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Integrated Water Resources Management on a Basin Level

A TRAINING MANUAL

UNESCO

ÉDITIONS MULTIMONDES

INTRODUCTION

Why should we pay attention, now and again, to water resources management on a basin level? At a time when water is the topic of the day on the international scene, because of a critical situation in several countries, it should be remembered that there are more than 300 large rivers and that their drainage basins cover more than half of the emerged land on our planet (Appendix 1). More than 200 rivers are international which means that they flow across borders; those countries find themselves in a special situation, that of riparian countries, because they belong to a common geographical unit that does not recognise political boundaries, the river basin. The same reality applies within the national territory, whether as a federal system or not, because of multiple political and institutional frontiers.

This entity, the basin, is of interest to us as a system that encompasses both natural resources and the human communities that depend on them. For a long time, man has seen the world as an inexhaustible resource to be used for his own profit. In this specific case, water mastering technologies have been used since Antiquity; man learned to bring water where and when he needed it. But, under the combined pressures of increased demand and the deterioration of water quality, traditional management models have failed; we have to move away from this technological mirage and develop new approaches that will allow for the satisfaction of human needs while maintaining the quality of natural systems that support the very existence of human communities.

We will have to learn to better manage the use of water under new paradigms:

- Dealing with water management in a more integrated way, moving away from the sector-by-sector approach;
- Looking for sustainable use of water, satisfying the needs of both Man and Nature;
- Moving progressively away from the centralised management models in order to adopt increased public participation processes.

These profound changes are widely discussed in the international arena and seem to be gaining some consensus, in theory at least.

This manual is designed to assist those who have to make decisions on a daily basis to apply these new approaches to river basin management. We should bear in mind that there is no single approach that can be applied to all cases. Quite the contrary; solutions will emerge through the sharing of diverse experiences, first at the basin level, but also on a larger scale.

THE INTERNATIONAL SCENE

The World Water Vision

Before delving into the proposed river basin management framework, it is important to clearly define the water issue and its recent evolution in the collective mind of those who move it ahead, as demonstrated by recent international events. In fact, over the last 20 years, the debate on water has shifted from the purely technical level, focused on water resources evaluation and allocation between major uses (resource management), to a more integrated approach that includes a broader range of domains, among which social and political aspects (demand management, including the needs of nature). The recognition of the multiple values of water is certainly the most significant milestone of the 20th century in terms of sustainable development.

Several major events have influenced the evolution of views on water resources management. In 1977, the Mar del Plata Conference initiated the international debate on water and

proposed the International Water Decade (1980-1990). Then, at the Dublin Conference in 1992, the international community adopted several basic principles on the sustainable use of water resources:

- Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment;
- Water development and management should be based on a participatory approach, involving users, planners, and policy makers at all levels;
- Women play a central role in water supply, management and preservation;
- Water has an economic value in all its competing uses and should be recognised as an economic good.

Agenda 21, Chapter 18, adopted at the Rio Earth Summit of 1992, deals in detail with the water issue; three objectives were defined and they include some elements on quality in water management:

- Maintenance of ecosystem integrity by protecting aquatic ecosystems from degradation on a drainage basin level;
- Public health protection, including safe drinking water and disease vector control;
- Human resources development.

Since then, the Dublin and Rio principles have been adopted internationally and constitute the basis for the debate on water resources management. Then, in less that 10 years, several international water organisations were created: the Water Supply and Sanitation Collaborative Council (WSSCC), the Global Water Partnership (GWP), the International Network of Basin Organisations (INBO), the World Water Council (WWC), the International Office for Water (IOW), and the International Secretariat for Water (ISW) to name but a few. During the same period, major international conferences were instrumental in supporting the debate on water issues.

The First World Water Forum organised in Marrakech in 1997 is a landmark in the revival of the international debate on water. Following this forum, the WWC initiated an innovative international task, the development of the World Water Vision; this exercise guided the debate in 1998 and 1999 to culminate at the second World Water Forum in The Hague in March 2000. More than 10000 people from all continents took part in this unprecedented consultation where they shared their recommendations and expectations for a more sustainable use of water. Several discussion papers were produced, dealing with issues at country, region or large theme levels (Water and Food, Water and Nature, etc.). The overall result was presented in *World Water Vision: Making Water Everybody's Business* published in March 2000 by the World Water Vision Unit which was the guest of the United Nations Educational, Scientific, and Cultural Organisation's International Hydrological Programme at its headquarters in Paris.

It is important to present, at the very beginning of this manual, the main results of this international consultation process; the ideas developed during the course of the Vision exercise, along with the vocabulary, will certainly influence the water debate for years to come.

Numerous findings occurred in the course of the Vision exercise, with proposals for major orientations in terms of water resources management on a basin level and their uses; the three following statements should be kept in mind, while reading this manual, since they constitute valuable markers along the pathway we are proposing.

The first statement may come as a surprise given the high level of media coverage which tends to associate water shortages more often with catastrophes and natural events (desertification, El Niño, climate change) than with human errors:

> There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people — and the environment — suffer badly. (World Water Council, 2000, p. xix.)

One portion of the solution to the serious current water crisis lies with a better management of water uses. The first goal of this manual being to contribute to the development of capacities in water resources management on a basin level, we also believe that part of the solution lies in the way human beings use water, and most of all, that we should be able to learn from past experiences.

The second statement has to do with sustainable development of water resources and integrated management, two principles at the very base of the management framework proposed in this manual:

> Our vision is a world in which all people have access to safe and sufficient water resources to meet their needs, including food, in ways that maintain the integrity of freshwater ecosystems. The Vision exercise's ultimate purpose is to generate global awareness of the water crisis women and men face and the possible solutions for addressing it. This awareness will lead to the development of new policies and legislative and institutional frameworks. The world's freshwater resources will be managed in an integrated manner at all levels, from the individual to the international, to serve the interest of humankind and planet earth — effectively, efficiently, and equitably. (World Water Council, 2000, p. 1.)

The third statement which caught our attention deals with the sharing of roles between different levels of interested parties, from the individual to public authorities, including the role of professionals.

> The Vision recognises that people's roles and behaviours must change to achieve sustainable water resource use and development. The main actors will be individuals and groups in households and communities with new responsibilities for using water and water-related services. Public authorities will need to empower and support them and carry out work that households and communities cannot manage for themselves. Water professionals and environmentalists will provide these stakeholders with the information they need to participate in decision-making and will help implement their decisions. Working together, these groups can achieve the Vision. (World Water Council, 2000, p. xiii.)

The Vision, as the title suggests, provides scenarios for the future of water resources in the medium term. It is not the purpose of this manual to enter into the details of these debates; nevertheless, we should be aware of an important warning regarding the overall context in which the management process will have to be developed. What is of particular interest for us are the uncertainty and interacting trends notions; we will have to keep these in mind while developing a framework for integrated water resources management on a basin level.

