Water and sustainable development

Rob Koudstaal, Frank R. Rijsberman and Hubert Savenije

In this paper, it is proposed that water resources should be managed as an integral part of a nation's social and economic development. Water resources managers should broaden their scope of work to include an integrated management approach. Instead of the traditional 'supply oriented approach' in which they act in response to ever-increasing demands for water from different sectors of the economy, water resources management agencies should play a more active role in guiding and stimulating socio-economic development through more efficient water use. Demand management should be an important tool which should go beyond the improvement of technical efficiencies. Most important is to develop economic and institutional approaches that accept charging for the full costs of the utilization and management of water resources. Implementation of such an approach will require more sectoral integration than is currently the case and will have considerable implications for organizations, staffing, institutional arrangements and corresponding capacity building.

In 1977, the United Nations Water Conference in Mar del Plata demonstrated a clear consensus that water is a key element in the development of many nations. A widely distributed Plan of Action was formulated which focused on improving conditions for low income groups. It initiated the International Drinking Water Supply and Sanitation Decade (IDWSSD) in the 1980s, which formally started in November 1980. Expectations were high that properly managed water resources would greatly enhance social and economic developments in the decade.

Although the link between properly managed water resources, economic development and social well-being is now widely recognized, policies for the sustainable use of water resources have largely failed to materialize. In many countries, the quantity and quality of surface and groundwater resources are deteriorating. Water resources management policies to date have focused on the development of water resources to satisfy the ever increasing demands for water or water related goods and services, and on the mitigation or reduction of droughts and floods.

The issues that water resources managers will have to deal with in the 1990s call for a more integrated approach to water resources management. In many developed and developing countries, national policies are formulated based on such integration, and efforts are growing to implement integrated approaches. International organizations strongly support this changing focus. The New Delhi Statement on safe water and sanitation for the 1990s [21], for example, refers to integrated water resources management in two of its four 'guiding principles'. The statement first calls for protection of the environment and safeguarding of health through integrated management of water and liquid and solid wastes. It also calls for an integrated approach in institutional reforms for the water sector. Other appeals for integrated water resources management policies can be found in OECD's recent report on the environment [18]. The OECD report recommends an integration of water quantity and quality management with the environmental concerns of the economic sectors. The report also considers appropriate pricing of natural resources to be a key tool for integrated water resources management. Similarly, the Asian Development Bank has adopted the integration of environmental management and

Rob Koudstaal and Frank R. Rijsberman are Directors of Resource Analysis, Zuiderstraat 110, 2611 SJ Delft, The Netherlands and Hubert Savenije is Associate Professor in Hydrology at the International Institute for Hydraulic and Environmental Engineering, PO Box 3015, 2601 DA Delft, The Netherlands.

This paper is an abridgement of a more extensive report which was prepared for and published as a keynote paper by the International Conference on Water and the Environment – Development Issues for the 21st Century, 26–31 January 1992, Dublin, Ireland.

0165-0203/92/040277-14

natural resources planning and management into concepts of development planning [1]. It can be concluded that 'integrated management' has been adopted by various national governments and international organizations, each from their own perspective, as the solution to a host of problems.

Without attempting to produce a definitive definition of the often-used word 'integrated' as it relates to water resources management, in this paper integrated management will be assumed to have the following characteristics:

- there is an interaction between quantity, quality and biological aspects of both groundwater and surface water;
- water demands and residual generation by different sectors of the economy are considered in relation to sectoral development and management plans, objectives and policies;
- full account is made of the relevant on-site and off-site environmental issues, in particular the long-term carrying capacity of natural systems;
- proper attention is paid to the tasks and responsibilities of all public and private agencies involved and to their linking mechanisms;
- there is public participation: social and cultural issues are considered, including the role of women and the traditional use of water;
- implementation aspects, including financing, monitoring and control, play a decisive role in planning for water resources management; and finally
- institutional and human resources development for the execution of management tasks are important components.

The first question that this paper addresses is: how can integrated water resources management contribute to socio-economic development?

To answer this question, it is important to review the context, or environment, in which water resources management is practised. The section entitled, 'Changing contexts: issues and problems', reviews the problems and issues that are likely to shape water resources management in the 1990s.

The second question this paper addresses is: what can – or should – water resources managers do in response to the new challenges ahead? In the section entitled, 'Integrated water resources management. . .', an attempt is made to outline some of the critical elements, or directions for successful water resources management in the 1990s. Some of the elements listed in that section are not new, but have not been very well integrated into the profession to date, while others represent new directions that need to be further developed.

The problem that remains is how the suggestions to alleviate the problems and issues of water resources management can be implemented. Many experts feel that the problems concerning the world's fresh and marine water resources are grossly underestimated. Worldwide public opinion and political interest appear to concentrate on climatic issues. In 1988, during the VI World Congress in Ottawa, Canada, the Committee on Water Strategies for the 21st Century of the International Water Resources Association concluded that the Brundtland report, *Our Common Future*, tends to underestimate severely the seriousness of the water-related components of environmental problems and pays no attention to the water scarcity now developing in Africa.

Possibly the most important reason why problems related to water resources are likely to increase in the foreseeable future is that there is no single, clear, tangible water problem, one easily definable like the 'energy shortage' or the increased concentration of CO_2. The water problem actually consists of a host of diffuse issues that are intricately linked with many, or most, human activities, and cannot be solved through a single global strategy. The world's attention is more easily focused on issues such as the extinction of exotic species, the disappearing rainforests, famines or holes in the ozone layer than on the more mundane issues of sustainable use and development of water resources. And yet, three quarters of the world's population still do not have access to safe and reliable drinking water and most of the serious environmental problems are water-related.

In this setting it is important to try to answer the question: how can the international community contribute to the development and implementation of the integrated water resources management concept? To answer that question, this paper focuses on integrated water resources management, both at the national and at the international level. The objective of this paper is not to present a blueprint for action, but to generate a discussion on the effectiveness and the feasibility of possible measures.

