CHAPTER 3

INTEGRATED WATER RESOURCES MANAGEMENT

3.1 INTRODUCTION

3.1.1 Sustainable water development

Since the 1970s, there has been a growing awareness that natural resources are limited and that future development must come to terms with this fact. The concept of sustainability has on the whole gained wide acceptance, although its meaning may vary, depending on the person. Sustainable development as defined by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme (UNEP) and the World Wildlife Fund (WWF) is adopted in this Guide: "improving the quality of human life while living within the carrying capacity of supporting ecosystems". (IUCN/UNEP/WWF, 1991).

Is there any way to measure the sustainability of development? If account can be taken of natural variability and trends in water resources availability, it is arguable that the effects of development will be reflected in changes in the resource base. The so-called ecological footprint is a tool that is used to measure the amount of land and water areas required to produce the resources it consumes and absorb its wastes (see, for example, http://www.footprintnetwork.org/). It has been estimated that today's global population has an ecological footprint that is 20 per cent larger than the biocapacity of the Earth. Monitoring of the quantity and quality of water in natural systems – streams, lakes, underground, snow and ice – thus becomes a prerequisite for tracking the extent to which development can be sustained.

The building of adequate databases through the monitoring of hydrological systems is a fundamental prerequisite of water resources assessment and management. This chapter reviews the adequacy of current monitoring networks and techniques in the light of a changing resource base and evolving water management philosophies related to sustainable development.

3.1.2 The changing nature of the resource

3.1.2.1 Natural changes

The hydrological system, driven by meteorological conditions, is constantly changing. Over long periods of time – decades to millenniums – variations in the receipt of energy from the Sun, acting through the atmospheric system, cause important changes in hydrological regimes. For example, changes in the distribution and extent of ice masses and vegetation cover usually reflect hydrological changes.

Recently, there has been increasing awareness that interactions between the air and the sea have extremely important effects on climate. El Niño Southern Oscillation events, for example, with teleconnections over wide areas, may have far-reaching hydrological ramifications, which are particularly relevant when associated with droughts and floods. Longer- term atmospheric phenomena such as the Pacific Decadal Oscillation and their teleconnections may also affect hydrological systems.

Natural events of a completely different type, such as major volcanic eruptions with massive emissions of dust and gases into the atmosphere, can also impact the hydrological system significantly.

3.1.2.2 Human-induced changes

Human activities increasingly affect hydrological systems. Some of the more important activities are listed below:

(a) The construction of dams and diversions has a major impact on flow regimes and sediment transport in many of the world's rivers, as well as on ecological systems in donor and recipient basins;
(b) Changes in land use often produce major effects on hydrological regimes as follows:
    (i) Deforestation often leading to more pronounced flood peaks and increased soil erosion;
    (ii) Draining of wetlands, often bringing about changes in the runoff regime;
    (iii) Frontier road and railway construction causing erosion, changes in human settlement and land-use change;
    (iv) Farming practices, resulting in varying infiltration rates and groundwater recharge;
    (v) Urbanization, prompting characteristically flashy runoff;
(c) The quality of water in many places has been adversely affected by industrial and municipal

waste and agricultural practices such as the use of fertilizers and pesticides;

(d) The emission of greenhouse gases leading to climate change and related changes to hydrological systems. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007), the duration, location and frequency of extreme weather and climate events are likely to change, and would result in mostly adverse impacts on biophysical systems;

(e) Long-range transport of air pollutants can cause ecological damage far from the emission sites.

Monitoring systems should take into account these many changes in order to better understand the hydrological system, predict water availability and manage resources effectively. In particular, anthropogenic climate change driven by significant increases in atmospheric greenhouse gases over the past few centuries and the resulting effects of climate change on hydrological systems pose enormous challenges for water managers. Given the uncertainty in regional climate scenarios and the likelihood that younger water resources managers will witness events not previously recorded in human history, there is an even greater need for quality assured hydrological datasets and robust physically based models than ever before.

3.1.3 Changing attitudes to management

There have been significant socio-economic changes in many parts of the world. Rapid population growth, particularly in developing countries and in burgeoning urban centres, combined with industrialization and rising living standards, have increased the demand for water. Pollution in many regions has reduced the quantities of safe drinking water. Groundwater levels have declined in many regions. Growing demand, outstripping supply, will become more common. Thus, more efficient and effective water management is imperative.

The past few decades have witnessed dramatic changes in water management. There have been two important underlying themes. First, there is a growing awareness that water is a fundamental element in the natural environment. The presence and movement of water through all biological systems is the basis of life. Water, land and biological systems must be viewed as interlinked, and monitoring of the various components of the ecosystem should be harmonized. Secondly, water is absolutely essential to all forms of economic activity, for example, agriculture and food

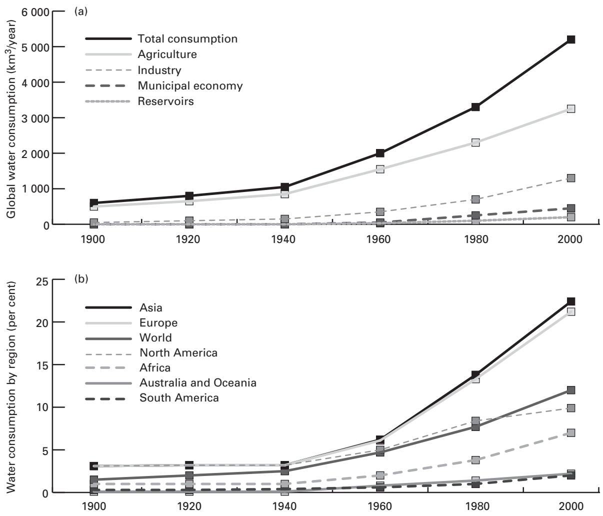

Figure II.3.1. Trends in world water consumption by (a) activity and (b) region

production, for much of industrial production and for the generation of energy. Water is also a critical factor in human health. Too much water, in the form of floods, or too little, such as drought, can lead to human and environmental disasters.

