cases they have found that they can eliminate some substantial new capital expenditures by accepting slightly less reliable services, and have chosen to do so. After initial suspicion, farmers have also enthusiastically embraced the practice of tradable water and salinity rights as mechanisms for ensuring that water is allocated voluntarily to the highest-value uses, and away from environmentally destructive areas. The users' associations have rapidly expanded their concerns into environmental management, and have become cornerstones of Australia's innovative Landcare programme.

Mexico

The Mexican story has many similarities. In 1992 the Government of Mexico passed a new Water Law, which largely embodied the Dublin/Rio Principles. Of particular note were two features: enshrining the principle of participation, from the irrigation district to the river basin management level, and formalizing property rights in water. The reform of the irrigation districts has been a remarkable success, and has proved to be an inspiration for similar reforms in places as diverse as Turkey and India. At the heart of the 'irrigation turnover process' was the idea that farmers could form users' associations which could manage the irrigation districts. In less than a decade, the results have been impressive. Over 92% of the 3 million hectares in irrigation districts have been turned over to the users' associations. This involves almost 400 associations and about half a million farmers. With users in the driver's seat, many good things have happened. Cost recovery has risen from around 30% to 80%. In some cases, users' associations have mobilized their own funds for rehabilitation and investment. And in some cases, as in the coastal aquifers of Sonora, users' associations have evolved in groundwater management agencies, with remarkable effect. In Hermosillo, for example, users have voluntarily reduced pumping by about 50%, bringing pumping and recharge into balance. This has been made possible both by participation, and by the fact that those who need water for high-value crops are able to obtain it through transactions in the water market.

An important difference in the reality of the urban water sector and the irrigation sector is that urban water systems are primarily a local issue, whereas farmers are deeply and increasingly exposed to the forces of a globalizing economy. On the one hand the forces of economic liberalization are positive, in that they remove one of the main arguments for water subsidies, namely that output prices were suppressed. In many developing countries most of the input and output price distortions have been substantially removed. In Mexico in 1990, for example, price and input subsidies accounted for about 30% of value added in agriculture. Today these distorting subsidies have largely been eliminated. On the other hand, there is one very fundamental block to completing this revolution, namely the protectionist agricultural policies of some industrialized countries. These policies are estimated to cost developing countries US\$20 billion a year in lost revenues (and for consumers in industrialized countries, welfare losses of US\$60 billion!). What are developing countries to make of the rhetoric in favour of capital liberalization when rich countries—with full employment

and strong safety nets—do not implement similar policies themselves? This Commission, accordingly, urges the rich countries of the world to eliminate their own agricultural subsidies. This will enhance the welfare of their own people, and also open markets for agricultural products from developing countries, and facilitate the end of environmentally destructive subsidies on water and energy for water pumping in developing countries.

Finally, it is pertinent to note that the recommendation on full-cost pricing of water services is not new, and yet it has been practised far too infrequently. What can be done to help make the transition from the 'vicious cycle' to the 'virtuous cycle' (of which full-cost pricing is a central element)? As with all reforms, it will require ingenuity and political commitment and adaptation to local circumstances. The experience of the city of Conakry in the West African country of Guinea (Box 5) is enlightening. It suggests that an essential element will be to use targeted, time-bound subsidies to attract first-class service providers who can be paid the costs of their services and can provide users with high-quality services. Once service quality is improved and consumers are informed about costs, subsidies can be phased out gradually.

Box 5. The transition from low-level to high-level equilibrium in Conakry, Guinea

In Conakry, Guinea, the performance of the water utility in the late 1980s was catastrophic: water for only a few hours a day, with the poor, as always, 'at the end of the line'. The familiar 'low-level equilibrium' prevailed—service was poor, people were not willing to pay, revenues were inadequate, service got worse and so on. The government made creative use of an external credit to get to a 'high-level equilibrium'. The assets were leased to a private operator who was paid a fee which reflected the full cost of the service. Users initially paid only about a quarter of this fee, with three-quarters of the operator's fee covered by the external credit. Users were informed that service would improve, and that as it did tariffs would be increased to cover costs over a five-year period. Although problems remain, this innovative approach worked well with coverage increasing by 300% in the first five years of the contract.