Changing contexts: issues and problems

To date, water resources management has focused largely on water resources development projects designed to satisfy the rapidly increasing demands from the various water using activities. In this paper this is referred to as the supply-oriented approach. Water resources management has, in fact, been largely concerned with engineering, that is, with the planning, design, construction and operation of water resources infrastructure. Gradually, over the last 20 years, it has become clear that water resources management needs

Vol. 16, No. 4

to broaden its focus to deal with the environmental, social, institutional and legal aspects of water development and use and also the problems of integration among different water using sectors and, increasingly, financing the provision of services in a climate of economic restraint.

Some of the major issues that water resources managers will have to deal with in the 1990s and beyond are outlined below.

Scarcity of water resources

Water is only useful for human activities if it is available at the right time, in the proper location and if it is of satisfactory quality. It not, water is likely to be a burden rather than a resource.

A major part of the education of a water resources professional, generally water resources engineers, has been spent on learning how to harness water resources: how to train rivers, build dams, provide water supplies and sanitation facilities, protect against floods, and irrigate and drain the farmer's fields. Until recently, it was generally understood that water is usually available even in arid countries. The aim of water resources development, therefore, was to make sure that it reached the user in a timely fashion, in adequate quantity and quality.

Without trying to prove the point *in extenso*, it is suggested here that in many cases all water resources that could be developed have been developed, and more. In many places, eg the mega-cities with their still rapidly growing populations, it is hard to imagine just where future water resources will come from to meet the rising demand. In many cases, the best dam sites have already been used, groundwater levels have already dropped etc. The situation is no better in the countryside. A FAO report [11] states that world wide problems of real scarcity are imposing serious limitations on agricultural water use.

Water resources managers, or their successors in the next century, are very likely to encounter a different kind of water resources scarcity: A scarcity that can not be solved by engineering measures. That scenario is exacerbated by the fact that all indications point to continued rapid growth in many countries and to even faster growth of cities.

This water scarcity, which could be called 'the new scarcity' to distinguish it from the old scarcity which could be solved by engineering measures, will require different solutions from the water resources profession, solutions that will have to include demand management. Demand management will be discussed later in this paper.

Internationally shared water resources

The new scarcity of water resources has also resulted in, and will continue to present, problems in internationally shared river basins. Continued water resources development will likely lead to increased competition, and conflicts, between countries over shared water resources. An example of a situation in which a country depends on others for its water resources is Hungary. Only 4% of the surface water in Hungary originates in the country, the other 96% enters the country as cross-boundary flow. A similar example in Africa is Mozambique. In the south of that country less than 2% of the total available surface water originates in Mozambique territory [6]. Other examples include: the Rhine river, which is shared by five European countries; the Colorado river, which is shared by Mexico and the USA; the Ganges, which crosses from India into Bangladesh.

No international legislation exists on how to share the benefits of such internationally shared resources. In 1966, the Helsinki rules [12] provided a useful framework but agreement between states or nations on shared water resources remain basically the subject of direct negotiations. There is a strong need for international guidelines which address the water quantity and water quality problems of shared water resources. The draft Law of the Non-Navigational Use of International Water Courses, prepared by the International Law Commission [22], addresses this need but so far has not been universally adopted.

Environmental degradation

The past two decades have shown a considerable change in opinion on the importance of the environment to economic development. Deterioration of environmental quality is no longer seen as an unavoidable cost of rapid economic growth, instead it is seen as a limitation or constraint to the medium- and long-term prospects of sustainable development. The environment is widely recognized as a necessary component of economic development and nowadays development related policies, administrations, organizations and individual projects of national and international agencies invariably pay attention to environmental issues. Proof of this recognition can be seen in the fact that in the decade between 1972 and 1982, the number of countries which had an environmental ministry or similar organization grew from 11 to 111 [3].

In the 1980s, the World Bank formally adopted a new lending policy on projects that have damaging environmental side effects and, for example, will not finance investments that result in toxic waste dis-

charge across international borders. Other examples of environmental concern are the June 1991 conference in Beijing attended by 41 ministers from developing countries [4] and the G7 meeting in London in July 1991 [14], both of which addressed global environmental issues.

The resolution of global environmental problems requires a fundamental policy re-orientation at the national level and cooperation at the international level. At the international level, the question of responsibility for global environmental problems creates conflicts between the developing and developed nations. The Beijing declaration makes clear the position of the developing countries [4]. It claims for the developing countries: 'the sovereign right to use their own natural resources in keeping with their developmental and environmental objectives and priorities', and does not accept the idea that environmental considerations may be used to introduce any form of conditionality in aid or development financing, or to impose trade barriers. In the Beijing declaration, the developed countries are considered to be responsible for the degradation of the global environment and consequently must take the lead in eliminating the damage to the environment as well as in assisting the developing countries to deal with the problems facing them. The declaration says, 'there should be preferential and non-commercial transfer of environmentally sound technologies to the developing countries'. However, such changes in the approaches and coordination of the developed world will not guarantee a more efficient use of water resources in the developing world without substantial re-orientation and structural changes at the domestic level.

In developed countries, considerable efforts over the past decades have concentrated on waste water reduction and treatment and on structuring a coordinated environmental management programme among countries, economic sectors and public and private entities. The success of all those efforts has been somewhat limited, but improvements have started to materialize. For example, the pollution of waterways by organic substances has been substantially reduced and significant pathogenic microbial contamination of drinking water has been virtually eliminated [18]. Conditions for sustainable development, however, are not improving. New discoveries of environmental degradation, on both the national and global scales, occur at an ever increasing rate.

In developing countries, integration of environmental issues into water resources management is often only at the starting phase and less information exists on the dimension of the problem and its adverse effect on sustainable development. Often, pollution and over-exploitation of groundwater aquifers is widespread and a threat to future socio-economic development.

Improved techniques for the economic evaluation of the environmental effects of development have led to a better understanding of the cost of non-sustainable development on impact assessment [13,15]. Included in those techniques are efforts to develop methodologies for environmental resource accounting and to formulate indicators which will enable countries to assess their development not just in terms of year by year economic performance but in terms of its stock and the efficient utilization of its natural resources. The goal of such techniques is to identify what is long-term sustainable development.

In the developing countries, many environmental problems have the following common denominators:

- the problems started some time ago and have a momentum of their own which will be difficult to reverse;
- the solution to those problems will require international coordination and the upgrading of national mechanisms and capabilities to deal with them; *and*
- often the problems which adversely affect the long-term prospects for the sustainable development affect their short-term economic prospects as well.