Figure II.3.1(a) shows trends in world water consumption from 1900 to 2000. Globally, consumption during that period increased tenfold; by the year 2000, almost half of the available water supplies was in use. Agriculture, particularly irrigation, remained the primary consumer despite a continuing decline in water use from 90.5 per cent in 1900 to 62.6 per cent in 2000. During the same period, industry's share of water consumption rose from 6.4 per cent to 24.7 per cent; that of cities with the same growth rate climbed from 2.8 per cent in 1900 to 8.5 per cent in 2000 (United Nations, 1997).

How has water consumption compared with the available water resources in each of the world's major regions during the twentieth century? Figure II.3.1(b) answers this question in terms of percentages calculated on the basis of theoretical resources, that is, the amount of water flow in rivers. According to these calculations, Europe and Asia clearly consumed much greater shares of their water resources than North America, Africa and, particularly, Australia and Oceania, and South America . It is also clear that Europe and Asia had the highest growth in consumption, except for South America, where the increase was offset by plentiful reserves of water.

Growing awareness of the pervasive nature of water, in addition to its importance in the natural environment and in human activity, has led to the recognition that a holistic approach to its management is necessary. Development of the resource for human use may have a detrimental environmental impact while, conversely, changes in the natural resource base may limit or otherwise affect human activities. These changes have led to the holisitic approach known as integrated water resources management.

3.1.3.1 Watershed management

There is general recognition that the natural management unit is the river basin. It makes sense to manage the water resources within a river basin and in a coordinated manner, as the water is often used several times as it moves from the headwaters to the river mouth. It also makes sense to manage all natural resources – vegetation, soils and the like – within the basin unit. Water demands for human activities should also be managed within the basin in an integrated manner.

Unfortunately, political boundaries do not normally coincide with basin boundaries. Rivers often cross international frontiers and traverse states or provinces within countries. Globally, about half of all the land surface falls within international basins and more than 200 significant basins are international in character.

3.1.3.2 Management fragmentation

It is common that several agencies or institutions within a State have authority over different aspects of water resources management. Departments or ministries of environment, agriculture, energy, industry, and health often have conflicting mandates.

All too often, the monitoring networks within a State are also fragmented politically and institutionally. Even within single agencies, the responsibilities for water quantity and water quality monitoring often are not coordinated. Vague institutional responsibilities and mandates within countries, and conflicting demands on water use between countries (within international basins) or inter-state disputes within federal States, pose real problems for the establishment and maintenance of effective monitoring networks.

It is against this complex background of rapidly changing water management philosophies, political and socio-economic realities and the resource base itself that several actions must be taken. These include the design and operation of monitoring systems, the storage and dissemination of data, followed by the use of those data as the basis on which sound decisions can be taken to plan, design and operate water projects and issue warnings and forecasts of hydrologically significant events.

3.2 INTEGRATED WATER RESOURCES MANAGEMENT [HOMS A00]

The term integrated may be defined as having all parts combined into one harmonious whole, coordinating diverse elements.

Integrated water resources management can be interpreted at three different levels. First, it involves the systematic consideration of various dimensions of water: surface and groundwater, and quantity and quality. The key is that water represents an ecological system, containing interrelated parts. Each part can influence, and be influenced by, other parts, and therefore needs to be planned for and managed with regard to those interrelationships. At this level, attention normally is given to how to integrate considerations related to water security and water quality.

At the second level, managers recognize that while water is an ecological system, it also interacts with other resource systems, ranging from terrestrial to other environmental systems. This second level is broader than the first, and turns attention to matters such as flood-plain management, drought mitigation, erosion control, irrigation, drainage, non-point sources of pollution, protection of wetlands and fish or wildlife habitat and recreational use. At this level, integration is needed because many water problems are triggered by land use or other development decisions involving major implications for aquatic systems.

The third level is broader still, and directs the manager toward interrelationships among the economy, society and the environment – of which water is but one component. Here, the concern is the extent to which water can facilitate or hinder economic development, reduce poverty, enhance health and well-being and protect heritage.

All three levels highlight the fact that planners and managers deal with a mix of systems, which often involves hierarchical relationships. As a result, a key feature of integrated water resources management is the application of a systems or ecosystem approach. Another key feature is the need to be focused and results oriented, as there is always a danger of defining systems or issues so broadly that they become impractical from a management perspective.

To quote the Inter-American Development Bank (1998), integrated water resources management involves decision-making on development and management of water resources for various uses, taking into account the needs and desires of different users and stakeholders.

In sum, the keys to effective integrated water resources management are a systems perspective, a focused and results-based approach, and partnerships and stakeholders. In the present chapter, attention is given to the rationale behind these aspects, how they have been applied in practice, what general lessons have been learned and what cautions should be borne in mind.

3.3 RATIONALE FOR INTEGRATED WATER RESOURCES MANAGEMENT

3.3.1 Water quantity and quality

The responsibility for managing the quantity, or supply, and quality of water is often assigned to separate agencies. This can be attributed to historical administrative reasons that are unrelated to the subject at hand, but also to the rationale that such a division nurtures efficiency because it enables professionals to focus on a specific aspect of water management. This practice has generally resulted in two groups or cultures of water professionals – managers of clean water and managers of dirty water – who operate separately.

A major disadvantage of this separation of authority for water quantity and quality is that the causes of, and therefore, solutions to, quantity and quality problems are frequently interdependent. For example, if flow in a river system drops because of natural variability, there may not be enough water to meet water-use needs or sufficient capacity to assimilate wastes deposited in the river. As a result, dams and reservoirs may be constructed in order to enhance storage to meet user needs and to provide augmented flow in the dry season in order to meet water quality standards. To achieve the optimum design of such dams and reservoirs, water quantity and quality needs should either be considered jointly or integrated in management practices.

3.3.2 Surface water and groundwater

In many regions of the world, groundwater is the major source of the flow in surface streams during the dry season. In addition, certain land-based activities, such as those causing leakage from underground storage tanks, can lead to pollution of aquifers. Other land-based activities, for instance, withdrawal, which is implemented to meet urban or agricultural needs that exceed rates of recharge, can also bring about the depletion of groundwater reserves.

Given the interconnections identified above, in order to achieve effective management of aquatic systems, it is necessary to study and manage surface water and groundwater as connected systems, particularly to ensure secure water supplies of acceptable quality. An integrated approach encourages – indeed, requires – the joint management of surface water and groundwater systems.