The issue of pricing, in summary, is, in the views of this Commission, central for three reasons. First, experience shows that clarity about who is paying for what, and what the resources are being used for, is an essential requirement for accountability and participation. Second, pricing is a key element in eliminating waste and environmental degradation. And, third, pricing is central if the required quantum leap of investment in the sector is to occur.

3.7 Technologies for Tomorrow

Beyond the institutional issues are the questions of technology. Without major technological innovation, there is little hope of bringing the water equation into balance. There is no doubt that many technological changes can help improve services for millions and reduce the stress on water systems around the world.

Technological innovation exists at many levels. At the community levels innovative on-site sanitation technologies such as ventilated improved pit

latrines have played a vital role, as have low-slope shallow neighbourhood sewers made famous by the condominal system of Brazil and the Orangi Pilot Project in Karachi (see Box 3). And there is much innovation to be made in recapturing the wisdom of the past, as has been demonstrated in rain-harvesting systems in India (Box 6) and China. This is also important in looking for traditional plants and wild races in breeding more adapted crops.

Box 6. Water harvesting in India

Where Indian communities have taken up water management themselves, they have not only ensured that the total investment costs were low but have also contributed substantially to these costs. For example, Tarun Bharat Sangh, an NGO, has been working with over 500 villages in the Alwar district of Rajasthan, which have been encouraged to build through their own efforts almost 2500 water-harvesting structures. These villages have contributed to raise as much as 51% to 92% of the total cost of these structures, and over time, with the success of these efforts, the share of village contribution has been increasing. As of 1997–98, the total investment in the water harvesting structures was Rs150 million (US\$3 million), of which Rs 110 million had come from the villagers. The structures were also built by the village communities at extremely low cost—ranging from a low of Rs2 (US\$0.04) per cubic metre of storage capacity to a maximum of Rs3 (US\$0.07) per cubic metre.

There are also vital needs for ‘high-tech’ innovation. In some cases the application may be mundane, for instance in the application of computer chips to control the digestion process in ‘smart composting toilets’. In other cases, such as so-called ‘precision agriculture’, it will mean the integration of drip technology, computerized sensors of evapotranspiration requirements, and just-in-time and just-where-needed application of water and fertilizers. In recent years breakthroughs in membrane technology have had profound effects in many areas, ranging from waste treatment to desalination.

A particularly important, promising and controversial area of innovation is biotechnology. Today, a revolution is taking place in the biological sciences. It is fuelled by the groundbreaking work in modern molecular genetics, the breathtaking advances in informatics and computing, and the enormous private sums being invested in biotechnology research. While taking care of both the short-term and long-term possible consequences, the benefits of that revolution can and must be harnessed for solving the challenges of water in the interests of the poor and the environment.

Today, we are living in a time unmatched for the opportunities that it provides. New higher yielding plants that are more environment friendly and more drought tolerant, plants that can grow in brine or have increased salt tolerance, edible vaccines, single-cell proteins to feed cattle and clean wastes, hyper-accumulating plants to take toxins out of the soil, and so much more. All of that, coupled with agronomic techniques suitable to the smallholder farmer, can be marshalled in the coming years to yield ‘more crop per drop’ of water.

Box 7. The promises and challenges of biotechnology

Despite the success of the Green Revolution today, we require a Doubly Green Revolution, a revolution that is even more productive and even more 'Green' in terms of conserving natural resources and the environment, and one that reaches the less favoured areas bypassed by the first. This is a tough demand, but we believe it can be met by a combination of (1) ecological approaches to sustainable agriculture, (2) greater participation by farmers in analysis, design and research, and (3) the application of modern biotechnology directed toward the needs of the poor in developing countries, in particular those living in drought-prone areas.