> Given the wide range of uncertainties affecting the water futures, there is also a wide range in possible uses and stress. This range presents the potential for influencing the outcome through actions focused on key issues that may prove to be turning points. [...] Whether the water crisis will deepen and intensify — or whether key trends can be bent and turned towards sustainable use and development of water resources — depends on many interacting trends in a complex system. (World Water Council, 2000, p. 23.)

Then the Vision proposes a list of issues, called "turning points in water futures". Some are in line with river basin management and will be presented in this manual. Among the issues we will deal with are: reforming water resources management institutions, increasing cooperation in international basins and valuing ecosystem functions.

THE PRIMARY OBJECTIVES OF INTEGRATED WATER RESOURCES MANAGEMENT

The three primary objectives of integrated water resources management are:

- Empower women, men, and communities to decide on their level of access to safe water and hygienic living conditions and on the types of water-using economic activities they desire — and to organise to achieve them.
- Produce more food and create more sustainable livelihoods per unit of water applied (more crops and jobs per drop) and ensure access for all to the food required to sustain healthy and productive lives.
- Manage human water use so as to conserve quantity and quality of freshwater and terrestrial ecosystems that provide services to humans and living things.

Five primary actions are required to achieve these objectives:

- Involve all stakeholders in integrated management.
- Move to full-cost pricing of water services for all human uses.
- Increase public funding for research and innovation in the public interest.
- Recognise the need for cooperation on integrated water resource management in international river basins.
- Massively increase investments in water.

(World Water Council, 2000, p. 2-3.)

The Action Plan

> For the World Water Vision to be achieved, concrete and realistic programmes of action will be needed. A first step towards such programmes of action will be the Framework for Action (FFA), which is being developed in parallel with the World Water Vision. It will be a route map of how to reach the Vision objectives and will identify key milestones along the way. The final outputs will establish which combinations of policy measures, management instruments, investment priorities and implementation strategies will be needed in order to reach those milestones. (GWP, 2001, p. 2.)

Several components of this FFA touch directly upon the main theme of this manual, Integrated Water Resources Management (IWRM); this new abbreviation is everywhere in recent publications dealing with water management and we will deal with it in Definitions and Approaches, along with other principles related to basin management.

A New Water Ethic

The water debate was also conducted at another level, ethical this time, with the publication of the "water manifest" by Petrella (1998), a document that played a role of catalyst in the renewal of the water debate. The economic value of water, recognised since Dublin 1992, was considered as a way to charge the costs of services and, too often, under the sole scenario of the privatisation of water services. The manifest considers access to water as a fundamental right. Water has a value but cannot be treated as a simple economic good because water is essential for life. Interestingly, the first consideration in the European Union Directive on Water, enacted in October 2000, holds to this principle: "Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such" (European Union, 2000). The social contract proposed by Petrella (1998) is based on two principles: access to water for all, and sustainable management and solidarity. The debate between the tenants of water as a collective good, with an access for the poorest, and those who sustain cost recovery through a tariff and fee approach, has certainly contributed to making the general public aware of the water issue; this debate was previously limited to specialists and was centred only on privatisation modalities for urban water services.

We should also mention the Social Charter for Water, an initiative of the Water Academy that was largely debated in The Hague in March 2000. This charter makes three recommendations that can be considered a summary of the general consensus developed in the course of recent international conferences:

WATER MANAGEMENT PRINCIPLES

- Manage water for all human beings and their descendants, while preserving the environment through a sustainable development policy (Rio, 1992).
- Closely associate users to the development choices (Dublin, 1992).
- Consider water as an economic and social good and allow for an access for all (Paris, 1998).

(Académie de l'Eau, 2000, p. 2.)

THE LARGE RIVER MANAGEMENT PROJECT

Context and Issues

In 1989, when Canada launched the Large River Management Project at the Dakar Summit, the situation of many large rivers was already serious; the combined pressures from desertification, increased salinity of irrigated lands, pollution and overexploitation of water resources were causing some serious impacts on water allocations in several large river systems. The situation was rendered even more complex by the fact that management instruments developed in the North had to be adapted to the specific needs of the South, but in a context of very limited resources.

The principal objective of the project, capacity development on river basin management, is still valid today; how can we develop the capacities of managers who, within national or regional institutions, are involved in decision-making on a daily basis in a complex environment and with limited means. Conflict resolution between users requires the gathering of a wide range of expertise and, of course, resources that are not available to national or regional institutions responsible for these tasks, mainly in the South.

As the French-speaking countries were at the origin of the project, activities were conducted first in West Africa before spreading to South-East Asia and East Africa. While favouring the use of the French language, this has never limited the participation of managers coming from countries where French was not spoken within a given river basin. In fact, most training activities were delivered simultaneously in French and English.

Clientele and Objectives

From the very beginning of the project, managers working within regional and national river basin organisations have been our main clientele. The project objectives are as follows:

- Identify capacity development needs;
- Develop, in collaboration with managers, management instruments well adapted to their needs;
- Facilitate the circulation of information and sharing of experiences;
- Conduct training and experience-sharing activities.

Results

The Large River Management Project is funded by Canada through the Agence Intergouvernementale de la Francophonie (an intergovernmental organisation grouping more than 40 French-speaking countries) and operated by the St. Lawrence Centre; this research institute is part of Environment Canada (Burton, 2001).

The project was initiated in West Africa on the Niger and Senegal Rivers. The first needs analysis was conducted through a workshop organised in Bamako (Mali) in 1990. Then a training manual was developed in cooperation with 12 Sahelian managers at a workshop organised in Segou (Mali) in 1991; the manual was published in both French and English (Burton and Boisvert, 1991). At the same time, some support was provided to the three documentation centres from the Organisation pour la mise en valeur du fleuve Senegal (OMVS), in collaboration with the Banque internationale d'information sur les États francophones (BIEF).

During the same period, the Réseau francophone de gestionnaires d'écosystèmes fluviaux et lacustres (Network of French-speaking Managers of River and Lake Ecosystems) was created, as the territory covered by the project had expanded within Africa (East and West) and Asia. The network was officially created in 1991 as part of the Orleans Forum (France); the author has been network coordinator from the outset.

In 1992-1993, 5 two-week seminars were organised:

- In Rwanda, with the Organisation for the management and the development of the Kagera River Basin (KBO);
- In Viet Nam with the Mekong Secretariat;
- In Chad, with the Lake Chad Basin Commission (LCBC);
- The Comité interafricain d'études hydrauliques (CIEH) organised the seminar on the Niger River in Burkina Faso;
- The Senegal River seminar was held in Senegal with the assistance of the Organisation pour la mise en valeur du fleuve Senegal (OMVS).