Economic and financial constraints

As more and more countries move towards a free market system, the former socialist countries, both in Europe and in the developing world, will be well advised to ask what the consequences of this shift will be for the use of their natural resources.

Unfortunately, both free market and planned economies incorporate failures which lead to inefficient use of natural resources, including water. In both economies, the prices of natural resources often do not reflect their real value or scarcity. In free-market systems this is, for instance, caused by: (i) what economists call externalities, as environmental problems often are; and (ii) price distorting policies of the government such as, for example, the Common Agriculture Policy (CAP) of the European Community. In centrally planned systems the pricing of natural resources is often independent of considerations of scarcity or environmental degradation.

In setting or influencing the price of natural resources such as water, governments usually use criteria which are strongly oriented towards short-term production targets rather than towards the long-term sustainable use of those resources. Traditional economic discounting techniques used for the evaluation of future time streams of costs and benefits tend to

disregard long-term effects. Long-term, in this context, is anything over a generation.

Water resource managers need to concern themselves with the fact that criteria and methods are lacking to evaluate the impact of alternative courses of action on the long-term sustainable use of water resources. Moreover, the challenge to them is to demonstrate to decision-makers the value of sustainable water resource development; to decision-makers who are under constant pressure to expand economic development, and who operate under tight financial constraints.

Donor coordination

International support for development comes mainly through bilateral and multilateral channels. The call for more and more effective support is increasing even as resources are becoming scarcer, the scale of the problem is growing larger and technological and economic gaps between developed and developing countries are widening. It would appear from past experiences that the mechanisms employed for development support have not been particularly effective, and that innovative new approaches need to be developed.

One example can be found in the evaluation of the results of the International Drinking Water Supply and Sanitation Decade (IDWSSD). Given the results of the Decade, it was estimated that to achieve full coverage by 2000, using conventional technologies and approaches would require five times the current level of investment [21]. However, financial and material support from the developed countries for the countries in Africa, South East Asia and Latin America, is not expected to grow in the coming decade. Moreover, developments in Eastern Europe and the former USSR will compete for the same development funds.

The challenge for donor countries and agencies in the 1990s will be to reach an increased level of efficiency in the use of the available resources and to develop appropriate institutional arrangements for donor coordination. UNDP [21], in its Delhi statement, calls for a reduction in costs of services through increased efficiency and the application of low cost appropriate technology. In a similar vein, an analysis by the World Bank [23] states: 'the role of the World Bank may require modification. More important than lending for projects or for structural adjustments may be the development of innovative approaches to address international and domestic institutional problems'.

This implies that international organizations are expected to play a more important role in the 1990s. Bilateral aid tends to focus on 'more of the same'. Most of the bilateral donors have their own specific objectives, approaches and political targets, which may result in isolated actions and corresponding inefficient use of resources. That is why real change, which requires better coordination and integration, appears to have a better chance through international agencies.

Malfunctioning institutions

Most water resources studies focus either on projects (usually water resources development projects) or on planning (such as water resources master plans or regional development plans). Rarely do those studies pay explicit attention to institutional issues or institutional reform or to implementation incentives. Implementation incentives are measures that aim to provide incentives to water users to change their water-using behaviour.

UNDTCD in its report, *Lessons for the 1990s* [20], concluded from an analysis of water management since the adoption of the Mar del Plata action plan, that little has changed since 1977 and that most common problems remain. Those problems include: a dominance of unregulated use of resources; inadequate and inefficient water resources management; failure to retain staff; and inappropriate and inadequate water legislation.

There are strong indications both at the project level and at the overall policy level, that improved performance of the water resources sector will depend on institutional reform, that is, changes in organizations, in laws and regulations, in linking mechanisms between sectoral agencies etc, rather than in additional technological improvements or more infrastructure. This is true for irrigation systems, for instance [2,5], and for water supply and sanitation systems, according to WHO's evaluation of the International Drinking Water and Sanitation Decade [24,25].

Global water supply during the decade has kept up with population growth but not by a wide margin. According to WHO information presented at the New Delhi meeting [21] the number of people remaining to be served was substantially reduced in the rural areas, but the urban unserved grew. From a review of the IDWSSD by that same meeting, eight key lessons have been formulated. They are:

(i) Government should encourage active participation and growing self-reliance to enable people to provide their own services.
(ii) Governments should concentrate less on direct

intervention and more on enabling public and private institutions to deliver services.

(iii) Governments need to improve their understanding of what services people want and are willing to pay for.

(iv) Appropriate pricing is an important tool to improve sector performance.

(v) Technological innovations are essential for coping with sector development problems.

(vi) Focusing on the role of women can enhance the sustainability of improvements in water supply and sanitation.

(vii) The establishment of achievable targets and effective monitoring systems are useful instruments for enhancing efforts.

(viii) Improve coordination through building national and international collaborative networks.

The most important institutional issues identified in subsequent WHO reports [24,25] are set out below.

Lack of sectoral integration

Traditionally, the organization of administration is such that ministries correspond to sectors of the economy. Their task is to optimize the production of their respective sector. However, sustainable development and the integrated management of natural and water resources require coordination between such sectors. Unfortunately, such coordination is often missing or functioning badly.

Decentralization of government

There is strong pressure in both the developed and the developing countries to decentralize government management. Experience has shown that at lower levels, knowledge and understanding of social and environmental issues is more detailed, and lines of problem identification, decision-making and implementation are shorter. Also, lower levels of government are often more organized along the lines of general agencies and less compartmentalized. Experience shows that general agencies are better equipped to care for such aspects as social issues, monitoring and control than is a national government. At the same time, however, aspects such as equity between social groups or regions, national policies on export and import, or central government financing, require the involvement of a national government. Water resources planners and managers, therefore, need to be able to advise governments on the most appropriate level of decentralization in specific instances.

Privatization

Another difficult institutional issue is how much government control there should be of the water resources sector. Government involvement is clearly needed to safeguard public interest in water resources management, particularly to compensate for market failures. Such involvement can relate to, for example, the regulation and control of overexploitation or pollution of resources; the provision of public goods; the management of common property resources; or the provision of a socially required minimum level of water supply to low income groups.