Biotechnology can help by harnessing the enormous power of the new knowledge about genes and their functions, and the ever more sophisticated techniques for manipulating genes. Plants that are more resistant to salinity and drought, whose metabolism requires less water, are a direct way in which water requirements in agriculture can be reduced. Likewise, developments in pest resistance (thereby reducing chemical pesticide use) and nitrogen-fixing ability (reducing fertilizer use) could reduce pollution from agricultural runoff. Furthermore, single-cell proteins for animal feed to reduce the need for crop residue consumption, or breaking the cellulose-lignin link to increase digestibility of such crop residues could all increase biomass suitability for more grain production for humans with the same amount of land and water. Biotechnology could also help in wastewater treatment for agricultural reuse. Finally it could help increase yields in rain-fed agriculture, thereby reducing the pressure to expand cultivated land areas with its negative impacts. All this is in addition to its expected contribution to yield increases in irrigated agriculture. To reach the hands of hundreds of millions of very poor farmers and to address the needs of the environment, many of these biotechnology research programmes may be of the public goods variety. They would require public funding for implementation through the CGIAR or other international or national not-for-profit agricultural research bodies.

The energy changes of the future will have equally profound implications. As energy costs have dropped (a trend which is expected to continue in coming decades) and as new technologies have been introduced, the cost of desalination has plummeted to less than a dollar per cubic metre. It is quite conceivable that further advances could lead to desalination becoming the 'source of choice' for municipal and industrial use in coastal cities.

The technological possibilities are tantalizing, and must be a central part of overcoming the 'gloomy arithmetic of water' described earlier. But technological innovation does not happen in isolation, and so the question becomes: What is needed by way of public policy to create the right climate for innovation and to ensure that these innovations are used to address the problems?

As described earlier, a major recommendation of this Commission is that there should be full-cost pricing for all water services (with governments dealing with subsidies in a transparent and targeted way). This will result in a huge increase in the role of the private sector as a provider and financier of water services to people and agriculture. Not only can this mobilize large-scale investments, but also it will mean that the private sector will be motivated to find ways of

providing better services at lower cost—in short, to innovate. There are, however, some areas where innovation will not happen without special attention. The question is whether the appropriate research will be done and whether the deployment of the appropriate results in the right places will be undertaken. This is not trivial, for there is a real danger that the benefits of proprietary science, driven by profits and patents, will focus on the needs of the wealthy or of services and products that can be sold in the large markets. This would serve to bring more and more to the privileged few rather than serve the needs of the billions of the marginalized poor and their children.

Provocatively, we can say that the oil price shock of 1973–74 revolutionized the attitudes of the world towards the energy sector, prompted conservation measures in the most profligate societies, and spurred investments in alternative and renewable energy sources. We need the same awakening of public consciousness concerning water.

What ties the prospects of these technologies together? It is the necessary framework for research and application that must meet three requirements:

- adequate incentives for the private sector to do those parts that they are well equipped to do;
- recognition of the value of traditional knowledge and technologies that can be re-evaluated and adapted to the needs of the location and the people concerned;
- recognizing the public goods nature of much of the environmental or other aspects that will require an effective programme of public-sponsored research and development.

3.8 No Silver Bullet, but an Integrated Package of Reforms

Every human being, now and in the future, should have access to safe water for drinking, appropriate sanitation, and enough food and energy at reasonable cost. Providing adequate water to meet these basic needs must be done in an equitable manner that works in harmony with nature.

It is clear that in striving to meet these lofty goals, we both face an unprecedented challenge and have an unprecedented set of capabilities for dealing with this challenge. It is equally clear that there is no silver bullet, in terms of either institutional reform or technologies.

- Full-cost pricing cannot happen unless service institutions are efficient, transparent and accountable to users, and unless government gives poor consumers assistance in paying their bills.
- Participation cannot work unless users are able to raise financial resources and use these for purposes they agree upon.
- The private sector will bring neither its money nor its know-how and management skills unless it can operate in a predictable, transparent regulatory environment, and unless it can get a reasonable return on its investment without undue political interference.
- Public providers will not be efficient unless they compete on a level playing field with private providers.
- Government will not spend enough on environmental protection unless it is able to get out of the business of large-scale subsidization of private services for which other alternatives are available.

What is equally clear is that it is possible to make this package of reforms work in the real world. To varying degrees a number of countries—several of which are referred to in this report—have already taken important steps down this road. The hope of the Commission is that the meeting in the Hague will lead to a redoubled effort to move more broadly and faster down this road. This and the role of each of the various actors is the subject of the next section of this report.

