

Responding to Increased Needs and Demands for Water

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Abstract.—The nature of the increased needs and demands for water relate to water quantity and quality, bringing in the dimensions of timing and location of water flows. Some key past international activities related to water and watershed policy are reviewed. The common threads that are shaping likely future responses relate to technical vs. institutional means of addressing problems, participatory stakeholder management, developing integrated solutions, and decentralization and privatization of management. Two major response areas are reviewed, namely, that of increasing efficiency in use to reduce per capita consumption and that of developing improved supplies of water through improved management.

Introduction

Other papers at this conference have established the rapidly growing demands for water, land and related natural resources, globally, nationally and locally. Sustainability of the flows of goods and services from land and water resources is high on the agendas of many countries now and will go higher over the next decade and beyond. Scientists and the media throughout the world have documented increasing water scarcity, crises, land degradation, and shortages and problems in meeting the demands for renewable natural resources.

The questions that we were asked to address in this paper is: How do we respond to these growing demands and needs; and how do we develop and manage resources to avoid crisis in the future? We recognize that this conference is dealing broadly with watershed and natural resources management and the multiple outputs from such management. However, for several reasons, we focus here on watershed management in relation to increased demands and need for water. First, we believe like many others that water will become the key land management issue in the 21st century. Second, water is the unifying theme that draws together the elements in integrated

watershed management. Third, water is perhaps the best and most dramatic example of why responding with watershed management innovations (i.e., addressing the supply side) is not enough. We also will need to address the demand, or requirements, side of the picture.

To What Are We Responding?

The basic issues — the water scarcities and related crises to which we will need to respond — include those related to water quantity and quality, and land available to meet the various needs of growing populations with ever increasing per capita demands on the limited and fixed land base.

There is no question that water will become a more expensive resource to use in most parts of the world. The increased cost will, to some extent, reduce use and waste of water. However, we still will see increasing scarcities of water of acceptable quality. Into the 21st century, it not only is the physical quantity available for consumption and use that will be important, but also the quality of such water in terms of safeguarding human health, and the flows of water needed to ensure sustainable aquatic ecosystems and their health and beauty.

The types of issues that will come to the forefront have been discussed in detail elsewhere in this Conference and need not be repeated here. The problems that need to be addressed also were highlighted at the major 1995 International Conference, 2020 Vision for Food, Agriculture, and the Environment, and in followup papers to the conference (cf. IFPRI 1995, Rosegrant 1997 and Scherr 1999).

Broadly speaking, there are some threads that already have come together to point the way to the priority future needs in the area of water and watershed management. First, there is accumulating evidence that we have been quite successful in developing the *technical* means to secure the most and best water that can be made available at any given time in any given place. And we have been spending billions of dollars putting the various pieces in place to have quality water for economic development, especially in most of the developed countries. Thus, Lant (1999) suggests that “the legacy of the 20th century water

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resources management is one dominated by federally funded civil and environmental engineering which, for the most part, has successfully achieved the fundamental objectives of putting water resources to the task of economic development and improving the quality of human life.” While continuing technical research on water resources will be a necessity, the focus will need to turn more to the institutional and management means for effectively utilizing technologies on the shelf.

Second, there is increasing evidence that in time of crisis and resource shortages, e.g., droughts and floods, people and their institutions in the United States and other countries can and do respond effectively to shortages of resources by reducing consumption and increasing investments, e.g., in the case of water supply and use (see Appendix 1). However, it also is evident that most of the emphasis has been on crisis management and not on developing the mitigation strategies that will change conditions to avoid future unsustainable resource use and development and crises in availability. Thus, Wilhite (1997) notes that while more than 27 states in the U.S. had prepared drought response plans by 1997, the plans are still largely reactive in nature, treating drought in an emergency response mode. He notes that “the transition from crisis to risk management is a difficult task.”