Each seminar was organised in collaboration with an international river basin organisation for a group of approximately 20 participants using the 1991 manual as a guide for an applied river basin management exercise. Participants formed a group representing most sectors and all countries within the basin. During the seminars, a diagnosis of the basin was produced using information provided by the participants themselves, the basic elements of an action plan were defined and the resources required for its implementation were identified. At the same time, a 15-member international orientation board was created for the network; members represented river basin organisations and funding agencies from both North and South. A quarterly bulletin was published (*RésEAUX*).

In 1994-1995, a workshop on integrated river basin management was organised in France in collaboration with the Seine-Normandie Water Agency. More than 50 participants from Europe, Africa, Asia and Canada took part in the exercise; several case studies were presented to illustrate the most interesting approaches to river basin management (Agence de Coopération Culturelle et Technique, 1995). A synthesis of the five 1992-1993 seminars was also presented (Burton, 1995). The quarterly bulletin was published along with the first directory of network members, some 400 managers from 45 countries. Alongside the project's regular activities, CIDA funded a seminar in 1995 on the River Nile as part of a bilateral programme. The same framework was applied with some 20 participants from several ministries from the national administration (Burton, 1995).

In 1996, the project funded the participation of six managers from the South in a workshop organised in Tulcea (Romania) by the IOW to discuss the importance of action plans. Also in 1996, CIDA provided funding for a major capacity development needs analysis in West Africa, conducted by the network coordinator. More than 200 managers from 6 countries, attached to the Senegal, Niger and Gambia River basins, were interviewed (Burton, 1996). In 1997, the project funded the participation of 7 managers to the World Water Congress held in Montreal. The quarterly bulletin was published and the members' directory re-edited.

In 1998-1999, the project activities were limited to the publication of the bulletin and the development of an Internet site (www.reseaux.org). Nevertheless, new requests for international experience sharing came from Latin America; two workshops, on the Rio Colorado (Argentina) and on Lake Chapala (Mexico) provided excellent opportunities to build on the experience gathered through the network. The same situation prevailed in 2000, with the publication of the bulletin in hard and electronic copies.

The results of more than 10 years of the Large River Management Project, both on river basin management approaches and capacity development, were summarised at several international conferences during the past two years (Burton, 1999; Burton, 1999a; Burton, 2000; Burton, 2001a).

Major Players

The Large River Management Project and the Network of French-speaking Managers of River and Lake Ecosystems (*RésEAUX*) have evolved in parallel since 1991 under the ACCT. Both the project and the network are managed by the same institution: the St. Lawrence Centre. Funds were provided originally by Canada with other partners joining. France made a contribution in 1995. We would like to recognise the significant contribution made by the members of our international orientation board during the development phase of the network. Finally, participation by the network coordinator in international missions in several countries was funded by CIDA and Environment Canada.

Part One of the manual will introduce the basic concepts related to integrated water resources management on a basin level. It will be presented in general terms, as the subject is much too vast to be addressed in detail. We will first present definitions and approaches, and then we will describe the basis for river basin management: knowledge, partnership and public participation. Then, the conditions that have to be present for the success of integrated river basin management will be analysed. Finally, a conclusion will provide a synthesis of Part One of the manual.

DEFINITIONS AND APPROACHES

We present, as an introduction, a few basic notions that are essential to understanding the issues related to water resources. Then we will briefly review a few river basin management models already in use, as a reminder only, since the reference list on the subject is very broad; the institutional model characterised by the Water Agency applied in France and several other countries around the world; the "integrated water resource management" approach proposed by the GWP; a practical definition on an ecosystem approach; a brief look at the existing links between water management and land use, before concluding with the framework for integrated water resources management on a basin level we propose in this manual.

BASIC NOTIONS

At the outset, it is important to remind the reader of some basic notions, mainly for those who are not familiar with the hydrological field. Even for the initiated, it is useful to be more precise with regard to the significance of some of the terminology used in this manual. A glossary is presented in Appendix 2 with some of the most common terms used in this vast domain of water management and uses.

The Water Cycle

The following information, and figures 1, 2 and 3 are from the Web site of the French Ministry of the Environment (France, 2001); it is the summary of a document produced in collaboration with the Quebec Ministry of the Environment (Canada).

FIGURE 1

The Water Cycle

"Water travels on the surface, underground and in the atmosphere in a well-known cycle.

1. Clouds provide precipitation in the form of rain, snow or hail.
2. Water runs on the surface. Part is captured by vegetation. The rest flows to rivers or infiltrates the soil to form underground water bodies.
3. Surface water from rivers, lakes and oceans evaporates under the effect the Sun and finds itself in a gaseous form in the atmosphere.
4. Water vapour condenses in contact with cold air masses, which creates clouds."

The Invisible Phenomena: 1, 2, 3, 4, 5, and 6

1 Evaporation: all water surface
2-3 Absorption: by vegetation roots and evapo-transpiration through the leaves
4-6 Water vapour (gas) and transport by winds
5 Energy for the whole cycle: the Sun

The Visible Phenomena: A, B, C, D, E and F

A Condensation (clouds, haze)
B Precipitation (rain, hail, snow)
C-D-E Snow melt, run-off, infiltration
F Superficial and underground flow

http://www.environnement.gouv.fr/dossier/eau/bassin/bassin2.htm (our translation).

This cycle has neither beginning nor end, water quantity remaining more or less the same since its apparition on planet Earth. Nevertheless, in the course of the history of our planet, major climate changes have created deserts or covered entire continents with ice. Water and climate are closely linked; it takes only a short-term regional variation in the hydrological cycle of a few days, months or years to cause floods or drought. This is why climate changes associated with greenhouse gases can have a direct effect on the annual flow of rivers and its seasonal or annual variability.

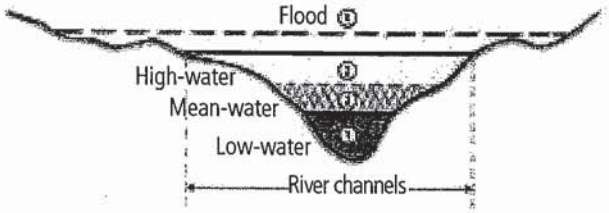
> It is generally accepted that the natural world is in a relatively comfortable stage of dynamic equilibrium, maintained by constant flux, change, adjustment, rebalancing, growth and decay, and recycling. In the natural environment, most water (65 per cent) cycles back to the atmosphere through the transpiration of trees, and another 25 per cent infiltrates the soil, recharging the ground water below. (Ontario, 1993, p. 1.)

> Each river is characterised by its flow regime. The flow is calculated in cubic meter per second (m^3/sec). This is the representation of the volume of water moved over a period of time. It varies with seasons. [...] This annual variation cycle reminds us of a natural respiration. The river normally flows within its low-water channel, but can sometimes overflow in the mean-water channel and more rarely in the high-water channel. The limits of the high-water channel correspond to the "high-water line" which is reached by the river under exceptional floods. (France, 2001; our translation.)