4. A Framework for Action: Necessary Steps to Turn Vision into Reality

4.1 Water Management is Everyone's Responsibility

When sketching out a vision of the future in this fashion, we are often asked: Who will implement this vision? Where will the funds come from? Who will make it happen? It is as if the person asking was not concerned—as if it was the responsibility of others to 'make it happen' and the speaker would be an observer or critic or evaluator of the actions of others. This is not so. Water is everybody's concern. Water management involves every person on this planet from the simple act of how they personally use water to the more direct involvement of how they see others use water in the home or on the job. Each has a role to play as concerned citizen and member of a community and as someone whose views must be heard on the topic in all these forums, be they formal or informal, specialized in water issues or simply forums that bring people together for other purposes.

We hope that this report will contribute to launching a worldwide movement for the better management of water. Having already spelled out the philosophical approach (integrated water resource management) and the institutional approach (participatory, basin-level organizations) and some of the key measures (full-cost pricing, targeted subsidies) let us address the issues of the scale of the challenge and the funding issues before we turn to the responsibilities of the principal actors.

4.2 Scale of the Challenge and Funding Requirements

How much investment will be required to reach the vision of a world where every human being, now and in the future, should be able to have enough clean water for drinking and sanitation, and enough accessible food grown with adequate water?

Let us try to impose some orders of magnitude. However, given that agriculture is responsible for so much of the withdrawals, a clarification on the issues of food security is in order. Food security does not mean food self-sufficiency in each country, i.e. that each country would grow within its own borders all the food required by its citizens. While most countries are expected to continue to grow the bulk of their food requirements nationally, both comparative advantage and water-use efficiency considerations will suggest that trade will play a larger role in meeting the quantitative needs for caloric coverage. After all, it takes 2000 tons of water to grow a ton of rice, and some 1000 tons of water to grow a ton of wheat. Besides, food security is about many things of which production is the most important but certainly not the only one. Food security involves recognition of access to the available food (income and purchasing power). It involves the manner in which the food is produced (ecologically

Table 2. Indicative annual investment requirements (in US\$ billions)

	2000	Vision
Water supply and sanitation	30	75
Agriculture	30–35	30
Environment, energy and industry	10–15	75
Total	70–80	180

sustainable), the complex farming systems of the smallholder farmers in the developing world, the policy framework (removing urban bias against rural and agricultural development), appropriate pricing and inputs, credit and distribution, appropriate technologies, and the nutritional content of the food being produced. Despite fully recognizing this multiplicity of factors that go into ensuring food security, for purposes of this report we are looking only at the water dimension of growing enough food, in an environmentally friendly and socially responsible fashion, to meet the quantitative requirements of global and regional food security. Clearly, much more needs to be discussed in terms of food security but others are addressing this complex though important issue.

Table 2 gives an idea of the level of capital investments that will be required to meet the Commission's objectives. The figures represent investments in new infrastructure only, exclusive of costs of renewing ageing or badly maintained systems, and excluding the costs of operations and maintenance. The total annual investment requirement of US\$180 billion compares with US\$70–80 billion currently being invested. The data are such that there are uncertainties in the numbers. What is clear is that there will need to be a quantum increase in the level and efficiency of investments.

The keys to both making investments more productive and to mobilizing new investments is the set of actions advocated in this report. As detailed in earlier chapters, these include empowering communities to mobilize their existing resources, to make service agencies and water resource management agencies accountable to users, appropriate pricing with transparent and predictive regulations and incentives to mobilize the innovation and investment of the private sector.

4.3 *Defining the Roles of the Different Actors*

If something is the concern of all, it must be clear that each actor has a different and complementary contribution to make in order for this changing reality to be created.

4.3.1 *The role of governments.* The role of governments is absolutely crucial. Even if the vast bulk of the funding required to make this vision a reality will come from the communities as labour and energy, and from the private sector as investments both large and small, to make this possible the governments remain the sovereign bodies that must be the enablers.

Governments' primary responsibilities will comprise the legislative and regulatory framework that governs water, from the creation of national and basin-

level authorities, to providing the enabling framework for community action that empowers the poor, minorities and women's groups to participate fully. Furthermore, their macro-economic policies must be sound, encourage domestic saving and private entrepreneurship, and provide the fiscal incentives for private investments. Their own patterns of investment in land and water must all support and not undermine the general approach we advocate in this report. They must be able to provide an effective as well as transparent and predictable regulatory framework for private action.