3.3.3 Upstream and downstream considerations

Decisions or action taken in the upstream part of a river basin or catchment have implications for downstream areas. For example, point and non-point pollution entering a river in the upper part of a basin may produce negative health or other impacts on downstream users, whether human or other species. Conversely, if officials in downstream urban areas determine that they can reduce their vulnerability to flooding by building storage dams and reservoirs in the upper part of their basin, then the upstream residents may suffer. This happens through inundation of urban and agricultural land caused by reservoir backwater, leading to loss of housing and livelihood for some farmers, and sometimes damage to, or loss of, heritage or areas such as burial grounds or historical sites.

The interconnections between areas of a river basin or catchment are often cited as a compelling reason for using the basin or catchment as the spatial unit for integrated water resources management. Such a rationale is logical. However, it must be understood that the relevant basin or catchment for surface water may not coincide with the spatial extent of an aquifer. It should never be assumed that surface and groundwater systems have the same spatial extent. The possibility of such a disconnection of the spatial boundaries of surface and groundwater systems poses a challenge to water managers, for which there is no obvious answer. Another challenge arises when interbasin transfers occur, requiring a perspective extending beyond the upstream and downstream needs in one basin, so as to consider the interconnections between two or more river basins.

Another challenge for defining the spatial boundaries of a management system based on ecosystem characteristics is the presence of various administrative and political boundaries. Rivers, and sometimes lakes, have been used to delineate boundaries between municipalities, provinces, states and countries and are shared by several countries or subnational administrative units. As a result, management of such rivers and lakes requires the involvement and collaboration of various partners. The most flagrant example is the Danube river, whose basin is shared by 19 countries. Ensuring that upstream and downstream interests and concerns are addressed in situations involving different countries poses a significant challenge for implementing an integrated approach.

3.3.4 Water, land and other resource systems

Many water problems originate on land. To achieve flood damage reduction, for example, it is generally not sufficient to manage or control the variability of water levels in rivers and lakes through dam, dykes and levees. Land-use activity related to urban development and agriculture can result in the removal or shrinking of wetlands, forest systems and grasslands, which in turn exacerbates erosion and flooding problems. Indeed, it is claimed that much flood damage along the Ganges river in India and along the Indus river in Pakistan can be attributed to the removal of forests in the Himalayas. Furthermore, initiatives to enhance water quality must often start with attention to activity associated with other resource systems. Thus, the use of pesticides, herbicides and fertilizers to improve agricultural productivity is often a major contributor to non-point sources of pollution, requiring attention to land-based activities to tackle the pollution of water systems.

Another challenge is the long-range transport of airborne pollutants. Even if an integrated approach is taken by key managers within the basin, they usually do not have the authority to deal with sources of pollution originating outside the basin, at times hundreds of kilometres away.

3.3.5 Environment, the economy and society

Historically, water management has been dominated in developed and developing nations by three professions: engineering, agriculture and public health. As a result, engineers began focusing on structural solutions for issues ranging from water security – whether for urban, industrial or agricultural use – to water quality and flood damage. In addition, health professionals started turning their attention to the treatment and disposal of sewage and other wastes detrimental to health.

The domination of water management by engineering and health professionals led to an emphasis on technical and economic perspectives. During the 1960s, there was a growing awareness that environmental aspects should receive greater attention, followed by the recognition that social or cultural issues also required special consideration. Such recognition led to a gradual acceptance of the desirability of teams – multidisciplinary, at least, or interdisciplinary, at best – to gather and integrate a range of professional and disciplinary views in developing management approaches. While each discipline represented in a multidisciplinary team yields discipline-specific results and leaves the integration of the various contributions to a third party, building an effective team requires overcoming many obstacles and challenges. This is necessary to develop and apply new knowledge, with team members working together as equal stakeholders to address a common challenge. However, such teams are essential if the intent is for strategies to address environmental, economic and social aspects in an integrated manner.

3.3.6 Vertical and horizontal fragmentation: systems and silos

Notwithstanding the compelling reasons for using integrated water resources management, there are pragmatic reasons for public agencies being structured to focus on one or a subset of resource systems. Hence, it is common to find separate departments or ministries of agriculture, forestry, wildlife and natural resources. The separation of functions into different agencies is known as horizontal fragmentation when, for a given level of government – national, state or local – responsibility for a particular resource is assigned to various agencies. Such arrangements require a range of technical expertise represented on a team that can concentrate on issues and opportunities related to that resource and, where appropriate, develop working relationships with users of the resource. Along with such organizational structures, inter-departmental committees or task forces may be used to coordinate different interests, mandates and perspectives.

Without coordination and collaboration, there is a real danger of losing effectiveness and efficiency. For example, as a ministry of agriculture carries out its mandate to increase lower-cost food production, it may seek to drain wetlands to put more land into farming, or it may encourage the use of fertilizers or other chemicals to boost crop production. In contrast, a ministry of natural resources may introduce programmes aimed at protecting or expanding wetlands in order to enhance wildlife habitat and capacity, and delay runoff during storms, thereby reducing downstream flooding. Such programmes can also serve to discourage the use of agrochemicals in order to reduce pollution of waterways used by fish, birds and other species. The activities of the aforementioned ministries might not result in a net change in the amount or type of wetlands in a jurisdiction, while expending significant funds to drain wetlands in some areas and enlarge them in others.

As mentioned above, horizontal fragmentation refers to the division of responsibility within one level or layer of government. Vertical fragmentation occurs when agencies at different levels of government – national, state or local – share an interest in or responsibility for a resource, such as water. For example, a State agency might design, build and operate a dam and reservoir, one purpose of which is to provide water for nearby communities. At the same time, a local government agency might be responsible for distributing the water from a reservoir to households, industry and farm irrigation systems. When this occurs, there is a real need for mechanisms or processes to coordinate mandates and activities among the levels of government. Vertical and horizontal fragmentation can create obstacles to integrated water resources management; therefore, integration is essential.

One way to overcome such fragmentation has been to do away with specific resource-oriented agencies and create more broadly based ones, such as ministries of the environment or of sustainable development. This was done by the Canadian Federal Government, which eliminated its Inlands Water Directorate and re-distributed the professional staff among various divisions within Environment Canada. The aim was to ensure that water was considered along with other resource issues in order to achieve sustainable development. The theory was logical. However, it soon became apparent that other federal staff or clients had great difficulty finding the water specialists with whom to raise their concerns. Furthermore, it became clear that most farmers or other water users thought of themselves as having a water or waste problem, rather than a sustainable development problem.