Beyond socially required minimum levels, there is no absolute need, however, for governments to be involved in, for example, the production of water for public supply. Such services could be privatized, as was done recently in the UK, provided the necessary safeguards to control monopolies are in place. In many countries some combined form of public and private management has been established. There are indications that privatization of some water-related services would result in more efficient use of resources. It is clear, therefore, that water resources professionals will have to be able to analyse the advantages and disadvantages of different levels of privatization to suit their individual countries.

Impacts on stakeholders

Planners have also found, and it was a costly lesson, that it pays to analyse carefully what the impacts of various water resources plans will be on the various stakeholders. Stakeholders, that is, everybody with a stake in water resources management, from water users and water managers to politicians, have to be involved in the planning and management of water resources. This goes both ways, planners need to involve decision-makers in the development of plans, just as much as they need to ensure public participation. Water resources planners in the future will therefore need to be able to carry out social impact analyses as well as economic analyses. As a case in point, the role of women in development projects has emerged as an important issue for the planning and management of water projects. Their role will have to be understood and planned for.

Integrated water resources management for sustainable development

The connotation of the word integrated in relation to water resources management has evolved slowly, reflecting the broadening scope of water resources management. In relation to sustainable development, the

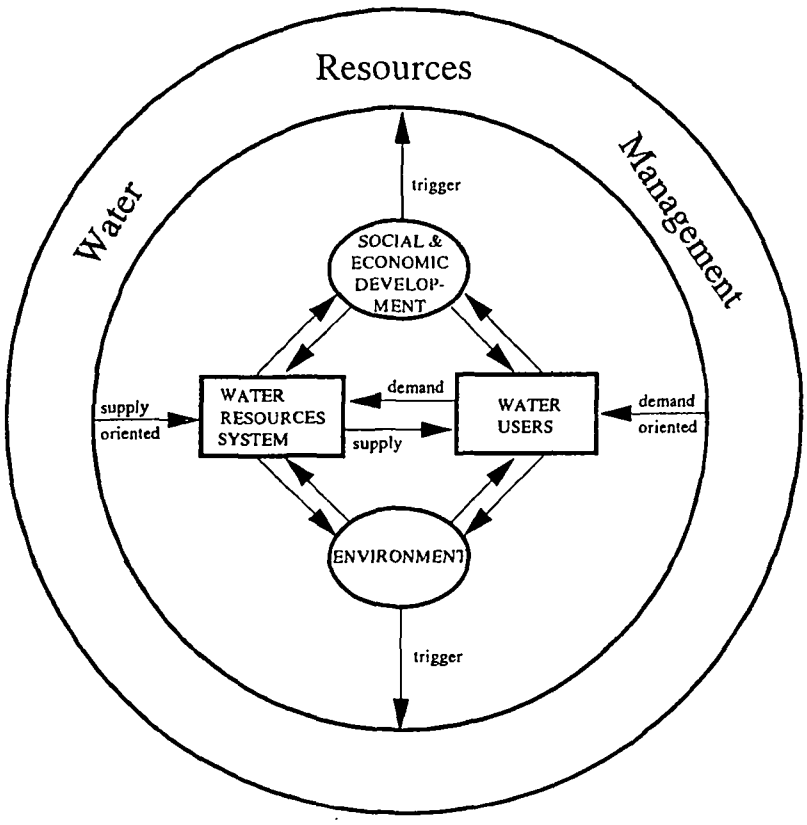

Figure 1. Schematic representation of integrated water resources management.

meaning of the word integrated clearly goes beyond such traditional concepts as: the coordination among water management agencies; the interaction between groundwater and surface water; or a planning approach which considers all possible strategies and impacts. At the beginning of this paper we presented what we consider to be the main characteristics of integrated water resources management, viewed as an instrument for sustainable development. Integrated management in this sense refers to the fact that water resources should be managed as an integral part of a nation's social and economic development. This differs substantially from a traditional approach where water resources management has been supply oriented in pursuit of ever increasing growth scenarios, and where its efforts were mainly focused on providing the proper conditions for socio-economic development by removing water shortages before they occur. According to the concept of integrated management presented here, water resources managers would play a more active role in stimulating and guiding sustainable socio-economic development through concerted actions towards both supply and demand.

The main concept of this approach is schematically represented in Figure 1. The definitions of water resources system, management and planning applied in the figure are as follows.

The Water Resources System is considered an input–output system, which includes all elements to produce water and related goods and services to meet final and derived demand from society. Such systems essentially consist of the following four components: (i) the total of water and its physical, chemical and biological constituents; (ii) the natural subsystem, including rivers, lakes, vegetation and soils; (iii) the man-made infrastructure such as canals, diversion weirs, dams and water treatment plants; and (iv) the administrative subsystem including the existing legislation and regulations as well as the institutional framework consisting of agencies and their linking mechanisms.

Water Resources Management (WRM) comprises the totality of tasks required to produce water and water related goods and services. Such tasks include planning and analysis, research, monitoring, direct production of water, provision of information, issuing regulations and standards and assessment of available resources. Typically, WRM is executed through a variety of public and private entities. The ultimate objective of water resources management is optimal socio-economic development and maximization of societal

wellbeing. This implies that WRM belongs among the responsibilities of governments. It should be emphasized that WRM objectives include long-term considerations related to sustainable development.

The general objective of Water Resources Management is to develop and utilize water resources in an efficient, environmentally sound, economically sustainable and equitable manner to satisfy the demand of society for water and water-related goods and services.

Planning for WRM refers to the formulation, analysis and presentation of strategies for WRM, consisting of the following components:

(i) *Supply oriented physical measures*, which refer to water resources infrastructure and corresponding operating rules to change time, location and quality characteristics of supplied water and to handle, modify and dispose wastes.

(ii) *Demand oriented implementation incentives*, which aim to induce water users to a desired behaviour through a set of economic and regulatory measures such as: charges, taxes, permits and zoning.

(iii) *Institutional arrangements* to implement (i) and (ii), specifying responsibilities and tasks of executing agencies and the modes of interaction between such agencies and the private sector.