While much of this cannot be done without leadership and a reinvigorated public sector, it is evident that this will mostly happen only when there is a demand from voters that the government perform this 'enabling and regulatory role'. As mentioned in Chapter 3, global experiences show that introduction of the private sector as a service provider is (appropriately) accompanied by a demand from consumers that there be transparency, effective regulation and proper service.

But as we move into the era of true public-private partnerships, governments must also ensure transparent and sustained rules for the accountability of public and the private operators alike, enforcement for the polluter pays/user pays principles, and the protection of environmental resources. Finally, governments will be the key agents to ensure that as full-cost pricing is generalized, the offsetting targeted subsidies are in place to protect the poor and are not diverted to the rich, as has happened so many times before. The ideal way to do this is to separate completely the commercial and welfare functions. Not to have subsidies hidden in opaque cross-subsidies, but to have them open and budgeted, with transparent mechanisms for targeting. This should not be confused with graduated tariffs that encourage conservation.

4.3.2 The role of communities and users. The bulk of the contributions in rural and peri-urban areas will come from the people themselves. First it is salutary to remember that many of the poor already pay a huge price for water, typically 5–10 times that which would be necessary to pay the full costs of a well-run piped supply. Nevertheless, credit may be required for many, and microcredit schemes to enable the rural poor to get tubewells, such as the Grameen scheme in Bangladesh, show that micro-finance systems can help. Extensive local knowledge exists for low-impact solutions to water harvesting (as described earlier for India) recharge of aquifers and other means of using water more wisely in rural areas, and experience in Chile, Mexico, Turkey and India show that irrigation users' associations can play a central role. Similarly, the urban-sector experiences from such successes as the Orangi Project in Karachi and the condominium scheme in Brazil show that the urban poor can contribute very effectively by their labour and energy, as well as their savings, in solving the water and sewerage problems of their communities.

As described earlier, transparent, on-budget subsidies to the poor are an essential part of the financing equation. These subsidies should empower local communities to find their own solutions, rather than subsidize the adoption of particular technical solutions, even if technical advice and information must be provided on the quality and quantity aspects of this water management.

But it is essential that users and communities have a central role in the broader picture of sustainable water management. They have a major role in ensuring that service providers are held accountable, and they must be represented in

'users' parliaments', which work with government in managing aquifers and river basins. Such experiences are now emerging. For example there is the users' association which manages the Hermosillo aquifer in Mexico, and which has managed the extraordinary feat of getting 50% reductions in pumping, so that abstractions now equal aquifer recharge. And there are the well-established river-basin financing agencies in France, where users decide on abstraction fees and polluter fees, and on the application of these resources to priority investments. Such approaches are now becoming a reality in countries as diverse as Chile, Mexico, Brazil, Zimbabwe, Indonesia and South Africa.

In all of this, global experience shows that money is the medium of accountability. If users are paying (even if from block grants) they will demand service; if they are not, supply and management agencies will end up as unaccountable, inefficient and often corrupt. If public investments are financed out of user charges (even if supplemented by public resources) users will ensure that these resources are used most effectively.

Finally, local communities should be the guardians of sound water-management practices, including involvement in quality monitoring, in ensuring that polluter pays and user pays principles are adequately enforced, by flagging violations. Their empowerment and participation form the basic building block of any participatory approach. Women's groups have always been a key factor in promoting social capital, providing the glue that holds communities together, and, given the gender dimension of hardship associated with lack of water access, their voices must be heard in all water-related schemes. In short, community empowerment is essential for effective management of water systems and for the protection of the environment.

Box 8. Women and water

Women are the major force in dealing with water in many communities. Their role in managing ecosystems, in agriculture, in fisheries and in marketing are also well recognized. But, whether it is unsafe water, poor sanitation, unreliable service or reduced water supplies, it is women who end up bearing the inequities of the status quo. Unsafe water and poor hygiene lead to increased incidence of microbial diseases, and greater time spent on tending the sick. Unreliable service means that women have to traverse greater distances and spend long hours collecting water for domestic consumption. And water scarcity limits economic opportunities for women because many home-based, small-scale enterprises are adversely affected.