A third thread is the emerging trend towards decentralization of responsibilities for the environment and towards participatory management of water resources and associated watersheds. By 1999, there were over 1,500 locally-led watershed management initiatives in the United States, almost all established since 1990 (Lant 1999). Participatory or “co-management” of natural resources is a growing phenomenon worldwide. We use the term co-management to refer to schemes that involve both government agencies and other groups in civil society, such as communities, cooperatives, associations and so forth.

The evidence of success in participatory management as a tool for sustainable development and ecosystem management is mounting. The way to the future will likely involve further development of innovative institutional mechanisms involving local participation.

A fourth trend is the increased importance given to globalization of environmental issues and responses. Over the past few decades, we have had growing international trade and a proliferation of international conventions and programs dealing with the environment and natural resources. Those dealing with biodiversity, climate change, desertification, and fisheries are just a few of the many agreements that have been reached among nations. In the future we most likely will see increased activity in this area.

In sum, we have to focus in the future on developing more appropriate and effective combinations of local and global institutional responses to mounting scarcities of

resources, responses that can (a) take full advantage of the growing accumulation of technical knowledge of how to manage natural resources, (b) utilize the sophistication of the local users of natural resources in terms of their understanding of the issues and options associated with sustainable ecosystem management, and (c) help resolve potential conflicts between the actions of users who are in different locations in the watershed (upstream-downstream conflicts).

Recent International Responses to Water Issues

The International Conference on Water and the Environment (ICWE) was held in Dublin, Ireland on January 26-31, 1992. It is generally regarded as the most comprehensive international water-policy conference yet held. In attendance were more than 500 participants, including government-designated experts from a hundred countries and representatives of eighty international, intergovernmental and non-governmental organizations.

At its closing session, the Conference adopted the so-called Dublin Statement and the Conference Report (World Meteorological Organization, Hydrology and Water Resources Programme 1999, World Bank 1993). In the Report, the participants presented four principles to guide the development of freshwater policies in the nations of the world. Furthermore, the participants recommended 10 new policies for the assessment, development and management of freshwater resources. The principles and policies provide an appropriate jumping off point for discussing specific response mechanisms and actions for the future.

The four principles were as follows:

Principle No. 1 - *Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.*

Principle No. 2 - *Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.*

Principle No. 3 - *Women should play a central part in the provision, management and safeguarding of water.*

Principle No. 4 - *Water has an economic value in all its competing uses and should be recognized as an economic good.*

Based on these four guiding principles, the Conference participants developed recommendations for an international freshwater policy agenda to enable countries to tackle their water resources problems on a wide range of

fronts. The 10 points of that freshwater policy agenda are as follows together with an interpretation of the urgency of each and the way forward in terms of response to global needs:

1. Alleviate poverty and disease

At the start of the 1990s, more than a quarter of the world's population still lacks the basic human needs of enough food to eat, a clean water supply and hygienic means of sanitation. The Conference recommends that priority be given in water resources development and management to the accelerated provision of food, water and sanitation to these unserved millions. However by the end of the 1990s it was clear that the lack of enough food was not a production problem but a lack of income and distribution problem.

2. Protect against natural disasters

Lack of preparedness, often aggravated by lack of data, means that droughts and floods take a huge toll in deaths, and cause misery and economic loss. Economic losses from natural disasters, including floods and droughts, increased three-fold between the 1960s and the 1980s. Development is being set back for years in some developing countries, because investments have not been made in basic data collection and disaster preparedness. Projected climate change and rising sea-levels will intensify the risk for some, while also threatening the apparent security of existing water resources. Damages and loss of life from floods and droughts can be drastically reduced by the disaster preparedness actions recommended in the Dublin Conference Report.

3. Contribute to water conservation and reuse

Current patterns of water use involve excessive waste. There is great scope for water savings in agriculture, in industry and in domestic water supplies. Irrigated agriculture accounts for about 69% of water withdrawals in the world. In many irrigation schemes, up to 60% of this water is lost on its way from the source to the plant. More efficient irrigation practices will lead to substantial freshwater savings although in many cases the water lost in irrigation will be used downstream as return flows. Thus the potential for real water savings is considerably less than 60%.