The horizontal axis in Figure 1 represents the interaction between the water resources system and its users: the system supplying water and conditioning water resources in response to demand from water users. This axis provides the management 'spindle' which is controlled through supply and demand oriented management measures. An essential part of the scheme is the input–output concept of both the water resources system and the water users, which relates those subsystems with the environment and the social and economic conditions of the society. Both should be interpreted broadly. The environment includes the natural environment and man-made infrastructures, while the social and economic conditions refer to the population, their economic activities, cultural heritage and the political and administrative structure. Relations are two directional: outgoing arrows from the water resources system and users represent 'impacts on and contributions to'; ingoing arrows mainly refer to 'conditions for'. The 'state' of the environment and social and economic development provide triggers for water resources management actions.

Apart from the 'supply arrow', outgoing arrows from the water resources system refer to the direct and indirect effects on socio-economic development and on the environment. Management and demand are considered inputs into the water resources system. Other ingoing arrows refer to the conditions set by the environment and by social and economic development on the performance of the water resources system. Examples include natural water availability, the existing infrastructure, and the institutional and human resources involved in the management of the water resources system.

Similar relations exist between water users and the environment and social and economic conditions. Relations with the environment can include such things as the generation of residuals and the constraints related to the availability of natural resources. Relations with social and economic conditions can include such things as the relationship between the production of food and the social and cultural characteristics of agricultural practices.

Of course, all these considerations are not new, and considerable efforts have been dedicated to all the aspects and the relations mentioned above. FAO, for example, already pays explicit and extensive attention to water demand and institutional issues and has done so since the 1970s [8,9,10]. FAO's focus has been, however, mainly on the technical aspects of the issue. In other situations where the emphasis has been on exploitation of resources for socio-economic development, the environment is, at best, taken as a constraint. Approaches where the emphasis lies on the sustainability of the system, and where the interaction between the sub-systems is determined by the carrying capacity of the socio-economic system and the environment, are favoured by conservationists.

It should be emphasized that the concept of integrated water resources management which is presented here in relation to sustainable development goes beyond technicalities and the mere identification and consideration of all (individual) relations. Water resources management focused on sustainable development substantially broadens the scope of the work of water resources managers and places them in a different position compared to the past. Water resources managers have a new role to play, a role that includes interaction with other sectors of the economy and with considerable implications for management activities. It should be recognized that providing more water is not always the best solution and that measures to increase the efficiency of water utilization or to improve the operation of water resources agencies, should be considered as realistic alternatives. Demand management will become an important factor in the management of scarce resources: in setting priorities where and to whom to improve access to water of good quality. Water resources management should be an important means for regional planning and an important tool in socio-economic development and its related aspects of equity.

In the following sections, we will examine those aspects of integrated water resources management that are not yet widely applied, but which we consider essential to an integrated approach.

Sustainable development

Since the presentation of the Brundtland Report, *Our Common Future*, in 1987, the concept of sustainable development has become widely recognized as the most promising approach to developing our resources without depriving future generations of their opportunities to enjoy the Earth's natural resources and its environment.

The value of the concept of sustainable development is that it emphasizes that the potential, or carrying capacity, of resources should be examined first, rather than just planning and minimizing adverse environmental impacts later. This is a bottom-up approach that starts with the productive capacity of the natural environment, rather than a top-down approach in which the environment is looked at as a constraint to development. When seen this way, the concept of sustainable development is also a valuable tool for water resources planners and managers to deal with the scarcity of water resources that can be expected in the future.

The approach set out in Figure 1 could be a good working model for sustainable development. In this approach, the management of water resources is stimulated through triggers stemming from the environment and society's socio-economic well-being, acting through both supply- and demand-oriented actions directed at a system that has found a balance between impacts and carrying capacity. The danger of imbalance, however, remains ever present. Especially in time of economic recession when people and politicians are inclined to attribute more weight to socio-economic development and accept that future generations pay the bill. The scheme set out in Figure 1, to work properly, needs the constant support of organizations that are not influenced by political and economic instabilities. Hopefully, international organizations can provide that support.

Demand management

The concept of water as an economic resource has long been promoted but is far from universally shared. In many countries and cultures, water is still considered a free good that should be provided at low cost in the amounts and qualities desired. WHO [24], in its report on *Water quality*, rightly states in its strategy for the 1990s that: 'the perception of water as a freely available public good must be abandoned altogether and its limited supply and competitive economic value fully recognized'. Demand management entails the formulation and application of incentives to limit demand and increase efficiency. It should be considered as one of the most important components of an integrated water resources management strategy (the others being physical measures and institutional arrangements). Implementation incentives to ensure that a demand strategy is followed can be grouped in two main categories:

- Economic instruments, which include: charges; subsidies; taxes; and regulations which create markets where water and emission rights are traded.
- Legal instruments, including, for example, general quota or individual licences for extraction or discharges, and ambient water quality standards. Such regulations are often combined with financial enforcement incentives such as fines and penalties.

Traditionally, for demand management, government agencies have merely used legal instruments, applying a command and control approach: direct regulations coupled with systems of monitoring and sanctioning of non-compliance. The general principles of economic instruments and their importance for integrated management, however, have been widely studied and accepted as potentially powerful tools. Discussions about their use in practice started about 25 years ago, but there appears to be a general reluctance (or lack of political will) to implement such instruments. OECD reports [16,17] summarize the experience in demand management in OECD countries.

- Licenses – legal instruments – are common, including license fees to generate revenues to pay for water control and supply works. Charges over and above such license fees to account for the value or scarcity of the resources are less common. The report concluded that the main reason for the application of charges is as a source of revenue for the treasury.
- Economic incentives are used only in combination with direct regulations, but economic efficiency is seldom a stated goal of the economic instruments (emission trading rights form an exception).
- The charges that are implemented in many countries are far below the desirable level from an economic efficiency point of view. Where effluent charges have been closer to an economic efficiency level, the effect has been a substantial reduction of industrial water use and discharges.
- There is a general reluctance to implement economic instruments. One important bottleneck is the administrative effort that is required initially. The

change from a situation where only few polluters pay negligible amounts to one in which more firms pay higher rates, will only be acceptable when this is seen to be necessary and justified.