The concepts of vertical and horizontal fragmentation illustrate that water and other resource managers face their greatest difficulties in handling so-called edge or boundary problems – those between the mandates and responsibilities of two or more agencies, and thus must be dealt with in a shared or partnership manner. Agencies usually do a very competent job dealing with problems or tasks that are clearly within their mandates and authority. In contrast, those with edge or boundary characteristics offer serious challenges, and thus call for an integrated approach, despite the practical administrative problems to be overcome.

3.3.7 Collaboration, coordination and coherence

Which criteria should be used to evaluate the success of a given management approach? It is common for the following criteria to be applied: effectiveness, in terms of achieving desired outputs or outcomes; efficiency, with regard to producing the desired effects without wasting time and energy; and equity, ensuring a fair distribution of benefits and costs of the desired results. The discussion in the previous subsections indicates that many aspects can hinder effectiveness, efficiency and equity.

Integrated water resources management is a tool that can help managers meet such criteria. The following factors are essential to achieve integration: collaboration, or the act of working together; coordination, that is, harmonious adjustments or working together, or, arranging in proper order; and relationships and coherence, that is, logical connection or consistency, harmonious connection of the parts of a whole.

Integration is a means to an end, not an end in itself. As a result, the use of integration in water management should be preceded by a shared vision about a desired future condition or state. Without such direction, it is difficult to determine which parts need to made into a whole, who should be working together to establish a proper order and relationships and what logical connections need to be made.

The rationale for integration as one tool to help in achieving a vision is to allow a desired future condition to be achieved effectively, efficiently and equitably. Integration is usually advocated because of its potential contribution to all three criteria. It contributes to effectiveness by helping ensure that different needs and opportunities are considered and incorporated into plans and activities; to efficiency by helping ensure that actions of one agency or organization do not undo the actions of another agency; and to equity, by forcing consideration of different values and interests of various stakeholders.

3.4 EVOLUTION OF INTEGRATED WATER RESOURCES MANAGEMENT

Integrated water resources management is not a new concept. It has existed in one form or another for well over half a century in the voices and writings of eminent water experts such as Gilbert White. In 1977, the United Nations Water Conference in Mar del Plata adopted a resolution promoting the concept. Later, integrated water resources management was highlighted as a guiding principle contained in the 1992 Dublin Statement on Water and Sustainable Development (ICWE, 1992). More recently, the Global Water Partnership programme has been based on this concept. (Tortajada, 2003). In various countries and regions, initiatives have been taken to manage water using integrated water resources management as a basis, even if the term was not being used. This section reviews experience with selected approaches to integrated water resources management.

3.4.1 United States of America: Ohio conservancy districts, Tennessee Valley Authority

In 1933, the Tennessee Valley Authority was established so that initiatives related to hydropower development, navigation and flood control in the Tennessee river basin could be pursued in a coordinated and integrated manner. Without the Authority, different agencies responsible for power supply, navigation and flood control would most likely operate independently, and thus miss an opportunity to design and operate activities to complement one another. In addition, the Tennessee Valley Authority became involved in other initiatives, such as rural planning, housing, health care, libraries and recreation, because no agencies provided such services or facilities.

3.4.2 Canada: conservation authorities

Legislation was passed in 1946 in Ontario to create conservation authorities, catchment-based organizations formed through a partnership of municipalities with the provincial government (Richardson, 1974; Mitchell and Shrubsole, 1992). The trigger was the realization that individual municipalities did not have the resources or authority to take initiatives such as the construction and operation of upstream dams and reservoirs for flood damage protection, which would benefit an individual municipality, as well as other downstream communities. In 2005, there were 36 conservation authorities in Ontario, covering areas in which over 90 percent of the population lived.

Conservation authorities were founded on the following principles, which have had enduring value:

(a) The best management unit was the watershed: Many of the economic staples of the province, such as agriculture and timber, depended on water and terrestrial resources, highlighting the need for an integrated approach;
(b) Local initiative was essential: A conservation authority would only be established when two or more municipalities in a watershed agreed to collaborate with each other and the provincial government;
(c) Provincial-municipal partnership was key: Although the provincial government would not impose a conservation authority, it would participate as a partner. However, this feature also meant that areas with few people or a modest tax base would not be able to form a conservation authority, because there would be no local capacity to raise the required funds;
(d) A comprehensive perspective was required: Many land-based problems were caused by too much or too little water, and water-based problems often were influenced by land-based activities. Thus, a comprehensive approach was promoted, meaning that water and associated land-based resources would be considered together;
(e) Coordination and cooperation were important: Any new conservation authority was required to create links with provincial and municipal agencies responsible for other natural resources, the environment and planning.

3.4.3 United States and Canada: the Great Lakes

The Great Lakes basin, shared by the United States and Canada, covers a surface area up to the outlet of Lake Ontario of 765 990 km^2, 521 830 km^2 of which is land and 244 160 km^2, water. It contains about 20 per cent of the world's surface freshwater supply, and is home to over 40 million people – 14 per cent of the total United States population and 30 per cent of the total Canadian population. Its governance involves two national, eight state, two provincial and hundreds of municipal governments.

The two national governments signed the Boundary Waters Treaty in 1909, and through that treaty created the International Joint Commission. It has six commissioners, three from the United States and three from Canada. It is a permanent bi-national body and forum for international cooperation and conflict resolution regarding air pollution, water quality, regulation of water levels and water flows between Canada and the United States along their common border. The Commission has quasi-judicial, investigative and surveillance roles and two operational arms: the Great Lakes Water Quality Board and the Great Lakes Science Advisory Board. The Commission drafted two important agreements, the 1972 and 1978 Great Lakes Water Quality Agreements, with amendments enacted in 1987. The 1978 agreement was the catalyst for the application of an ecosystem approach.

3.4.4 Australia: total catchment management

Burton (1986) may be credited with the development of total catchment management in Australia. In 1947 the State Government of New South Wales created the Conservation Ministry to coordinate the management of the water, soil and forest resources in the state. In 1950, legislation was passed to create the Hunter Valley Conservation Trust, with responsibility for the coordinated management of water and land resources in that valley, inland from Newcastle on the coast of New South Wales. At a state-wide level, the State Premier in 1984 approved the creation of the Inter-Departmental Committee on Total Catchment Management and subsequently announced that a total catchment management plan would be developed for each of the major river valleys in New South Wales.