Recycling could reduce the consumption of many industrial consumers by 50% or more, with the additional benefit of reduced pollution. Application of the "polluter pays" principle and realistic water pricing will encourage conservation and

reuse. On average, 36% of the water produced by urban water utilities in developing countries is "unaccounted for." Better management could reduce these costly losses.

Combined savings in agriculture, industry and domestic water supplies could significantly defer investment in costly new water-resource development and have enormous impact on the sustainability of future supplies. More savings will come from multiple use of water. Compliance with effective discharge standards, based on new water protection objectives, will enable successive downstream consumers to reuse water, which presently is too contaminated after the first use.

4. Provide for sustainable urban development

The sustainability of urban growth is threatened by curtailment of the copious supplies of cheap water, as a result of the depletion and degradation caused by past profligacy. After a generation or more of excessive water use and reckless discharge of municipal and industrial wastes, the situation in the majority of the world's major cities is appalling and getting worse. As water scarcity and pollution force development of ever more distant sources, the marginal costs of meeting fresh demands are growing rapidly. Future guaranteed supplies must be based on appropriate water charges and discharge controls. Residual contamination of land and water can no longer be seen as a reasonable trade-off for the jobs and prosperity brought by industrial growth.

5. Contribute to agricultural production and rural water supply

Achieving food security is a high priority in many countries, and agriculture must not only provide food for rising populations, but also save water for other uses. The challenge is to develop and apply water-saving technology and management methods, and, through capacity building, enable communities to introduce institutions and incentives for the rural population to adopt new approaches, for both rainfed and irrigated agriculture. The rural population must also have better access to a potable water supply and to sanitation services. It is an immense task, but not an impossible one, provided appropriate policies and programs are adopted at all levels: local, national and international.

6. Protect aquatic ecosystems

Water is a vital part of the environment and a home for many forms of life on which the

well-being of humans ultimately depends. Disruption of flows has reduced the productivity of many such ecosystems, devastated fisheries, agriculture and grazing, and marginalized the rural communities which rely on these. Various kinds of pollution, including transboundary pollution, exacerbate these problems, degrade water supplies, require more expensive water treatment, destroy aquatic fauna, and deny recreation opportunities.

Integrated management of river basins provides the opportunity to safeguard aquatic ecosystems, and make their benefits available to society on a sustainable basis.

7. Resolve water conflicts

The most appropriate geographical entity for the planning and management of water resources is the river basin, including surface and groundwater. Ideally, the effective integrated planning and development of transboundary river or lake basins has similar institutional requirements to a basin entirely within one country. The essential function of existing international basin organizations is one of reconciling and harmonizing the interests of riparian countries, monitoring water quantity and quality, development of concerted action programs, exchange of information, and enforcing agreements.

In the coming decades, management of international watersheds will greatly increase in importance. A high priority should therefore be given to the preparation and implementation of integrated management plans, endorsed by all affected governments and backed by international agreements.

8. Invest in people and institutions

Implementation of action programs for water and sustainable development will require a substantial investment, not only in the capital projects concerned, but, crucially, in building the capacity of people and institutions to plan and implement those projects.

9. Enhance the knowledge base

Measurement of components of the water cycle, in quantity and quality, and of other characteristics of the environment affecting water are an essential basis for undertaking effective water management. Research and analysis techniques, applied on an interdisciplinary basis, permit the understanding of these data and their application to many uses.

With the threat of global warming due to increasing greenhouse gas concentrations in the atmosphere, the need for measurements and data exchange on the hydrological cycle on a global scale is evident. The data are required to understand both the world's climate system and the potential impacts on water resources of climate change and sea level rise. All countries must participate and, where necessary, be assisted to take part in the global monitoring, the study of the effects and the development of appropriate response strategies.