- The most effective charges appear to be effluent and user charges which are directly related to the quantities of water used. Metering is essential.
- Tax differentiation appears to be another effective instrument. It invites comparison of alternatives by the consumer and is often administratively simple because it uses the existing tax system.
- Subsidies are used mainly to compensate for the adverse effects of direct regulation and not as economic incentives to promote more environmentally friendly behaviour.
- Emission trading has been widely applied from the point of view of economic efficiency. It implies a shift in decision-making responsibility from government authorities to the individual activities (industries, treatment plants). Substantial cost savings have been recorded. The administrative burden on the government is high, however.

It can be concluded from the OECD study that there is a growing understanding that the application of demand oriented measures will be crucial to future water resources management.

Sectoral integration

Most water uses, such as public water supply, agriculture, navigation, recreation and mining, represent different sectors of the economy, and are managed by different responsible ministries and agencies. Such entities have their own production oriented objectives. The public water supply sector is concerned about total volumes of potable water, the agricultural sector about food, the navigation sector about transported goods etc.

National, regional or sectoral development plans generally assume that water is available at low cost or even free: costs of access to water do not often play an important role in sectoral investment and operational decisions. Consequently, little attention is paid to the efficient use of water or, in more general terms, to an efficient use of natural resources. Cross-sectoral efforts such as water resources and land use planning, which aim explicitly at the development of society as a whole, attempt to fill this gap. Implementation of cross-sectoral plans, however, still depends on sectoral agencies.

In most countries, the political will to increase the coordination of water resources management among sectors is low, though generally some kind of structure for coordination does exist. What is lacking is a capacity for implementation even when the coordinating bodies produce master plans. Unfortunately, important decisions on water policy, eg who pays how much for water, are often made elsewhere. Still, an important impact of the coordination exercise can be an increased understanding by technical officers of the need for and the issues involved in coordination.

Institutional arrangements and capacity building

Institutional arrangements here, refer to tasks and responsibilities of agencies at different levels of government, the corresponding linking mechanisms between them, and the laws, standards and regulations that form the institutional framework in which agencies work.

Proper institutional arrangements are important for all the tasks of water resources management. This includes planning and analysis, monitoring, construction and implementation. As mentioned above, ministries in both developed and developing countries traditionally focus on productive growth of the economic sectors they represent. Utilization of natural resources for sustainable development is not an issue that fits into that structure. Environmentally sustainable development requires coordinated decision-making on planning and implementation issues, which in many countries is missing or not working.

To create an institutional arrangement in which coordinated decision-making can be implemented, three possible linking mechanisms can be envisaged.

(i) A single entity which has overall supervisory responsibilities. This does not mean that the entity should undertake all water management tasks itself; many of the tasks of 'integrated' management can be delegated to other entities, but they would be hierarchically subordinate to the supervisory agency. In theory, a water management authority could be created in this model, but it would have to take over power from many other agencies, and it could therefore be quite unpopular with sectoral agencies.

(ii) Where no agency with overall supervisory responsibility for water management exists, one of the many agencies involved could be given the responsibility for heading a joint task force, working group, or coordinating committee on a continuous basis. Such a task force could be comprised of representatives of the various sectoral government agencies, as well as representatives of local and provincial government. This is the model followed in the Netherlands for the development of management plans for the Eastern Scheldt, Western Scheldt, Krammer-Vol-

kerak, and Haringvliet-Hollandsch Diep-Biesbosch areas.

(iii) Another type of linking mechanism is represented by the Delaware River Basin Commission (DRBC) in the USA. This interstate–federal agency combines the powers of the states with the powers of the federal government. The legislation establishing the DRBC gave it broad powers, both supervisory and operational. The DRBC has specific responsibility for integrated planning. This is accomplished by developing and maintaining a comprehensive plan, and by reviewing all activities proposed by other agencies which could significantly affect the water resources of the basin. The DRBC has authority to veto any proposal which it considers to have an adverse impact on water resource management in the basin.

Two points merit emphasis. First, the most difficult problem with respect to the implementation of water resources management plans involves integrating land use plans by local governmental agencies with water resources management plans. As long as land use planning is the responsibility of local government agencies, implementation of some of the necessary measures to achieve the desired outputs from water resources will not be possible.

Second, the extent to which integrated analysis can be achieved is to a large extent dependent on the training and interest of the individuals who are doing the analysis, and the context in which the planning is done. The evolution of planning in the US Corps of Engineers is illustrative. For several decades following the passage of the Flood Control Act of 1936, planners in the Corps considered only physical structures to reduce flood damage, to improve water quality and to provide public water supply. No 'non-structural' measures, including 'demand management' measures, were considered. Only after many years, substantial external pressure, rejection of Corps proposals which excluded consideration of such alternatives, and the addition of personnel with broader training and backgrounds in other disciplines, did planning by the Corps include a wider range of options.

Capacity building

An important aspect of institutional arrangements is to create the capacity to implement effectively integrated water resources management plans. That capacity depends upon the financial, administrative and technical capabilities of the institutions involved and on a favourable policy environment.

WMO in its report [25] states that an important aspect of capacity building is the ability of a water authority to collect, analyse and elaborate information on water resources. This should include environmental and socio-economic information which is essential for integrated water resources management.

One important aspect of capacity building is the availability of human resources. There is an urgent need for adequately trained professionals who can work in the multi-sectoral environment of integrated water resources management. In addition to an understanding of the technical disciplines related to the various water users, the future water resources manager should be knowledgable about economics, ecology etc, and be able to undertake legal and social analysis in a complex society. Here lies an important task for universities and educational institutes to prepare the next generation of water management professionals for the immense tasks that they are to face. One of the problems is that the teachers who have to educate the future generation make use of experiences gained in a world less complex than the future one will be. Equally important, trained professionals should be able to work in an enabling environment with good career opportunities and incentive structures. If that is not taken care of, a costly brain-drain will follow.

Public participation and stakeholder involvement

Stakeholders can be defined as people, organizations or institutions that have a direct interest in the water resources system. Stakeholders include: water users, politicians, influential persons, pressure groups, research institutes etc. In planning water resources development, the involvement of stakeholders is essential to making the plan work, because the involvement of the stakeholders is a prerequisite for commitment.