3.4.5 New Zealand: Resource Management Act

New Zealand's experience with integrated water resources management goes back to the 1940s (Memon, 2000). Later, starting in the 1960s, catchment control plans for soil conservation and river control were initiated, and these were followed in the 1970s with basin-wide resource inventories and informal water allocation plans.

The Resource Management Act of 1991 was major milestone, distinguished by its provision of "a statutory basis for a relatively integrated approach to environmental planning" (Memon, 2000). Furthermore, the Act replaced a large number of separate and sometimes inconsistent and overlapping acts related to the use of land, water, air and geothermal resources. Under this law, duties are divided among three levels. The central government focuses on policy and monitoring. At the subnational level, water and other resource and environmental management tasks are undertaken within a two-tier system involving directly elected multiple-purpose regional councils and territorial local authorities: city and district councils. The 12 regional councils are set up according to major river basin catchments.

3.4.6 South Africa

The Water Act of 1956 was introduced to achieve a fair allocation of water between competing agricultural and industrial needs. A key aspect of the legislation was giving water rights to riparian property owners, leaving them free to retain water through dams and other means. By the mid 1990s, however, it was recognized that the 1956 statute had some serious limitations. First, water quality concerns were not being systematically incorporated into management decisions which normally emphasized water quantity allocation. One result was growing organic pollution and eutrophication. Second, water requirements for the environment were not being adequately recognized. Third, at least in many rural areas, access to water was viewed as inequitable. Lastly, several analyses during the 1990s had noted the need for a more integrated approach to water management (Department of Water Affairs and Forestry and Water Resources Commission, 1996; Lazarus, 1997; Gorgens and others, 1998). The outcome was the White Paper on a National Water Policy for South Africa, which had been started in 1995 through consultations which extended over two years (Department of Water Affairs and Forestry, 1997).

South Africa introduced the new Water Services Act in 1997 and the National Water Act in 1998 to alter the way in which water was managed. A key aspect of the new approach was the incorporation of integrated water resources management. The National Water Act recognized that water was a scarce and unevenly distributed national resource and also a resource that belonged to all people, not just riparian landowners. Sustainability and equity were identified as fundamental principles, and meeting the basic needs of present and future generations was a key objective, along with protecting the environment and meeting international obligations for shared water resources. Social and economic development was also to be promoted through the allocation and use of water.

The National Water Act emphasizes decentralization. Key new institutions include catchment management agencies, through which responsibility for water management is delegated to the regional or catchment level and which involve local communities. Each catchment management agency is responsible for a catchment management strategy, and through it the agency has powers to manage, monitor, conserve and protect water resources; make rules to regulate water use; require the establishment of management systems; and temporarily control, limit or prohibit the use of water during periods of water shortage. Water user associations also are established under the legislation, with the main purpose of helping and coordinating individual water users.

Based on the experience in South Afric
(1999) concluded that the successful u
grated water resources managemen
recognition that integrated water resourc
ment has the following characteristics:

(a) It is a team business. A team require
understanding and individual and t
and skills, rules and regulations fo
and proper organization. This also requires coaching, coordination, policies, integrated strategies and planning;
(b) It is about winning and achieving goals. This calls for commitment and passion for the game, individual and team motivation, team spirit, and mutual trust and respect for the game, the team and supporters;
(c) It is about superior strategies. This requires understanding of the real business, involvement of the right players and champions, addressing value systems, tactical organization, entrepreneurship, boundarylessness, innovation and the creation of a winning culture;
(d) It is about champions, people with vision, initiative and passion and outstanding leadership;
(e) It is an exercise in public administration and political science. There must be support for the programme or it will fail.

The above points are relevant beyond South Africa, and deserve attention when designing, establishing or implementing integrated water resources management strategies.

3.5 PERSPECTIVES ON INTEGRATED WATER RESOURCES MANAGEMENT

3.5.1 Dublin Conference: Earth Summit, 1992

Prior to the United Nations Conference on Environment and Development, commonly known as the Earth Summit, in Rio de Janeiro in June 1992, the International Conference on Water and the Environment was held in January 1992 in Dublin, Ireland. It was convened by WMO on behalf of all nations with an interest in freshwater. This was the most all-embracing event focused on global water issues since the United Nations Water Conference in Mar del Plata in Argentina in March 1977. The purpose of the Dublin Conference was to identify priority issues related to freshwater, and to recommend actions to address them (ICWE, 1992). The ideas and proposals from Dublin were taken to the Earth Summit, and many of the recommendations were subsequently included in Agenda 21, the strategy for sustainable development in the twenty-first century (Young and others, 1994).

ublin Statement on Water and Sustainable
pment, the main output from the confer-
merged from deliberations by more than 500
from 114 countries, 28 United Nations agen-
d organizations and 58 non-governmental
ergovernmental organizations. The pream-
he Dublin Statement asserts that concerted
action is needed to reverse trends of over-consumption, pollution, and rising threats from both floods and droughts. Action needs to come from local, national and international levels, and four principles guide future initiatives. The first principle has been interpreted as a call for integrated water management:

> Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment. Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater aquifer.

The other principles emphasized the following needs:

(a) A participatory approach, involving users, planners and policymakers at all levels, with decisions to be taken at the lowest appropriate level;

(b) An enhanced role for women in the provision, management and safeguarding of water;
(c) The recognition that water has economic value in all its competing uses and thus should also be considered an economic good. Managing water as an economic good was viewed as an important way to achieve efficient and equitable use, and to encourage conservation and protection of water resources. In addition, all human beings have the basic right to access to clean water and sanitation at an affordable price.

The first principle of the Dublin Statement, a call for a holistic approach which, since the Earth Summit has usually been referred to an integrated approach, is the principle which has received the most attention. It emphasized that water problems cannot be treated in isolation, and indeed should be considered in relation to land-based and land-use planning issues. This was not a revolutionary principle, as the Organisation for Economic Cooperation and Development (1989) had previously published guidelines for integration relative to water management. Subsequently, researchers such as MacKenzie (1996) urged adoption of an ecosystem [holistic] approach, noting that it "can be seen as both comprehensive (in scope) and integrated (in content)".