These are the concepts and the terminology at the base of a river-basin management framework. Nevertheless, in spite of the noticeable simplicity of the processes described above, much remains to be understood: how, in fact, to correctly evaluate the "renewable" portion of water resources, the one that can be used in a sustainable manner, taking into account the complex relations between surface and ground waters? We use three terms to differentiate water resources:

- *Blue water:* renewable water resources, the portion of rainfall that enters streams and recharges groundwater;
- *Green water:* the portion of rainfall that is stored in the soil and evaporates from it;
- *Fossil water:* groundwater that has accumulated over a long period of time, often in previous geological periods, and is not or barely recharged. It is not a renewable resource.

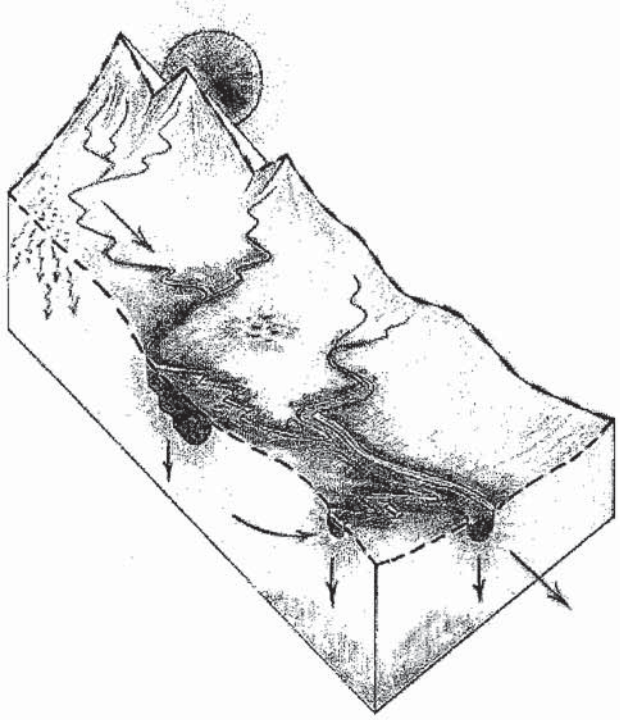
FIGURE 2
The River Residence



The River Residence
1. Low-water and normal situation
2. Flood; snow-melt and heavy precipitation
3. High-water level: exceptional situation
4. Flood

The high-level line defines the risks for urbanisation.
http://www.Environnement.gouv.fr/dossier/eau/bassin/bassin2.htm

FIGURE 3
The River Basin



"Like a country, a river basin has frontiers; these are natural boundaries. They follow mountain crests and we call these boundaries 'water parting line' or 'divide'. Rainfall that falls on one mountain slope will reach the river below; the rainfall on the other slope will flow to the neighbouring river. The river basin has the shape of a valley. Rain may also infiltrate the soil and form underground reservoirs. In this event, there is underground circulation of water." (France, 2001; our translation.) [http://www.Environnement.gouv.fr/dossier/eau/bassin/bassin1.htm]

It should also be noted that watersheds come in different sizes and include both river and lake basins; some of the larger lakes are fed by several rivers and constitute important natural systems for management, as is the case with the Aral Sea and Lake Chad. Another reminder: the natural limits of the basin do not follow political or administrative boundaries; a basin will be "national" if it is within one country or "international" if it covers several countries.

Water Quality

"The very notion of water quality is linked to the intended use of the water: swimming, drinking and cooking, irrigation, industrial process water, etc. Whatever we use it for, its quality must be preserved. As the natural content varies considerably, we must define average conditions for natural and safe waters. Above a predefined threshold, water will be declared polluted. [...] Water pollution results from the addition, in an ecosystem, of a substance that modifies the equilibrium. Water pollution is a harmful modification of water caused by the addition of substances likely to modify its quality, aesthetic aspect and use for human purposes. The polluting agent may be physical, chemical or biological in nature and cause discomfort, nuisance or contamination." (IOW, 2001; our translation.)

It is essential not to restrict the debate on water resource management to quantitative dimensions only. There is still an important aspect missing in the definition provided above: the very needs of the ecosystem itself. Any sustainable management approach will have to ensure that water can, by its quality, both satisfy the needs of human beings and maintain the natural functions of the ecosystem which shelters them.

The Ecosystem

This brings us naturally to a key notion to be included in any framework aiming at the sustainable management of water resources, the ecosystem. It is an organised system, including physical, chemical and biological components; man and his activities are part of this system.

BASIC CONCEPTS FOR AN ECOSYSTEM DEFINITION

- Sustained life is a property of ecosystems, not species. Individual species cannot survive indefinitely. The smallest unit of the biosphere that can support life over the long term is an ecosystem.
- Ecosystems are open systems of matter and energy (composition) in various combinations (structures) that change over time (function). Ecosystems undergo continuous change in response to pressures from component populations (human or otherwise) and the physical environment.
- Everything in an ecosystem is related to everything else. These interrelationships underline another important characteristic of an ecosystem — it is more that the sum of its parts.

- People are an important part of ecosystems. As noted above, sustained life is a property of systems, not individual species. This implies the necessity of maintaining the health and integrity of natural systems to ensure our own survival.
- Ecosystems possess various spatial and temporal scales. The choice of scale depends on the problem to be addressed or the human activities to be managed.
- Any ecosystem is open to "outside" influences (Allen *et al.*, 1991). Consideration of outside influences complicates efforts to predict or model cause and effect relationships and highlights the need for flexibility and adaptability.

(Canada, 1996; p. 1-2.)

We will use the term "river ecosystem" throughout this manual to keep reminding the reader that the only possible approach to sustainable management of water resources is one that considers both man and nature as part of the same natural system. We may consider, for management purposes, that the limits of the river ecosystem correspond to the basin; however, several ecosystems of different sizes are nested within this vast ensemble; as they influence local conditions, they will have to be accounted for in our management approach. Finally, the term "river ecosystem" is often used as a synonym for "environment", which should be avoided entirely; in fact, the term ecosystem encompasses environmental but also social and economic dimensions.

BASIN-WIDE MANAGEMENT

An in-depth reflection was conducted on the general theme of basin-wide management at the Second World Water Forum. A technical workshop was organised at The Hague in 1999 in preparation for the Forum; the workshop proceedings are of particular interest, first by the diversity of the case studies presented, but also as a remarkable summary of the current debate on river basin management (Mostert, 1999). The results of these discussions were presented as recommendations at the Forum in March 2000 (The Netherlands, 2000). These are two very important documents that present both theory and practical applications. A worldwide overview of basin-wide management was completed in 1999 and 2000.