Bringing women into the decision-making loop concerning the planning, allocation and management of water resources is vital. Ensuring that women's needs are addressed should be an essential element of enlightened public policy. These are not Utopian ideas. A review by the World Bank of 121 water projects showed that ensuring women's participation in decision making impacts positively on both project quality and sustainability.

At another level, it is encouraging to note that women professionals are playing an increasingly important role in project design and implementation. For example, in the GAP project in Anatolia, Turkey, 50% of the engineers employed are women. But such examples are few and far

between, and there is an urgent need to replicate best practice examples and make them better known.

The Dublin Conference recognized that central role in a specific 'gender principle' that calls for positive policies to address women's specific needs and empower them to participate at all levels in water resources programmes. It is time to accept and systematically implement that principle.

4.3.3 The private sector. Implicit in all of these reforms is a greatly increased role for the private sector in providing water services for people and irrigation and electric power. There are several levels at which the private sector can make a major contribution.

The first and most obvious is in terms of financing. The hope here is that the water sector can attract a small proportion of the estimated US\$250 billion a year of private capital which now flows to developing countries (and which is now five times the size of official development assistance). And there are signs of hope, with international private investments in water supply in developing countries having risen from virtually nothing to an accumulated US\$25 billion over the last eight years. It is equally clear that there is a lot more money available from the private sector for urban water, irrigation and hydropower-generation services. But it is equally clear that such flows will materialize only if investors are comfortable, which means that there is a predictable, transparent regulatory framework which simultaneously protects the interests of investors and consumers alike.

Second, it is clear that the private sector can considerably improve the dismal technical and financial performance that characterizes most public utilities in developing countries. This means that the large, existing infrastructure and financial resources can be used far more efficiently for greater common good.

Beyond these broadly recognized impacts, there are more subtle but equally important consequences from involvement of the private sector. First, it is important to recognize that the private sector serves less than 5% of all urban water consumers in the developing world. In the foreseeable future most consumers will still get their water services from public companies. These public companies are typically subject to no regulation and have no accountability to or contract with their users. Improving performance of these companies is a vital policy challenge. Emerging experience in many countries shows that the single greatest stimulus to improving performance of public service companies is competition resulting from the introduction of private companies! For it is the insertion of the private sector which catalyses a demand for regulation, for information on comparative performance and for transparency and accountability. It is the private sector which, in the words of one astute observer, "has ended the days of water services as a sleepy backwater, and brought it under the light of public scrutiny".

Private companies also catalyze action on water-resources management. A private company cannot take a contract when it is unsure of the bulk supply of water, for it is its own reputation that is at stake when the tap runs dry. Private companies have thus demanded clarification of often murky basin management rules and water rights. Similarly, private companies have liabilities for wastewater discharges, and again force a discussion of discharge standards and policies.

Finally, although international water companies can and will play a vital role, especially in the initial 'market creating' stage, local companies and local entrepreneurs have a similar positive role to play. It is they who have often enabled people to compensate for the shortcomings of public services. This has frequently been done in a highly competitive environment, in which they have learned to provide people with the services they want and are willing to pay for. It is vital that their initiative and capacity are harnessed as the vital process of regulation takes hold.

4.3.4 The role of international agencies. Official development assistance cannot be the source of financing for the massive investments required. However, it can play a useful role in assuring the financing of complementary services such as research, reforms of governance, and setting up subsidy systems for the poor that must accompany private sector participation.

Two observations and corollaries are important. First, whereas official development assistance was a dominant form of capital ten years ago, these official flows are now dwarfed by private sector flows. The corollary is that official flows must be seen as instruments facilitating the capture of private flows and complementing these flows. Second, it is clear that development assistance can play an enormous positive role when countries themselves have the right policies and priorities, but that conditionality does little to correct policy distortions. The corollary is that international agencies should increasingly be directing their limited financial resources to those countries that have embarked on paths of equitable and sustainable reform. International agencies, of course, must play an important role in providing technical assistance and institutional strengthening to assist countries that want to implement the kinds of actions recommended by this Commission.

The fundamental message is clear: it is the people of developing countries and their political leadership who can and must drive reform processes. Happily there are now an increasing number of political leaders—some of them attending the Hague meeting—who have made the courageous steps which are necessary for reform. It is from their reforms that most of the lessons in this report are drawn. It is the fundamental responsibility of the international community to support them, and other political leaders who have the courage to make these needed changes.