Agenda 21 was the key outcome of the Earth Summit (United Nations, 1992). Chapter 18 of the Agenda deals with freshwater resources and provides a compelling rationale for integrated water resources management:

> ...the holistic management of freshwater as a finite and vulnerable resource, and the integration of sectoral water plans and programmes within the framework of national economic and social policy, are of paramount importance for action in the 1990s and beyond. The fragmentation of responsibilities for water resources development among sectoral agencies is proving, however, to be an even greater impediment to promoting integrated water management than had been anticipated.

In this assessment, Agenda 21 highlights the challenge of edge or boundary problems, noted earlier, as well as the significance of vertical and horizontal fragmentation.

3.5.2 World Water Council and the World Water Fora

The World Water Council was established in 1996 to provide an open platform for the discussion of water issues. Detailed information on the Council may be found on its Website, http://www.worldwatercouncil.org/.

The Council is an initiative of water specialists, the academic community and international agencies. It regularly convenes World Water fora to discuss water issues, develop proposals for action and highlight the importance of water. The First World Water Forum was held in Marrakech, Morocco, in March 1997, the second, in The Hague, Netherlands, in March 2000, the third, in Tokyo, Japan, in March 2003 and the fourth, in Mexico City, Mexico, in March 2006. The Fifth World Water Forum is planned to be held in Istanbul, Turkey, in March 2009.

The World Water Fora have been consistent in endorsing integrated water resources management. For example, the Ministerial Declaration of The Hague on Water Security in the 21st Century stated as follows:

> The actions advocated here are based on integrated water resources management, that includes the planning of management of water resources, both conventional and non-conventional, and land. This takes account of social, economic and environmental factors and integrates surface water, groundwater and the ecosystems through which they flow. It recognizes the importance of water quality issues.

The Ministerial Declaration emerging from the Third World Water Forum in Japan also endorsed integrated water resources management:

> Whilst efforts being taken so far on water resources development and management should be continued and strengthened, we recognize that good governance, capacity-building and financing are of the utmost importance to succeed in our efforts. In this context, we will promote integrated water resources management.

3.5.3 Global Water Partnership

The Global Water Partnership was set up in 1996, the same year as the World Water Council. Detailed information can be found at http://www.worldwatercouncil.org/.

The Partnership is an international network with support from a number of countries and international funding agencies. Its mandate is to support integrated approaches to sustainable water management consistent with the Dublin and Rio principles by encouraging stakeholders at all levels to work together in more effective, efficient and collaborative ways. Its primary function is to encourage the exchange of information and, quite explicitly, to promote integrated water resources management. As an international network, it is open to all bodies involved in water management – governments of developed and developing countries, United Nations agencies, multilateral banks, professional associations, research institutes, the private sector and non-governmental organizations.

The Global Water Partnership network includes a secretariat in Stockholm and nine technical advisory committees for each the following regions: Southern Africa, West Africa, the Mediterranean, Central and Eastern Europe, Central America, South America, South Asia, South-East Asia and China.

3.5.4 World Summit on Sustainable Development, Johannesburg, 2002

The World Summit on Sustainable Development was held ten years after the Earth Summit in Rio de Janeiro. A plan of implementation was prepared to build on and extend the actions proposed in Agenda 21. Section IV of the Plan addresses matters related to protecting and managing the natural resource base of economic and social development, and the first topic covered was an integrated approach to their management.

With respect to an integrated approach, the Plan stipulated as follows:

> Human activities are having an increasing impact on the integrity of ecosystems that provide essential resources and services for human well-being and economic activities. Managing the natural resources base in a sustainable and integrated manner is essential for sustainable development. In this regard, to reverse the current trend in natural resource degradation as soon as possible, it is necessary to implement strategies which should include targets adopted at the national and, where appropriate, regional levels to protect ecosystems and to achieve integrated management of land, water and living resources, while strengthening regional, national and local capacities.

With reference to freshwater, the Plan stated that the objective should be to develop integrated water resources management and efficiency plans by 2005, with support to developing countries, through actions at all levels to "develop and implement national/regional strategies, plans and programmes with regard to integrated river basin, watershed and groundwater management".

3.6 ELEMENTS OF BEST PRACTICE FOR INTEGRATED WATER RESOURCES MANAGEMENT

3.6.1 Alternative interpretations: comprehensive versus integrated approaches

At the beginning of this chapter, the term integrated was defined as having all parts combined into a harmonious whole or coordinating diverse elements. This definition has led to integrated water resources management being characterized as a systems, ecosystem, holistic or comprehensive approach. However, emphasis on having all parts combined into a harmonious whole has also provided integrated water resources management with its greatest challenge.

At the strategic planning level, it is appropriate to interpret integrated water resources management as a comprehensive approach that seeks to identify and consider the broadest number of variables that are significant for the coordinated management of water and associated land and environmental resources. However, if such an interpretation is continued at the operational level, experience has shown that this contributes to inordinately lengthy periods of time needed for planning, and also results in plans which are usually insufficiently focused to be of value to managers.

Given the above challenges, a comprehensive approach should be used at the strategic planning level to ensure that the widest possible perspective is maintained, in order to avoid overlooking any key external or internal variable or relationship. However, at the operational level, more focus is needed. In that regard, an integrated approach, while maintaining interest in systems, variables and their interrelationships, is more selective and focused, concentrating on the subset of variables and relationship judged to be the most important and amenable to being influenced by management actions. If such a distinction is made between comprehensive and integrative interpretations of a systems, ecosystem or holistic approach, it should be possible to complete planning exercises in a more reasonable length of time, identify the most important priorities for action, and thereby meet the needs of managers and users (Mitchell, 1990).

3.6.2 Vision for a desirable future

Integrated water resources management is a means to an end, not an end to itself. As a result, before its implemention, or as an initial step in such a process, it is important to have a well-established vision or direction about a desired future condition for an area or catchment. Integrated water resources management will be one instrument to assist in its achievement.

A vision articulates the destination towards which a group or society agrees to aim. The vision represents a future which in significant ways is better or more desirable than the present. Without such direction, it is difficult to determine which parts need to be brought together into a whole, and who should be working together to arrange a proper order and establish relationships.