The use of the river basin as the most appropriate management unit is not new but it is now an internationally accepted principle. The Ministerial Declaration of The Hague on Water security in the 21st Century, part of the Final Report of the Second World Water Forum, presents basin management as a challenge associated with security:

> Sharing water resources: to promote peaceful cooperation and develop synergies between different uses of water at all levels, whenever possible, within and, in the case of boundary and trans-boundary water resources, between states concerned, through sustainable river basin management or other appropriate approaches. (World Water Council, 2000a, p. 26.)

It is interesting to note the flexibility given to managers regarding the approach to be used; river basin management is not presented as an absolute but as an interesting approach to promote cooperation. This political dimension, closely associated with peace, is another dimension put forward by several international forums during the past two years.

River basin management, under its formal institutional definition, has been applied in several countries. The Water Academy conducted a comparative analysis of river basin management in 2000 looking at nine case studies from Europe, Latin America and Indonesia. These cases applied the model developed by the French Water Agencies. The conclusions are quite interesting as they summarise the results from one of the best-known river basin management models.

THE WATER AGENCY MODEL

"**Major tendencies.** The basic principle of managing water resources and the environment on the basin level is unanimously recognised. In most cases, this principle is formally applied; the limits of the management territory are those of the basin. When the change in the use of the basin limits required institutional modifications that were too important, which could retard the reform of the water management system, the preservation of existing management institutions was the preferred option. The second important principle, which consists in the introduction of an economic dimension to water management (polluter-user-payer principle), is also generally considered as the necessary base to ensure the viability of the system. But, in the case studies, the implementation is quite timid because, in most countries involved, it is necessary to modify the water act or some aspects of the fiscal acts first. [...]

"**The difficulties.** The most important difficulty, already encountered or foreseen, is naturally of a financial nature. After the dialogue and decentralisation stages, how to proceed with the development and maintenance of the new river basin organisation and to implement activities for the restoration and the protection of water resources and the environment? Theoretical simulations have shown that, in most cases, the users and polluters could sustain the fee system. But cumulated delays in environmental protection require massive investments and force regions to resort to state budgets, whenever possible, or to external funding sources. So, in the process of creating new river basin institutions, simply proclaiming the polluter-user-payer principle may well be insufficient; it is never too early to analyse the financial aspects of the decentralisation of decision-making powers.

"**The necessary reorientation.** Improvement of drinking water supply and sanitation is, in general, the first priority for the population of the basins under study. But the price of water and the sanitation tax is not sufficient for a healthy management and the development of the services, while protecting the environment at the same time. Inevitably, river-basin authorities and municipalities will be faced one day with the need to "professionalise" the service and fix tariffs. This is the sector where European systems may bring about a significant contribution."

(Académie de l'eau, 2000a; our translation)

INTEGRATED WATER RESOURCES MANAGEMENT

A new concept was introduced in 2000: "integrated water resource management" (IWRM). This concept is widely used both in the Vision and the Action Plan. In the Action Plan, specific conclusions were identified, translated in terms of needs to be met in order to meet the objectives of the Vision; "Defined targets: Comprehensive policies and strategies for IWRM to be implemented in 75% of the countries by 2005 and in all countries by 2015." (World Water Council, 2000a, p. 57.)

To reach these objectives, there is a need for:

- National integrated water resource management (IWRM) policies, taking into consideration river basin management.
- Transparent and flexible national laws as a prerequisite for IWRM policy development.
- The participation of all stakeholders at all levels of IRWM, with special attention to gender and youth.
- The improvement of consultation structures and processes at all levels, especially at the local level.
- Better co-ordination and institutional strengthening to overcome fragmented responsibilities in the field of IWRM.
- The provision of additional financing, especially at the community level.
- Increased awareness and communication.
- More involvement of women in water management as important stakeholders, especially in developing countries.
- The formation of an inter-ministerial committee on gender. The reallocation of budgets in water projects and representation of women was discussed.
- Looking at models of IRWM, it is necessary to recognise the existing diversity present between different countries. In order to create conditions in which such models can work, appropriate incentives and the right balance between public and private sectors are needed. (World Water Council, 2000a, p. 56.)

The technical Advisory Committee (TAC) of GWP found it necessary to clarify certain principles associated with IWRM. A special document analyses the whole question (GWP, 2000a). IWRM is also addressed in the "ToolBox" developed by the GWP (GWP, 2000b): "The aim of the ToolBox is to bring together the global experience in an accessible and helpful compendium of optional approaches, to support the practical and effective development of IWRM."

But what is different with this IWRM concept compared to the traditional river basin approach and why was it introduced? The traditional river basin models tend to focus on water supply and pollution permits both associated with fees, according to the polluter-user-payer principle; this approach has some merits but also limitations as seen above.

> A second line of argument against the term "river basin management" is that often areas other than the river basin are important and, therefore, that integrated water resources management (IWRM) is a better term. In fact, as used in this paper, RBM is almost synonymous with IWRM. However, the term RBM emphasises the relation between water and land resources and the geographical and often international dimension (upstream-downstream). Moreover, the term RBM does not imply that all management should take place at the basin level or that river basins are closed systems or the only relevant geographical areas. It does imply, however, that river basins are important units that should be managed carefully, for the benefit of present and future generations. (Mostert *et al.*, 1999, p. 25.)

In order to better understand, but also to apply the IWRM concept, one should read some remarks formulated at the 1999 River Basin Workshop held in The Hague (Allan *et al.*, 1999). The authors insist on the fundamentally political dimension of water resources management; even though some of their comments may come as a surprise to some, this hidden face of water management is not often discussed as clearly. According to Allan *et al.* (1999), there are two requirements for the sustainable management of water resources:

> The first requirement of sustainable integrated water resources management is that the interest of the using sectors and communities are taken into account. Institutions that enable communication, contention and compromise are essential. Inputting hydrological and other scientific information is important but it is a relatively minor element in the process. Water managing outcomes are sometimes achieved without information and frequently through the political suppression of technical information. Political contention in not a medium in which technical information — hydrological, environmental and economic — will be given their proper due but this is the only medium there is. [...] A second requirement of effective IWRM is that the role of water be considered in wider hydrological, ecological, economic, trading and socio-political contexts than the river basin and its hydrology. Water resource planning inspired only by the hydrological cycle, and the capacity of engineers to modify it, is a lethally narrow inspiration and a very unsafe foundation for water resource planning and policy making. (Allan *et al.*, p. 127.)

According to these authors, the concept of IWRM is solid but poses a real challenge for its implementation. The term "integration" will have to be clearly defined, mainly because results will be quite different according to the different scales to which it is applied. Moreover, "If the debate on integration is confined to the scientific and the engineering communities, the chances for integrated water management taking place will be small. Water is allocated in a political world where political logic prevails [...]." (Allan *et al.*, p. 136.)