10. Improve personnel, institutional and legal arrangements

All actions identified in the Dublin Conference Report require well-trained and qualified personnel. Countries should identify, as part of national development plans, training needs for water-resources assessment and management, and take steps internally and, if necessary with technical co-operation agencies, to provide the required training, and working conditions which help to retain the trained personnel. Governments must also assess their capacity to equip their water and other specialists to implement the full range of activities for integrated water-resources management. This requires provision of an enabling environment in terms of institutional and legal arrangements, including those for effective water-demand management.

Awareness raising is a vital part of a participatory approach to water resources management. Information, education and communication support programs must be an integral part of the development process.

Following the Dublin Conference, the Dublin Statement was commended to the world leaders assembled at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992. The Dublin Statement, in turn, formed the basis for the UNCED Conference participants' recommendations regarding new policies for water and sustainable development. Since then, the Global Partnership on Water was developed. This partnership among nations of the world, has as its objectives to:

- Support integrated water resources management programs by collaboration, at their request, with governments and existing networks and by forging new collaborative arrangements.
- Encourage governments, aid agencies and other stakeholders to adopt consistent, mutually complementary policies and programs.
- Build mechanisms for sharing information and experiences.

- Develop innovative and effective solutions to problems common to integrated water resources management.
- Suggest practical policies and good practices based on those solutions.
- Help match needs to available resources.

Future Responses to Water Issues

The implications of the Dublin Conference, the 2020 Conference and similar policy oriented gatherings are all too clear: Major increases will be needed in our future efforts to meet water demands if mounting crises and shortages of water are to be avoided in some countries. Thus, the simple answer to the question asked of us in this paper is that we need to:

- Address the problems in a more intense and an integrated fashion and to draw on the most cost effective means available, both on the demand and supply sides.
- Create the institutions that will permit effective management of water supplies and use. We need to create incentives and other means to use available water more effectively and efficiently (demand side).
- Manage more effectively the existing supply of resources and search for new sources of water (supply side).

Below we dissect this broad answer and look at the multitude of specific, interrelated ways in which we can increase efficiency and effectiveness in use and expand the sources of water and quantities available in given places at given times.

Specific Actions and Policies

Figure 1 provides a summary of two major areas of response to increasing demand for, and scarcity of water. One involves reductions in per capita consumption of water, chiefly through improvements in the efficiency of water use. The other involves finding and developing new and improved supplies of water. Within each category, there are several distinct actions to consider, as indicated in the figure.

Increasing Efficiency in Use: Reducing Per Capita Consumption

Total water consumption is a function of per capita consumption and the size of the population directly or indirectly consuming water. Direct consumption of water by households is a small but critical part of the total fresh water use in the world. However, it does not put much pressure on water supplies other than in arid and / or areas where available water is extremely scarce. The main pressure on water supplies comes through indirect human consumption, where the direct impacts are associated with water use by agriculture and industry. Levels of indirect consumption are heavily influenced by the efficiency with which water is used by agriculture and industry. (Agriculture alone accounts for over two-thirds of the world's consumption of fresh water). Given the fact that about one third of the world's crops are produced with irrigation and this proportion is increasing, it follows that, if the efficiency of use in irrigation is increased, this could have a notable effect on per capita indirect consumption of water.

As indicated in figure 1, greater efficiency in use and reduced per capita consumption can be achieved by (a) changing technologies to ones that make more efficient and effective use of water, (b) giving people greater responsibility for their water supplies, so they reduce waste, and (c) increasing prices to reflect the true scarcity value of water and the cost of supplying it.

The Supply Side: Developing New and Improved Supplies of Water

Populations in key areas are growing, so we cannot rely on reductions in per capita consumption alone - although such reductions can go a long way towards easing the pressure on existing supplies and avoiding future scarcity and crisis. We also need to be concerned with increasing supplies at given times in given places. As discussed in earlier sessions, effective, *usable* supplies can be increased in a number of ways. First, timing of natural water flows can be manipulated to some extent through watershed management, ensuring supplies of water when it otherwise would not be available. Second, usable quantity of water at any given time can be increased to some extent through various techniques such as water harvesting, gaining access to deep aquifers, increasing storage and changing storage techniques to reduce evaporation. Third, by changing quality of water, e.g., through desalinization, the effectively usable amount of water can be increased dramatically, although often at a significantly higher cost than other water sources.