Developing a shared vision can be a major challenge, since at any given time a range of values, interests and needs will exist among different stakeholder groups in a river basin or catchment. However, if there is no sense of direction, or clearly defined ends, integrated water resources management will not be able to create one. Thus, planners and managers must understand that without a vision it is unlikely that integrated water resources management will be an effective tool. Even worse, it may be discredited because it did not deliver a vision, something it was never intended to do.

When thinking about a vision for the future, it is helpful to distinguish among what is most probable, desirable and feasible. Planners and managers often focus first on identifying most probable futures, and insight on this is very valuable. However, too often, they stop there, or then move directly to considering what would be feasible futures, in light of what is deemed as most probable. An important point to remember is that the most probable future may not be the most desirable future; that is precisely why planners and managers seek to create a vision – to determine the desired future condition.

3.6.3 Spatial scale: watershed, sub-watershed, tributary and site

It is important to make a distinction among different situations when applying integrated water resources management. The need to adjust the amount of detail included as spatial scale changes is especially significant. In a report focusing on lessons learned and best practices related to watershed management, three Ontario conservation authorities (2002) shared some interesting insights.

In Ontario, watershed planning, equivalent to integrated water resources management, is conducted on four different scales, "with the level of detail increasing as the size of planning area decreases". In that context, the most logical and efficient way to conduct integrated water resources management is to start with a catchment or river basin plan, then develop sub-catchment or sub-watershed plans on a priority basis, and subsequently follow those with tributary plans, and finally with environmental site plans, as appropriate. Key lessons indicate that what is done at each stage provides direction and information for the next lower level and also helps avoid or minimize the potential for duplication.

However, financial constraints often result in sub-basin or sub-watershed plans being prepared first, and integrated later into an overall basin or catchment plan for integrated water resources management. In a similar way, tributary plans may be completed before the sub-catchment plans. The three Canadian conservation authorities distinguish among the four levels of integrated water resources management in the following ways:

(a) Basin or catchment plans: Such plans cover large areas. These plans include goals, objectives and targets for the entire basin and document both environmental resources and environmental problems. They also provide catchment-wide policy and direction for protecting surface and groundwater, natural features, fisheries, open space systems, terrestrial and aquatic habitats, and other important features;
(b) Sub-basin or sub-catchment plans: These plans involve a smaller area compared with the basin or catchment level plan. On this spatial scale, enhanced detail is provided to allow local environmental issues to be addressed. Goals, objectives and targets for management of the sub-catchment are identified. Sub-basin or sub-catchment plans dealing with integrated water resources management are custom designed to reflect local conditions and concerns. Recommendations may be included subsequently in official plans, secondary plans, growth management plans or other municipal planning instruments;
(c) Tributary plans: Plans on this scale are usually prepared to guide proposals for significant land

use changes, such as proposals for sub-divisions, large-scale water taking, gravel extraction, intensive agriculture and industrial estates. These are prepared for a portion of a sub-catchment and generally cover an area ranging from 2 to 10 km^2. Ideally, the boundaries of a tributary plan should align with the drainage basin of a tributary, but this is not always possible in practice. Recommendations emerging from tributary plans generally appear in secondary land-use plans, official land-use plan amendments, conditions for draft plan approval or for site plan approval;

(d) Environmental site plans: Such plans are usually developed to meet conditions set out in a draft plan. They provide details on proposed environmental and stormwater measures, and are usually submitted in parallel with plans for grading, erosion or sediment control and site servicing. Recommendations from environmental site plans normally appear in engineering design drawings for draft plans for a subdivision or industrial estate.

The four scales or levels identified above deserve attention from all planners and managers involved in integrated water resources management. By being aware that various levels of detail are appropriate on different spatial scales, planners and managers can increase the likelihood that issues and problems will be addressed at a suitable level of detail, overlap or duplication of work will be avoided, the time needed to complete integrated water resources management plans will be reduced and capacity for implementation will be boosted. If all of these are accomplished, the credibility and value of integrated water resources management will be enhanced.

3.6.4 Partnerships and alliances

Integrated water resources management was designed to ensure a holistic or ecosystem approach, and to facilitate the coordination of initiatives by different stakeholders. With regard to the latter, a strong motivation is required to break down what is often referred to as the silo effect, or the tendency of agencies to take decisions with regard only to their own mandates and authority, without reference to those of other organizations. In this manner, there is a reasonable expectation that integrated water resources management will be more effective and efficient compared with a non-integrated approach. However, in promoting a holistic approach, integrated water resources management can experience tension with arrangements for including participatory mechanisms. Many individuals, communities or stakeholder groups do not always give attention to the entire system, but rather only to that part or aspect related to their own needs and interests. Thus, individuals often focus on the impacts of catchment management on their own property, while municipal governments frequently worry about the area under their responsibility. As a result, if integrated water resources management and participatory methods are to be used together, care must be taken to understand the strengths and limitations of both.

Collaboration allows stakeholders to join forces in sharing their views on different aspects of a problem, and then together explore differences and search constructively for solutions going beyond any one stakeholder's capacities and limitations. In this way, they can share resources, enhance each other's capacity for mutual benefit and achieve a common purpose by sharing risks, responsibilities and rewards (Gray, 1989; Himmelman, 1996).

In addition to the above features, Gunton and Day (2003) point out that it is essential to determine if a collaborative approach is appropriate in any specific situation. In their view, a collaborative approach "may not work in all circumstances" . To help determine when participatory approaches are appropriate, they identify five pre-conditions for success:

(a) Commitment of decision-making agencies to a participatory approach;
(b) Commitment of all stakeholders;
(c) Urgency for resolution of an issue or issues;
(d) Absence of fundamental value differences;
(e) Existence of feasible solutions. In their view, the challenge is not whether all pre-conditions are met perfectly, but whether they are met adequately enough to allow a participatory process to begin.

3.6.5 Links to regional planning and impact assessment

Integrated water resources management plans or strategies often lack a legislative or statutory basis. This can have several negative consequences. First, agencies receiving recommendations from an integrated water resources management plan may simply ignore them, believing that they fall outside their legislated mandate or mission. Second, if agencies do strive to implement recommendations from such a plan, they have to determine what priority these recommendations should have relative to other responsibilities. For either of these reasons, there is a high probability that little action will be taken.