4.3.5 The roles of NGOs and communities. A new alliance of local people, NGOs and agencies focused on water-asset creation and optimal use, offering equal opportunities to all men and women, can make a major contribution to achievement of the objectives of the Commission. Development and support for community-level actions could include:

- watershed action programmes, where local people work with NGOs and research organizations to promote conservation and local empowerment;
- local councils to develop particular programmes and tackle local water-management problems in water-source rehabilitation and pollution;
- basin-level organizations for integrated water management;
- construction of groundwater recharge wells to improve village water supply and improve the management of aquifers;
- integrated disaster preparedness linked to community-level action;

- drought-relief programmes that mobilize work and food supplies in drought-affected communities;
- community action in controlling waterborne diseases;
- local action for monitoring water quality, crop selection and quality control of produce irrigated with effluent water;
- initiatives in integrated pest management (reducing use of pesticides and related pollution);
- agencies to reform water rights and system management in areas affected by diseases such as AIDS, where children and the elderly become new key actors.

4.4 Promoting Innovation

Given the potential of the new technologies and the innate abilities of people, we can expect that enormous gains could be made as new innovations occur in either institutional arrangements or technology application. The latter may be by the rediscovery and deployment of traditional technologies or the emergence of new technologies. A key to get the maximum benefit globally of these new developments will be how quickly they will be adequately evaluated, disseminated and adopted throughout the world.

Innovation also requires some assistance in incubation. Thus an innovation fund may be envisaged that would help promote environmentally and socially desirable technical and institutional innovations. The possibilities are many and varied: they might include support for national 'water stamps for the poor' programmes; time-bound subsidies for transition arrangements (such as that of Conakry described in Box 4); support in providing medium-term 'bridging loans' in countries where long-term capital markets are not developed; political risk guarantees for private operators entering risky markets; new forms of mobilizing NGOs and communities to improve services and protect the environment, and exploring new approaches to negotiation of international water treaties.

In terms of technology there are innumerable opportunities, which include innovations in particular 'orphan' areas such as biotechnology for the food crops of the poor in water-deprived areas. Finally, there are geographic areas with problems that cry out for new approaches. For example, the Indo-Gangetic Plains have very large numbers of poor people and hunger, yet so much water is badly distributed in space and time. It is a very big challenge to work out a water-management paradigm for this area that is environmentally sound, socially responsible and economically productive.

4.5 Summary of Key Recommendations

The Commission's report covers many aspects, and on many of these we have made clear recommendations. It may be useful here to restate these, grouped under four thematic headings: research, policy, institutions and investments. How to follow up on these is the topic of the next and last chapter in our report.

4.5.1 Policy. The philosophical approach should be integrated water-resources management, based on participation, water pricing, private sector involvement, and respecting the integrity of ecosystems. The single most important policy recommendation we can make is the adoption of full-cost pricing of water use

and services. It will be the basis for promoting conservation, reducing waste and mobilizing resources. But this can only be done when service providers are accountable and efficient. And it will require a new generation of subsidy programmes, ones that provide subsidies to individuals, that are transparent and targeted, and are the responsibility of government. It will also require a careful and politically viable strategy for transition, with time-bound 'adjustment subsidies' playing a vital role.

4.5.2 Institutions. At the heart of this vision is a vision of institutional renewal. Governments will play a central role, but a very different one. They will withdraw from their role as service providers, passing these responsibilities to users and the private sector. Above all they will be responsible for creating an 'enabling environment', one designed to ensure that there are incentives for investors and for innovators, but also that the interests of the public are secured. This will require that government phases out of its role as a financier of private services, and assumes a role as manager of well-designed subsidy schemes for the poor, and as custodian of the environment. Government will also become an enabling partner for the plethora of national basin and aquifer agencies that will play an increased role in water management.

User groups will play a more and more prominent role at all levels, from the basin level to the neighbourhood level. At the more aggregate level this will mean participation in decisions on how to manage water resources; at the local level it will mean participation in neighbourhood water service and consumer watchdog associations. In all of these women have vital roles to play.