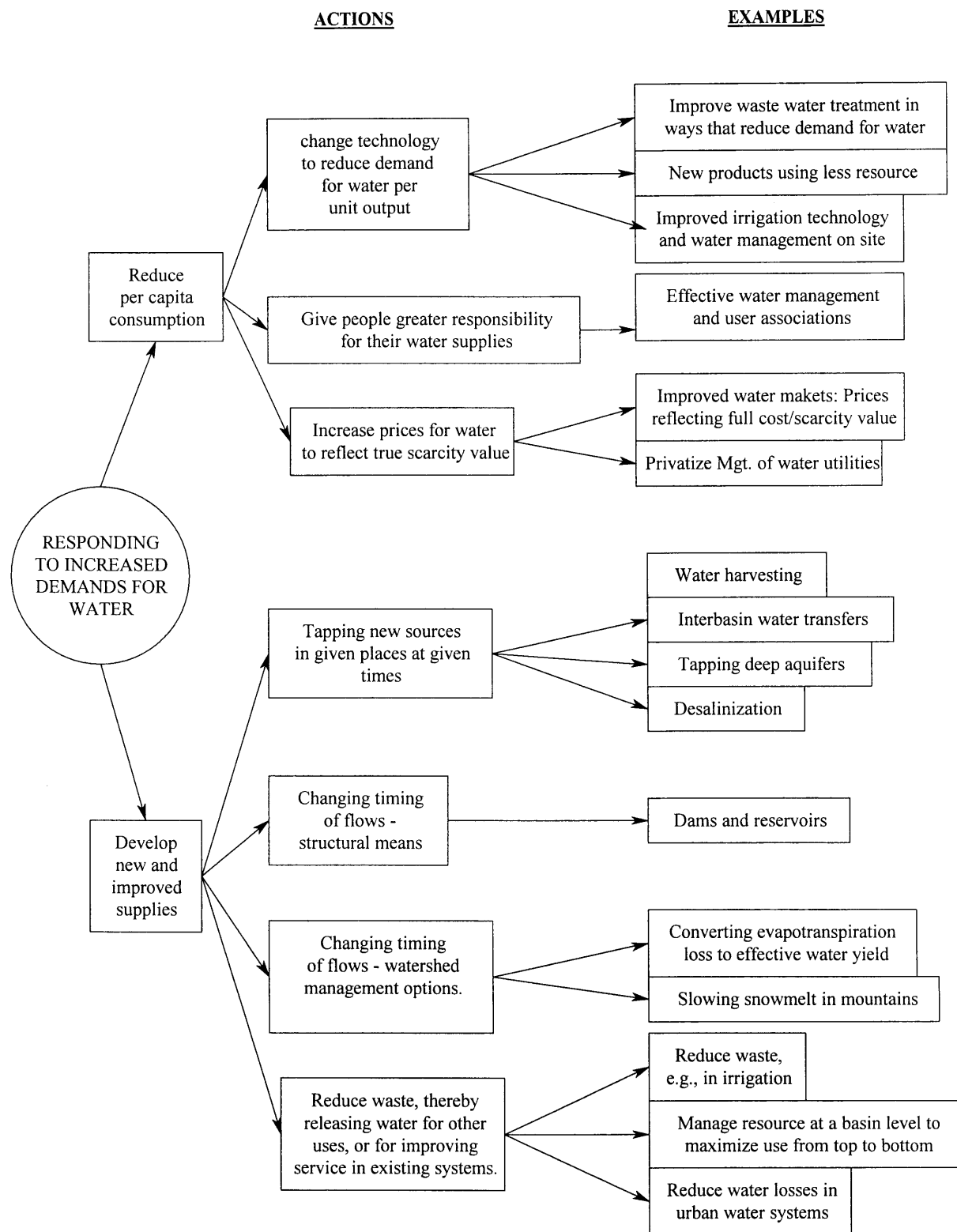


Figure 1. Responding to increased demands and needs for water.