One way to overcome this problem is to link recommendations to instruments – such as official regional or municipal land-use plans, or environmental impact assessments – which have a statutory basis. It was for that reason that in 3.5.3 the discussion highlights how recommendations from integrated water resources management catchment, sub-catchment, tributary or environmental site plans in Ontario were incorporated into official plans, secondary plans or environmental impact assessment processes.

Water planners and managers should therefore familiarize themselves with the opportunities to connect the recommendations from integrated water resources management plans to regional or local land-use official plans or to environmental impact assessment processes, when these have a statutory basis. Another alternative is to strive for a statutory basis for integrated water resources management but, at the moment, such arrangements are the exception, not the rule.

3.6.6 Designing institutional arrangements

Once a vision is established, it is important to consider the institutional arrangements – the formal and informal mix of values, rules, organizational structures and cultures, mechanisms and processes – available for implementing integrated water resources management.

Experience suggests that governments often look first to make changes to organizational structures, such as when ministries of the environment were created in the 1970s or ministries of sustainable development, in the 1990s. However, this can be effective only where edge or boundary problems are identified, as highlighted in 3.2.6, and are therefore rarely the best place to start. As a result, when introducing or modifying institutional arrangements for integrated water resources management once a vision has been established, planners and managers should do the following:

(a) Determine what actions can be taken to give credibility or legitimacy to integrated water resources management. This is usually done by having some combination of a legislative base, administrative policy commitment and ongoing financial support;

(b) Decide which management functions are to be integrated. Given their utility-like characteristics, some functions, such as water supply, sewage treatment and waste disposal, could be allocated to the private sector, while others, such as flood-plain management or wetland protection, should be allocated to the public sector on the basis of their common property characteristics;

(c) Determine appropriate organizational structures, on the principle that structures should follow, not lead, functions. A continuum of structures exists, ranging from one large, centralized, multiple-purpose organization to many, small, decentralized, single- or limited-function organizations. Each arrangement has strengths and weaknesses and all encounter edge or boundary problems;

(d) As structures will never align perfectly with functions, next consider what mix of processes – for example, public participation and impact assessment – and mechanisms, such as interdepartmental task forces or committees, will be most effective to ensure coordination, collaboration and coherence among different agencies or groups. The following observation has been made (Grindle and Hilderbrand, 1995):

> Capacity builders need to create active mechanisms for interaction and coordination. Formal means of communication and coordination can be created, such as high-level and technical-level coordination committees, interlocking boards of directors or advisors, joint workshops and seminars, and relocating offices or improving technology so that communication is physically easier. Informal communications can be stimulated to supplement and support these formal interactions.

The value of such initiatives has been reiterated by noting that:

> interventions which allow professionals to work alongside one another as equals are increasingly important. Such interventions include networking and twinning arrangements, as well as workshops, seminars and platforms for cooperation which facilitate the sharing of knowledge (Franks, 1999);

(e) Most importantly perhaps, managers and planners should establish organizational cultures and staff attitudes to foster collaboration and cooperation, rather than competition. According to Grindle and Hilderbrand (1995), "Without exception, the organizations that performed well were able to inculcate a sense of mission and commitment to organizational goals among staff" and "one of the most important sets of findings is the evidence that relates organizational performance to the strength and orientation of its organizational culture". Such a supportive culture can be created and nurtured through training and education programmes focusing on the nature of and need for collaborative processes, and conflict resolution.

The above concepts together provide a framework to assist planners and managers as alternatives are considered regarding appropriate institutional arrangements to support integrated water resources management.

3.6.7 Monitoring and evaluating

As noted in 3.5.2, it is important to have a desirable future for which to aim and then use integrated water resources management as a means to achieve it. It is equally important to include provision for monitoring and evaluation so that the journey toward a desirable future can be tracked and, if necessary, adjusted.

To ensure a results-based focus, it is normal to monitor for effectiveness: are objectives being achieved? In addition, attention should be given to efficiency (are objectives being attained in the most cost-effective manner?) and equity (are the benefits and costs being distributed fairly?). Another dimension increasingly receiving attention is transparency or accountability: is it possible to see how decisions are taken and resources allocated?

Comparing the above product- and process-oriented dimensions provides a systematic basis against which to assess progress, or lack of progress, related to the role of integrated water resources management in helping achieve a vision. Without systematic monitoring followed by evaluation, the opportunity to learn from experience is reduced, as well as the opportunity to make adjustments in the light of new information, knowledge and experience.

3.7 CAUTIONS REGARDING INTEGRATED WATER RESOURCES MANAGEMENT

3.7.1 When to apply integrated water resources management

It is all too often assumed that integrated water resources management is good or desirable. However, because integration does not occur without costs, care should be taken when deciding whether or not integrated water resources management is appropriate. Staff time and other resources are required to accomplish integration; those resources are then not available for other needs or tasks. Often overlooked is the need to establish that serious resource scarcity and/or environmental degradation problems are the result of many interconnected causal factors whose resolution requires an integrated approach. In contrast, many situations are characterized by relatively straightforward problems that can be handled effectively by one agency or organization. If such a situation exists, integrated water resources management is unlikely to be needed. However, if there are multiple causes, or the actions of numerous agencies or participants might work at cross-purposes or could be designed to complement each other, then integrated water resources management will be appropriate (Hooper and others, 1999).

3.7.2 Implementation gap

Once it has been decided that integrated water resources management is appropriate, it is important to ensure that capacity exists to move from concept to action. As indicated in 3.5, many challenges can be encountered when striving to implement integrated water resources management: too broad an interpretation which leads to difficulties in completing analyses and plans in a timely manner, lack of a vision to be achieved through use of integrated water resources management, lack of recognition of the need to change the detail sought as the spatial scale changes, confusion over the role of partners or stakeholders, lack of credibility or legitimacy of a integrated water resources management plan, inadequate institutional arrangements and low monitoring and evaluation capacity. Any one or a combination thereof can hinder integrated water resources management. Most of these aspects are not unique to the approach, but are generic challenges for planning and management. Nevertheless, if these shortcomings are not recognized and addressed, they will most likely contribute to integrated water resources management being ineffective, and thus to its being discredited.

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