Water users, probably the most important group of stakeholders, play a dual role in water resources management: on the one hand, they are the ultimate beneficiaries of the water made available, but on the other hand, they are the ultimate water managers, whose behaviour in terms of water use and waste generation plays a decisive role on the condition of the water resources system as a whole. One group of stakeholders that requires specific attention is women. It is slowly being recognized that women play a central and crucial role in the supply, use and management of water resources in many countries, and that this role should be recognized more explicitly in water resources planning and management.

The position of stakeholders and the related social issues are therefore crucial in integrated water

resources management. Planning that does not pay sufficient attention to both has little chance of being successfully implemented. There is a great deal of truth in the saying that planning requires both strong planning mechanisms on a national level and a strong social structure on a local level. The desired behaviour of stakeholders can be stimulated through proper economic incentives and regulations, but it can never be completely enforced by government agencies and will always depend on their cooperation and commitment. An improved understanding on the part of water resources managers of the role of water in the lives of the stakeholders and the need for their effective participation is essential for successful demand management, and can substantially contribute to the acceptability of its controversial effects. Similarly, the successful formulation of alternative or additional measures and the distribution of costs and benefits in relation to both willingness and ability to pay depends upon an understanding of who the stakeholders are.

Many water resources projects in the recent past, however, still show a considerable lack of public participation or considerations of social issues. Many river basin projects, for example, concentrate on dam construction and the direct benefits of a regulated river flow. As a result, productive land may be lost, populations may have to be resettled and riverine production systems, including flood water agriculture and fishing, may be seriously damaged. Examples include the Kariba Dam on the Zambesi river, Lake Kanji in Nigeria, Keban Dam in Turkey and the Ubolratana Dam in Thailand [7,19]. Other examples relate to Bangladesh, where polder construction has generated unequal benefits between farmers and fishermen, and among different farmers. Fights and destruction of dikes have occurred on numerous occasions.

Fortunately, the news is not altogether bad. In many areas the awareness of the importance of public participation and the use of local knowledge is growing. In Bangladesh, due to experiences like the one cited above, considerable efforts are now made for local participation in flood control and drainage projects. The responsibility for implementation, operation and maintenance of such projects now lies principally with the local authorities and farmer organizations.

Priorities for action

Essentially, water resources management is a national responsibility. A sustainable use of natural resources that is economically efficient as well as equitable, implies that decisions need to be taken to allocate financial as well as natural resources among competing users or groups of users. Typically, such decisions which will affect the availability of resources to future generations are the mandate of national governments. Consequently, a strong organization at the national level, including experienced and trained staff, and operational linking mechanisms between all the agencies involved, is a prerequisite for adequate water resources management.

The institutional structure at the national level should be complemented and supported through institutions at the local level. That includes, for example, village communities, irrigation associations and local water boards. Experience has shown that socially desirable use-levels for the various uses can be stimulated through management actions, but cannot be enforced without the understanding and participation of the water users.

Priorities for water resources management

Integrated water resources management may enhance the role of water resources in socio-economic development in both developed and developing countries. However, it should be kept in mind that such development will need to be sustainable from an environmental as well as a social point of view. Some proposals to improve the development and use of the water resources system are given below.

- Demand management should be developed into an operational alternative to supply management. Water should be considered an economic resource, and consequently adequate pricing should be implemented where applicable. The price of water should not only cover the direct costs of production, but should include its scarcity value as well. In the development of water pricing systems special attention should be paid to: (i) pollution and over-exploitation (mining) in relation to long-term sustainable use of the water; and (ii) social aspects of equity concerning the access to water and the ability of low income groups to pay.
- Public participation and community management. Large-scale infrastructure has proven to have large, and often adverse, social and environmental impacts. Water resources development should pay more attention to the self-reliance of local communities, based on traditional approaches which are often socially acceptable and environmentally 'sound'. To achieve that objective requires public participation at all stages in the planning process. In addition, community management should be considered a viable alternative to complement the necessary strong role of government coordination and planning.
- Functional institutional arrangements (structure

and linking mechanisms) are crucial for implementation of integrated water resources management. Institutional conflicts can lead to issues of: coordination with other sectors of the economy and the overall economic development planning process, including the development and operation of cross-sectoral information systems; implementation of planned actions, in particular in relation to demand management; and enforcement of regulations.

- Careful planning and adequate supporting analysis is an important vehicle to prepare for successful implementation of integrated water resources management. Proper planning can improve decisions on investments and on allocation of water. Planning should not be a blueprint exercise but should be an open-ended cyclical process. What is required at the national level is a capability for planning rather than cook-book master plans. A capability for planning would include: (i) the availability and access to reliable and relevant data, including monitoring and control data on implemented measures; (ii) proper institutional arrangements for implementation; and (iii) adequate and well-trained staff.
- Monitoring and control is important for both supply and demand management and should cover both the water resources system and its users. With respect to the water resources system, attention should focus on water quality issues, such as: sources of pollution, distribution and accumulation of pollutants in the ecosystem, and harmonization of sampling and analysis procedures. However, not only the performance of the water resources system should be monitored. Water resources managers should enforce strict compliance with regulations governing the behaviour of water users and the impacts of water utilization on the natural environment. Without such monitoring and control, demand management is not likely to be successful.
- In particular in developed countries, integration between water, air, soil and coastal management should be improved. Interactions to be considered are not only physical, chemical and biological, but also utilization and regulation. For example, successful air pollution abatement measures, might well result in an increase in water pollution.

At this point, a word of caution is necessary. Although the need for, and the objectives of, integrated water resources management appear to be widely supported, translation of such support into implementable policies for the sustainable use of water resources is difficult and time consuming.