The private sector has a major role to play, as mobilizer of investment, as innovator, as service provider and as advocate for transparent and effective resource-management policies.

Finally, a special effort to involve youth is essential. From schools to universities to youth groups, education about water issues coupled with opportunities for genuine participation will be essential. They will be the creators of better tomorrows.

4.5.3 Research and data. There is an urgent need for better data on the stocks and flows of water, especially groundwater and water and aquatic environmental quality, and ecosystem health at the basin level. These are not academic issues, they are actually matters of life and death in many communities around the world, witness the issues of arsenic in the groundwater in Bangladesh and West Bengal, India, or the heavy metals finding their way into the water in many poor countries with inadequate wastewater treatment programmes. In arid regions, a shortage of data limits the optimum use of what little fresh water is available. The lack of information on past flooding encourages people to settle in flood-prone lands. Thus it is equally important that the raw data be publicly available, and that reliable processed data be made public in forms that facilitate public understanding of water issues, and public participation in water management.

Experience shows, too, that if users are empowered, through aquifer associations or river-basin associations, they will demand more and better data. In many instances they will, quite correctly, decide to raise resources for this purpose, through water levies for example. Stimulating the demand for information will lead to a major increase in funding for data collection, and for making such data useful and broadly available to users.

We shall need to learn much more concerning the complex processes involved in the hydrological cycle, the functioning and basic water requirements of ecosystems, and the likely impact on these of future changes in the world's climate. Budgets must be restored to the national agencies and institutions charged with such studies and with assessing the quality and quantity of fresh water available.

Increased public funding for research in agriculture and other aspects of water management will be essential. The private sector can and will address many issues, but the public goods nature that affects the billions of poor farming families and the environmental-management aspects of agriculture in developing countries where water use accounts for as much as 80–90% of the water withdrawals will require public funding. A major increase in funding of national agricultural research systems (NARS) and the international Agricultural Research Centers (IARCs) of the Consultative Group on International Agricultural Research (CGIAR) would be a modest investment for the international donor community and would bring enormous benefits to the world.

4.5.4 Investments. As to investment incentives, it is our judgement that with full-cost pricing no special incentives are needed for the private sector with three (temporary) exceptions. There should be (1) time-bound 'adjustment subsidies' to facilitate the entry of private operators under conditions of very low tariffs; (2) political risk guarantees (with private operators assuming the commercial risk); and (3) 'bridging financing' where local capital markets are not willing to finance the long-maturity instruments needed for this capital intensive industry.

All of this should be provided within a framework of transparent, predictable regulations and a competitive accountable system of contract award and adjudication.

The capital provided by the international and local private sectors should lighten the burden on public budgets. This will make it possible for government to provide funding for public goods such as the restoration of wetlands and other measures to ensure that ecosystems may continue to provide undervalued services such as flood control and the protection of fish and wildlife habitat.

4.5.5 Some concrete next steps. There must be institutionalized follow-up to the development of action plans for carrying out the above recommendations. Governments do have the prime responsibility but leadership needs to be provided at the international level as well. The Global Environment Facility has a mandate to provide incremental funding to assist countries in incorporating environmental considerations in the management of international waters consistent with sustainable development goals. The Commission recommends that the GEF leverage additional financing, especially by the private sector, to fund national land/water actions that simultaneously contribute to national, regional and global benefits.

The World Water Council (WWC) should continue to keep the world focused on water issues, and the World Water Forum should be the venue where stocktaking and rededication are undertaken periodically.

The Global Water Partnership was established to encourage programmes to fill gaps in research and technical assistance required for the implementation of integrated water-resource management. Through its emerging Regional Water Partnerships it is currently developing Frameworks for Action to support the

implementation of regional and sector visions. The Commission recommends that the international community support the action-oriented programmes that emerge from these efforts.

The international agencies should continue their increased emphasis on water, and a stocktaking report should be produced at least every second year. Intergovernmental Forums such as the CSD, Rio + 10, and others should feature water issues prominently.

Finally, it is clear that implementation of the recommendations of the Commission will depend on innovative approaches to institutions and technology. Research into such innovation must be stimulated. The Commission recommends that an Innovation Fund be established for this purpose with support from both the private and public sectors. It can be affiliated with the Global Water Partnership.

18 February 2000