The IWRM concept introduced in 2000 focuses on the necessity to deal with water management from several angles at the same time, including the technical (surface and underground water) and the political, economic and social dimensions. This is a very global concept, maybe too global: the intention is quite valid as it forces the debate out of purely technical circles, but concrete implementation of IWRM, over and above the recognition of the value of the concept, may prove very difficult.

THE ECOSYSTEM APPROACH

Another approach, not directly linked to river basins, has been part of the debate on water for a few years now; even though the ecosystem approach is not limited in its application to aquatic ecosystems, it is considered as one of the holistic approaches and is frequently used in the context of sustainable development of natural resources. We will apply the ecosystem approach to river-basin management in this manual; it will even be our main integration platform.

In the Vision, a principle for water resources management, taking into account the integrity of ecosystem, is very present:

> All agreed at the outset that ecosystems must be conserved and restored in order to ensure sustainable water resources for humanity. However, water is not just a physical substance essential to human life, but is also the environment that supports all other living things. [...] We must change thinking to recognise that ecosystems are the source of water. It is not a question of how much water to put back to conserve nature and biodiversity but how much not to take out in the first place. (World Water Council, 2000a, p. 52.)

The recognition of this principle represents not only a net progress towards the sustainable use of water resources, but it is the only possible pathway; however, it requires profound changes in the traditional technological approaches by which water was viewed exclusively at the service of humans.

In 1996, Environment Canada conducted an in-depth study on the ecosystem approach. This approach is largely applied in all major action plans dealing with Canadian large river and lake ecosystems.

Key Concepts of and Advantages to the Ecosystem Approach

The following are the key concepts of an ecosystem approach:

- Given that all components of an ecosystem (physical, chemical, and biological) are interdependent, 'resources must be managed as dynamic and integrative systems rather than as independent and distinct elements. Its practice means that all stakeholders understand the implications of their actions on the sustainability of ecosystems' (Wrona, 1994).
- The dynamic and complex nature of ecosystems requires that the ecosystem approach must be flexible and adaptive.
- The complex nature of the problems and issues within an ecosystem can be addressed only by the integration of scientific, social, and economic concerns; environmental research, planning, reporting, and management must become even more interdisciplinary.

Numerous advantages to the ecosystem approach have been identified in the literature [...]:

- the focus is on the interrelationships among ecosystem components, which encourages integrated management of those components.
- the focus is on long-term and/or large-scale issues, which permits a more 'anticipate and prevent' strategy to management, rather than the more common 'react and cure' mode.
- the role of culture, values, and socioeconomic systems in environmental and resource management issues is recognized;
- and a mechanism is offered for integrating science and management.

(Canada, 1996, p. 2-3.)

One will find in the European Union Directive on Water a direct reference to the ecosystem approach: "(16)Further integration of protection and sustainable management of water into other Community policy areas such as energy, transport, agriculture, fisheries, regional policy and tourism is necessary." (European Union, 2000, p. 2.) This is a clear illustration of the fact that the principles of the ecosystem approach are now part of the international agenda.

We can conclude once more that the sustainable management of water resources will have to take into account the complexity of the systems themselves; simplistic approaches will not be sufficient.

LAND USE PLANNING

IWRM, as described in the Integrated Water Resources Management section, calls for coordinated management of natural resources within a given territory. In parallel with water management, a whole set of processes and approaches has been developed that we will group under the name of "land use planning". Is it possible to reconcile the two models, one terrestrial and one aquatic, superimposed within the same territory, the river basin?

The Province of Ontario attempted an experience in Canada; a series of practical guides was published in 1993 dealing with sub-basin management in the context of municipal land use planning. The excerpt quoted here presents a six-step framework designed for municipal planners:

> Municipalities have the legislative authority and political responsibility to undertake comprehensive land use planning which considers environmental issues. [...] When ecosystem considerations are integrated into the planning process, it is more likely that land use decisions will not jeopardise ecosystem and human health. An ecosystem approach can result in economic savings by avoiding the need for costly remedial actions. An ecosystem approach to land use planning requires that boundaries for land use planning be based on biophysical boundaries as the context for examining the relationships between the natural environment and human activities. The primary boundary for an ecosystem approach to land use planning should be the **watershed**. This is based on using the hydrological cycle as the pathway that integrates physical, chemical and biological processes of the ecosystem. (Ontario, 1993, p. iv.)

The interest of this example among several others is that it reinforces the principles put forward by GWP and presented in the Integrated Water Resources Management section; the implementation of approaches based on integrated water resources management is only possible if concrete experiences are largely shared and adapted to the peculiarities of individual contexts. One might always think that both land use planning and IWRM could be reconciled at the basin level; but this also means an increased level of complexity because of the larger number of interested parties (institutional, political, social and financial) that will have to be dealt with.

INTEGRATED BASIN-WIDE MANAGEMENT

Before we move directly to the framework described in this manual, we would like to propose a definition of "integrated river basin management" used in the 1991 manual.

> INTEGRATED RIVER BASIN MANAGEMENT
>
> Integrated basin-wide management means that informed decision-makers take into account all uses and resources of the watershed, following an ecosystem approach. The overall goal is to ensure that human communities will benefit forever from the watershed through the development of harmonious relationships between users themselves and between man and river. Locally, integrated management requires the participation of all users, at appropriate levels; at the national and, even more so, at the international level, integrated basin-wide management has to take into account political and legal considerations. (Burton and Boisvert, 1991.)

As mentioned earlier, the notion of integrated river basin management has been widely discussed, first at the Dublin Conference in 1992 and then at several international conferences, most notably, within the Vision exercise:

> To ensure the sustainability of water, we must view it holistically, balancing competing demands on it — domestic, agricultural, industrial (including energy), and environmental. Sustainable management of water resources requires systemic, integrated decision-making that recognises the interdependence of three areas. First, decisions on land use also affect water, and decisions on water also affect the environment and land use. Second, decisions on our economic and social future, currently sectoral and fragmented, affect hydrology and the ecosystems in which we live. Third, decisions at the international, national, and local levels are interrelated. (World Water Council, 2000, p. 1.)

We believe that the definition proposed in 1991 is still valid in 2000 and its basic principles are:

- *The river ecosystem notion*: this is a system built on multiple interrelationships that evolves over time following its own rules. All actions within this system will cause reactions of a more or less complex nature. Water is limited both in terms of quantity and quality; the allocation to multiple uses, including nature's needs, is the real management challenge.
- *Man is part of and depends on the system.* We have to find ways to ensure sustainable development while avoiding conflicts between humans but also between man and nature. We must bear in mind that man does not manage the river basin but, at best, manages his activities with respect for existing resources and constraints of the basin.
- Finally, *users participation* must be ensured in order to achieve a sustainable use of natural resources, notably water. For international basins, the political and legal dimensions are particularly important.