Action plan for the international community

An action plan for the 1990s for national governments and international agencies designed to promote, develop and implement integrated water resources management, should concentrate on the following areas:

- There needs to be improved coordination of donor support for water resources development in developing countries. Long-term support to implement sustainable development and use of natural resources is needed instead of short-term support for project implementation.
- The development and implementation of international rules and legislation on shared rivers and river basins as proposed by the International Law Commission should be given high priority.
- Research and technological developments for the more efficient use of water are strongly affected by government policies and actions. Such actions should be supported and coordinated on an international level. Of special relevance to water resources management today are: waste and pollution control technologies; water saving technologies in agriculture and industries, including re-use of water; and the public health aspects of irrigation projects.
- Institutional support. Institutional arrangements on a national level are crucial for proper implementation of water resources management. Existing knowledge and experience at the international level should be mobilized and used to support individual nations to strengthen their institutional arrangements. Long-term programmes, preferably through United Nations organizations, should be developed and promoted to this end.
- Education, training and capacity building are essential for a new approach to the implementation of water resources management. Education and awareness of the importance of an efficient use of water resources for sustainable development, is at the root of the understanding that water is not a free resource any more. Training of water resources managers is instrumental in passing on the concept of integrated management and providing them with the tools for implementation. Managers are needed with a firm grasp of economic, social, environmental and legal aspects as well as engineering aspects of resources management.
- Awareness and promotion. Continuous efforts are required to increase the awareness of water resources problems in relation to sustainable development and to develop and promote integrated water resources management. Studies, publications, workshops, creation of new institutes or

support of existing ones, are among the main instruments in this respect. It may be necessary to mount a strong lobbying effort to give the issues of water resources management and sustainable development a higher priority on the international environmental agenda.

Concerted actions are required at international, national and local levels. Demand management and corresponding institutional changes are high priority actions, which essentially belong to national and/or local responsibilities. The international community plays an important role in: the development and implementation of international rules and legislation; research and technology development for a more efficient water use; and awareness and promotion. In relation to developing countries, priority actions for donor organizations should include improved coordination and institutional support, education and capacity building.

References

1 Asian Development Bank, *Economic Policies for Sustainable Development*, Manila, Philippines, October 1989.

2 Viqar Ahmed and Michael Bamberger, *Monitoring and Evaluating Development Projects: The South Asian Experience*, EDI Seminar Series, World Bank, Washington, DC, 1989.

3 Warren C. Baum and S. M. Tolbert, *Investing in Development, Lessons of World Bank Experience*, World Bank, Oxford University Press, 1985.

4 Beijing, *Protecting the Environment, Final Declaration of the Ministerial Conference of Environment and Development*, Conference of 41 developing countries from 18–19 June 1991 in Beijing, China, in preparation of the UNCED 1992 conference, 1991.

5 Ronald G. Cummings, Victor Brajer, James W. McFarland, Jose Trava and Mohammed T. El Ashry, *Waterworks: Improving Irrigation Management in Mexican Agriculture*, WRI Paper No 5, World Resources Institute, Washington, DC, 1989.

6 Euroconsult, *Review of the Water Resources of Maputo Province*, People's Republic of Mozambique, National Directorate of Waters, 1989.

7 Essam El-Hinnawi and Manzur Ul-Haque Hashmi, *Global Environment Issues, United Nations Environment Programme*, Tycooly International Publishing Ltd, Dublin.

8 FAO, Planning methodology seminar Bucharest, *Report of the FAO/UNDP Seminar on the Methodology of Planning Land and Water Development Projects*, Bucharest, Rumania, 5–14 September 1971, Irrigation and Drainage Paper 11, Food and Agricultural Organization of the United Nations, Rome, 1972.

9 FAO, Farm water management seminar Manila, *Report of the FAO/UNDP Seminar on Measures to Accelerate Benefits from Water Development Projects by Improved Irrigation, Drainage and Water Use at Farm Level*, Quezon City/Manila, Philippines, 7–16 October 1970, Irrigation and Drainage Paper 12, Food and Agricultural Organization of the United Nations, Rome, 1972.

10 FAO, Water use seminar Damascus, *Report of the FAO/UNDP Seminar on the Effective Use of Irrigation Water at the Farm Level*, Damascus, Syria, 7–13 December 1971, Irrigation and Drainage Paper 13, Food and Agricultural Organization of the United Nations, Rome, 1972.

11 FAO, Agricultural water use; assessment of progress in the implementation of the Mar del Plata Action Plan, *Report of the Regional Assessment Missions*, 1991.

12 Alvin S. Goodman, *Principles of Water Resources Planning*, Prentice-Hall, Englewood Cliffs, NJ, 1984.

12 Helsinki, *Helsinki Rules on the Uses of the Waters of International Rivers, Adopted by the International Law Association*, 52nd conference held in Helsinki on 20 August 1966, The International Law Association, London, 1966.

13 Maynard M. Hufschmidt *et al, Environment, Natural Systems and Development; an Economic Valuation Guide*, The Johns Hopkins University Press, Baltimore and London, 1983.

14 London, *Final declaration of the G7 conference*, London, 15–17 July 1991.

15 NOAA, *The Use of Economic Analysis in Valuing Natural Resource Damages*, US Department of Commerce, National Oceanographic and Atmospheric Administration, Environmental Law Institute, Washington, DC, USA, June 1984.

16 OECD, *Pricing of Water Services*, Paris, 1987.

17 OECD, *Economic Instruments for Environmental Protection*, Paris, 1989.

18 OECD, *The State of the Environment*, Paris, 1991.

19 Thayer Scudder, 'Conservation vs development: river basin projects in Africa', *Environment*, Vol 31, No 2, March 1989.

20 UNDTCD, *Water Management Since the Adoption of the Mar del Plata Action Plan: Lessons for the 1990s*, United Nations, New York, 1991.

21 UNDP, *Safe Water 2000, 'The New Delhi Statement'*, Global consultation on safe water and sanitation for the 1990s, New Delhi, India, 10–14 September 1990.

22 United Nations, *The Law of the Non-Navigational Uses of International Watercourses*, Draft, International Law Commission, forty-third session, 29 April–19 July 1991.

23 World Bank, *Problems of Developing Countries in the 1990s*; Volume I, general topics. Second Global Prospects Conference, background papers. World Bank Discussion Papers 97, F. Desmond McCarthy, ed, 1990.

24 WHO, *Water Quality; Progress in Implementing the Mar del Plata Action Plan and a Strategy for the 1990s*, Geneva, Switzerland, 1991.

25 WHO, *Report on Water Resources Assessment; Progress in the Implementation of the Mar del Plata Action Plan and a Strategy for the 1990s*, Geneva, Switzerland, 1991.