The problem never has been and never will be the total quantity of water available on and under the earth's surface. Water covers three quarters of the surface of the globe (an avg. of 7,000 m³ per person flows into the rivers and underground channels of the earth each year). It is estimated that humans effectively use less than 1 percent of water that exists at any given time. Rather, the issue is the amount of *effectively* usable fresh water of a given quality, available at a given time in a given place *at reasonable cost* (The Economist [322(7752):11,12]). In looking at potential supply side responses to increased water needs, it is necessary to consider timing, location, quality, and cost issues.

Managing the Available Water

In the future we need to focus on improving the management of our existing supplies of water and other, related natural resources. After a long period during the past century of constructing large water projects, especially for irrigation, hydropower and flood control, the water agencies in many countries find that their mission has changed. Agencies like the U.S. Bureau of Reclamation find that their major concern regarding water supply now is being focused on better management of existing systems rather than building new systems. For a number of countries the transition from a construction mentality to a management mentality has been difficult. Many don't have the skills that are required for effective operation and management of large, complex water systems. They lack the basic motivation to provide service to the users. To make the transition, governments need to alter roles, functions, and responsibilities of water and land management agencies and change how agencies relate to one another. When more than one water agency exists, they should be encouraged or required to exchange information, communicate on a regular basis, and coordinate operations. Management procedures should be promoted that are transparent, decentralized, and responsive to users' requests.

One way of doing this has been to foster formal and informal water-user associations that have a strong sense of owning the water. The feeling of ownership can grow out of users' direct involvement in planning, construction and management. It also can occur through granting water rights to the water associations and/or the direct involvement of users in financing water structures. Other options include establishing financially independent water utilities or concessional management contracts with private firms.

A key is to effectively introduce and implement private market incentives in the management of scarce water resources. Policymakers need to make sure that clear lines

of accountability and responsibility are developed. It needs to be quite clear as to who is responsible and accountable for delivering water to consumers or water-user associations. Management also must develop and use a system of data collection, monitoring, and information delivery. Water managers need information about water supplies and demand, while users, such as farmers, must know about likely supplies so they can plant the right crops. Timely information can improve decisions at all levels. Without good information and monitoring, it will be difficult to assign responsibility and hold water managers accountable for performance.

Policies and Policy Instruments for Effective Response

A great number of laws and policies exist in the United States and in most developed countries that guide the effectiveness with which the above responses to increasing demands and needs for water are implemented. Thus, implementation of these policies is accomplished through use of four main types of mechanisms: (1) promotion of local commitment and participation, (2) regulatory mechanisms, (3) fiscal and financial mechanisms to influence private behavior, and (4) public investment and improved management of resources.

Policy design and actions take place within a social and institutional setting that is unique for every country. The uniqueness relate to differences in organizations, customs, laws, rights, responsibilities, regulations and informal rules that guide and influence the success or failure of a particular policy or action. Effective policy actions may require changing institutions as well as developing new policy instruments.

Institutional arrangements specify who benefits from water use; and they establish incentives that guide water use. Well-designed and functioning institutional arrangements can set up regulations, pricing mechanisms, water rights, and government interventions to effectively guide water use. However, inadequate institutional arrangements can impede efficient water use and cause serious problems of waste and misuse.

Institutional arrangements also establish the interface between government and the private sectors in water and watershed management. Management usually involves a mix of government and private sector activity. Once the mix has been decided on, the next step is to select the policy instruments that will work best. Usually some combinations of policy actions and instruments are more effective than just a simple action or instrument. An example is a rapidly growing city that faces very expen-

sive new water supplies. Instead of choosing the costly option of developing new water sources (dam or water transfer) the water agency decides on a strategy of replacing leaky pipes, charging higher water fees, and providing users with water conservation assistance.