But what about the integration of surface and ground waters? Links do exist between these two worlds, particularly through the aquifers; but, on a daily basis decisions are rarely made by the same institutions, and, moreover, information is generally not sufficient to establish clear links between these two realities. In the course of the seminars (Part Two of the manual), we will limit ourselves to surface waters using a basin-wide approach. Nevertheless, ground water will have to be taken into account in terms of the satisfaction of population needs, mainly for water supply and agriculture; moreover, ground water is important for the integrity of wetlands distributed throughout the basin.

Finally, here are a few attitude changes required for the application of an integrated river basin management approach:

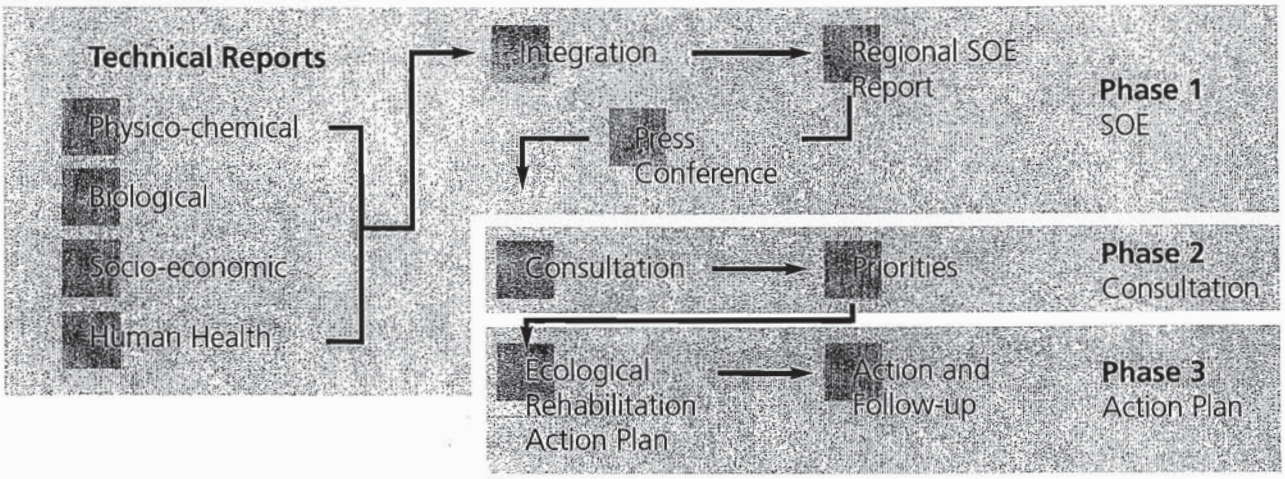
- Integrated management implies taking into account all users and resources of the basin.
- We cannot manage resources on a sectoral project basis any longer, one at a time, every funding agency acting independently from another within the same basin.
- A more global framework is needed if we are to avoid the negative impacts of a project on other resources and in order to take into account upstream-downstream aspects.
- This is even more important for international basins where development choices may differ from one country to another.
- This kind of "master plan" approach does not require that everything be defined in detail; rather, it should focus on global considerations and development choices accessible to political decision-makers.

The Origin of the Framework

The river basin management framework proposed in this manual was originally developed for the St. Lawrence River, as the basis for the collection and integration of information for a programme called "Zone of prime concerns" (ZIP: the French acronym). The ZIP programme is above all an awareness programme aimed at the development of public consultation and participation processes as a support for actions on a local scale. This programme is part of a much larger programme — the St. Lawrence Action Plan — in place since 1988. The challenge was to design a framework for the gathering of existing information distributed among several governmental institutions and to integrate this information in a coherent synthesis useful to local communities; a framework was designed for this very purpose and applied in the field (Burton, 1991).

The first task consists in the definition of the limits of the territory for each ZIP. Three types of limits are used: the hydrological limits (hydro-zones), the biological limits (bio-geographical regions), and the administrative limits. The final definition of the ZIP takes into account the limits of the riparian municipalities in order to be able to include socio-economic information from municipal sources. Within each ZIP, technical reports are produced for the specific area so as to present a diagnosis of the current situation. Four technical reports are prepared dealing with the following aspects: physical and chemical, biological, social and economic, and human health. These sectoral documents are finally integrated to produce an integration paper presenting a synthesis of the state of the ZIP. This is the document submitted for public consultation at a public hearing; the community is invited to comment the state of the environment report, to identify its own priorities and to define the roles of each group of stakeholders for future action. A local action plan is developed by the community to be implemented according the available resources. (Burton, 1997; Figure 4.)

FIGURE 4
The ZIP Programme



This process is applied on successive river stretches, from upstream to downstream; the river continuum is taken into account by the inclusion of the mass balance of inputs (water quality) at the entrance of each stretch of river.

The Proposed Management Framework

From the model applied to the St. Lawrence River, we developed a broader, more comprehensive framework that was subsequently adapted to the African river ecosystems (Figure 5; Burton, 1995b). The management framework will be described in detail in Part Two of the manual.

Available information is the cornerstone of the process. The challenge is to establish a diagnosis of the current situation and define issues without waiting for everything to be known. This framework is based on sound scientific judgment and common sense.

The process is in three phases: documentation, planning, and action (Figure 5). We will not attempt to analyse the framework in detail for the moment; what must be remembered is that it consists of three phases illustrated graphically by a different geometric figure. The complete framework consists of nine successive steps with a loop at the end allowing for some feedback once all steps have been completed.

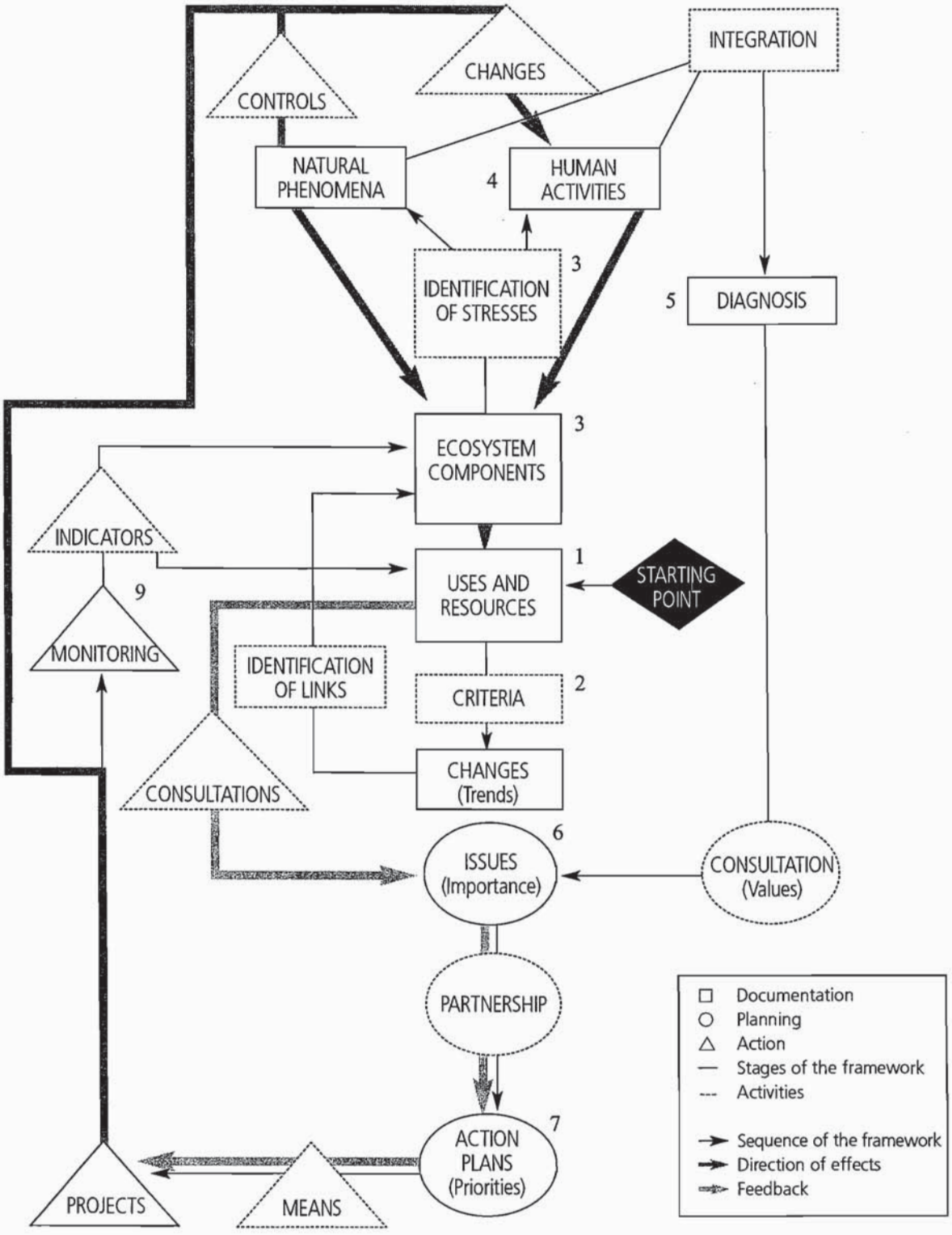
The first phase, Documentation, seeks to gather and evaluate the relevance of information that can be used to identify the problems specific to the uses and biological resources of the territory under study. It takes place in several stages, from the description of the current state of uses and resources to the establishment of a diagnosis (Stages 1 to 5).

The second phase, Planning, seeks, through public consultation and dialogue among partners, to define the action to be taken to solve problems deemed to be high priority. It is in two stages: identification of issues and definition of an action plan. The process now moves away from the closed circles of government and research and opens up broadly to society itself (Stages 6 and 7).

The third phase, Action, puts in place the necessary means and ensures that the projects yield the anticipated results, with planning and projects being revised, if this is not the case. Action consists of two overlapping stages: the projects themselves (whose scope can vary in time and space), and monitoring, which measures the effects of the action (Stages 8 and 9).

FIGURE 5

The Integrated River Basin Management Framework



We now present two basic concepts that underlie the entire framework.

Starting point

Uses and biological resources are the starting point for the overall management framework for four reasons:

- They are the real reasons for action, an attempt to maintain or recover uses while conserving resources;
- These notions involve a very broad range of players who have to share common resources;
- Numerous administrative structures are defined on the basis of the management of uses or resources;
- These notions are concrete, easy to document and of direct interest to managers and users.

The more traditional starting point would have been the water resource inventory, before planning, and once all allocations have been made in the most important sectors (agriculture, domestic uses and industry, etc.). We have decided to initiate the thinking by paying attention to the diversity of water uses, in order to project a more realistic image of the complex relationship between man and water within the basin. The sensitive issue of defining priorities is not resolved as such, but it will be more easily addressed with a better understanding of the diversity of those implications. We should point out that an exhaustive inventory of all water uses could be quite fastidious if one tries to describe everything in detail. But completed at the right level of detail, the inventory of uses will allow for the identification of non-predicted consequences of allocation decisions for specific user groups; indeed, whatever the abundance of water, conflicts can emerge in a particular region or at a given time of the year.

Ecosystem

This level of synthesis is essential: it is not enough to limit oneself to uses and biological resources, for the following three reasons, at the very least:

- Changes cannot be explained without sound knowledge of ecological phenomena;
- By undergoing this level of synthesis, several phenomena may be explained at once;
- By putting in place some measurement tools, ecosystem changes can be identified before the effects are felt in terms of uses or biological resources.

We refer here to the definition of the ecosystem provided earlier (see section on Ecosystem Approach), that of an organised system made of physical, biological and chemical components. The system is very complex and it will not be possible to analyse it in details, but we know some of the basic components. This first level of integration allows us to pool a wide variety of water uses within a functional system that has evolved over time.

Finally, depending on the complexity of the project and the scale of the management task, the framework can be shortened. Here are two remarks on this subject:

Minimum path

In each of the three phases of the framework, certain controls are essential if the process is to remain valid:

- In the Documentation phase, the list of problems must provide, for each use or resource affected, an explanation of the causes of these changes;
- In the Planning phase, the action plan must provide possible solutions for each problem identified;
- In the Action phase, the monitoring of effects must make it possible to assess whether the objectives are attained.

Avoid an impasse

During the process, certain circumstances may represent an impasse for the overall framework. In some cases there is no choice; we will have to use data from elsewhere and adapt it (margin of error). The missing information will have to be collected as quickly as possible, without postponing the planning exercise excessively. Data on quality is often harder to obtain than that concerning the quantity of a use or resource. Data acquisition programmes should be put in place from the start of the exercise, once the deficiencies are identified.

- In the Documentation phase, there is an impasse if the information is lacking (criteria, valid quantitative data). In this case, we are left with "opinions" rather than verifiable facts.
- In the Planning phase, the impasse may stem from the absence of consensus with respect to the issues (consultation) or priorities (partnership). Negotiating agreements brings solutions in the longer term rather than imposing choices; urgency is often the only rallying point.
- In the Action phase, the lack of means is an impasse requiring immediate attention. At the same time, the lack of concrete results, despite the means provided, represents an impasse that must be rectified as soon as possible through revised planning and a reallocation of these means.

We should keep the discussion on the two previous points (minimum path and impasse) for the end of the planning exercise (or the end of the seminar). This comes as a global observation flowing from the intrinsic limits of the basin management framework, either because of the scale and complexity of the project or the limited means available.