Clearly, any effective water policy will have to change basic incentive structures. Policies and organization can be changed to provide water managers with a strong incentive to improve the efficiency and equity of water distribution. This might be done by giving users more responsibility for the costs of, and benefits from, water delivery and allocation. Another way would be to give water users tradable water rights, and then let them employ the water managers much like they are doing in some irrigation systems in Mexico. A third possibility is to have the manager's salaries depending on the efficiency of water delivery and/or the percentage of fees collected from water users. In several countries, such as the Philippines, water managers receive a bonus, for good service or when a high percentage of farmers pay their water fees (90%). The important point is to have a strong link between those using the water and those managing it.

Incentives also are needed to encourage water users to make efficient use decisions concerning their supplies. This can be difficult when many users are involved or when monitoring is difficult. The two most effective instruments are water markets and prices that are based on the opportunity cost of providing the water. Water markets are probably the easiest means of introducing the appropriate incentives for efficient water use if rights have been established and allocated. On the other hand, it may be very difficult to establish and allocate water rights separate from land rights. Both are essential for establishing effective water markets.

Where it is not possible to allocate water rights to users, then administrative water pricing although not as flexible as pricing by market, can provide needed incentives. This option works best for domestic and industrial uses where the water is piped directly to the users. It is much easier to meter than the delivery of water to widely dispersed farmers. To lessen the impact of higher water prices on low income families, the price increases can be combined with assistance for using water conservation measures. Bogor, Indonesia, cut water use by over 50% by using such measures as price increases and conservation measures.

Another option is not to provide all the water users demand and in this way create a scarcity value for the water they receive. In irrigated areas, this might mean they only receive enough water to irrigate 75% of their land. This would force users to conserve water and adopt new technology to make better use of the water. If farmers were also allowed to trade water then you could get the added efficiency of moving more of the water to the most productive farmers.

The key factor is that users and managers need incentives to improve water use and allocation. Where these incentives have been changed major improvements in water use have occurred. Changes are coming for both users and managers. Thirty years from now we will be all very surprised by what has been achieved. For example, who could have predicted thirty years ago that we would have an international market for bottled water and that bottled water would be available in small villages all over the world?

Conclusion

This conference, as well as others such as the 1992 International Conference on Water and the Environment held in Dublin, Ireland, has recognized the potential gravity of social problems associated with inadequate global supplies of quality water. Past efforts to alleviate the problem have focused largely on increasing water supplies through engineering projects. Future efforts must, however, also address ways of stemming excessive demand. Thus, the future will require a complete examination of both the supply and demand side of water issues. Specific actions will require a reduction in per capita use of water, development of new and improved water supplies, and better management of existing water projects. Keys to future improvement of the world water situation will be: 1) promotion of local commitment and participation, 2) regulatory mechanisms, 3) fiscal and financial mechanisms to influence private behavior, and 4) public investment and improved management of resources.

Acknowledgments

The authors wish to thank Peter Ffolliott and Karlyn Eckman for their excellent comments on an earlier version of this draft.

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Appendix 1. Community Response to Water Crisis: The 1986-1992 California Drought

The 1986-1992 drought in California was severe for many cities in the state. Santa Barbara, for example, was dependent on local sources for its water supply. Based on their study of Santa Barbara's response to the drought, Loaiciga and Renehan (1997) found that:

- Water use dropped 46% at the height of the drought relative to pre-drought water use; and water use remained (in 1997) at 61% of the pre-drought level.
- Average cost of water rose by \$3.08 per unit (100 cu.ft.), largely because of investments aimed at supply augmentation and conservation mitigate future drought. The rise includes part of the cost of hedging against future drought risks.
- The gap between average cost of supply and average revenue per unit of water rose in real terms from \$0.14 per unit in 1986 to \$0.75 in 1996; this is a disturbing development, since it limits the ability to build up funds for future hazards to water supply.