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Water resources and river basin management in Latin America

Axel Dourojeunni R. Director; Natural Resources and Infrastructure Division, Economic Commission for Latin America and the Caribbean (ECLAC). Address: CEPAL, Casilla 179-D, Santiago, Chile. Phone: (56-2) 210-22-4H. Fax: (562) 208-0252 and (56-2) 208-19-46. E-mail: adourojeunni@elac.cl Web page: http://www.elac.cl/drni/ and http://www.elac.org/drni/

Abstract

The sustainability of development remains an academic concept unless it is linked to clear objectives that must be attained in given territories and to the management processes needed to achieve this. Management of the natural resources located within the area of a river basin is a valuable option for guiding and coordinating processes of management for development in the light of environmental variables. In order to turn environmental policies into concrete actions it is necessary to have suitable management bodies, which are normally very complex. The establishment of such bodies means generating a public/private system which is not only financially independent, socially oriented and sensitive to environmental aspects, but must also act in a democratic and participative manner. In the past, the idea of establishing bodies to guide the management of the natural resources of a river basin (especially water, of course) has aroused the interest of the countries of the region, with varying results. This interest has now become an urgent necessity, in view of the greater competition for multiple water use and the need to check pollution and manage the environment correctly. This article considers some of the essential elements which must be taken into account when proposing to set up such bodies, puts forward some concepts on management at the river basin level and identifies the various ways in which the subject can be approached, and offers some recommendations for improving policy formulation and the functioning of integrated systems for the management of water resources and river basins.

Key words: Water resources, planning, water management, water institutions.

Resumen

El desarrollo sostenible permanece como un concepto netamente académico a menos que se relacione con objetivos claros que deben formularse para áreas y procesos de manejo específicos. El manejo de los recursos de una cuenca es una opción válida para dirigir y conducir procesos de manejo de variables ambientales, lo cual requerirá instituciones administrativas complejas, las que pueden ser sistemas públicos o privados, financieramente independientes, orientados socialmente, sensibles al ambiente. En la actualidad la necesidad de establecer cuerpos administrativos para el manejo de los recursos, se ha incrementado debido al alto grado de competencia por los usos múltiples del agua y los problemas ambientales asociados. En este trabajo se discuten los elementos esenciales que deben considerarse en el establecimiento los mencionados cuerpos administrativos, se describen procedimientos y se formulan recomendaciones para mejorar las políticas para la operación integrada de los sistemas.

Palabras claves: Recursos hídricos, planificación, gestión del agua, instituciones de gestión del agua.
Sustainable development does not refer to a tangible and quantifiable goal to be achieved in a given period of time, but rather to the possibility of maintaining a balance between factors that explain a certain level of development among human beings, a level that is always transitory, evolving and, at least in theory, should always lead to an improvement in the quality of human life. Sustainable development is thus the result of a set of decisions and processes which have to be carried out by generations of human beings, under ever-changing conditions and usually insufficient information, subject to uncertainties and with goals which are not shared by a population that is showing a growing trend to individualism.

One of the biggest concerns at present, at least to judge from policy statements, is to find viable development options based on equitable and lasting economic growth. The latter consideration has gained in importance in recent years because of the realization that many alleged advances, especially in terms of changing production patterns, have been outweighed by the damage they cause to the environment.

The greater awareness and understanding that now exists of mankind's interaction with the environment, and the vulnerability of forms of development which do not take this into account, have been made more explicit by the addition to the word "development" of the qualifying adjective "sustainable". Since sustainability should be implicit in the very concept of development, this adjective should be only a transitory addition that will be needed only until the vital importance that development should be of a lasting nature is definitively incorporated in the concept.

On the other hand, the sustainability of development remains only an academic idea or abstract aspiration unless the concept is linked both with clear objectives that must be attained within a given area that contains the natural elements and resources needed for the subsistence of the human race and with the management processes needed to achieve those objectives. Political intentions must be transformed into concrete policies for implementation, and it is here that the greatest challenges arise.

In the Latin American and Caribbean region, there has been widespread reference to environmental problems, theories have been put forward on environmental issues, laws have been enacted, and even some Ministries of the Environment have been set up. What has not been done, however, is to lay the necessary bases for the management of each of the natural resources -water, soil, forests, fauna, minerals and energy- or of certain key natural areas such as coastal strips, river basins and deserts.

This means that very broad goals have been set without deciding on the necessary steps for reaching them. Territorial organization for the management of each resource and later of the environment in general; organization and training of the population; research on ecosystems; the establishment of systems of management for given areas; the strengthening of public institutions (especially the municipalities) to provide support for environmental management; awareness and heightening of the economic value of natural resources; the keeping of natural heritage accounts, and the preparation of operating manuals and rules are essential aspects for making real progress in the management of natural resources and the environment in general.

The management of natural resources in the context of the dynamic evolution of a river basin, more generally known as river basin management, is one of the possible options for organizing the participation of users of natural resources within the process of environmental management. A river basin is uniquely fitted to serve as the basis for the coordination of the actions of all those involved in the use of a shared resource -water- and for the evaluation of the effects of environmental management measures on that resource. Water quality largely reflects the environmental management capacity within the basin in question. A first step towards river basin management is to limit action to the management of the water resources existing within the area of the basin. Water management is a complex process designed to control the cycle of a natural resource whose availability is erratic and irregular over time and space. Furthermore, water is vulnerable to the treatment it receives, since it can easily be polluted, thus affecting all its actual or potential subsequent uses.

The aim of this process is to solve conflicts among multiple users who, whether they like it or not, depend on a shared resource. Consequently, even though they may have water use concessions or rights, they nevertheless affect and depend on each other. The supply usually comes from a common system, to which surpluses and
effluents are returned. Surface, ground and atmospheric water resources, together with the areas of evacuation, thus form a single unit.

The actions taken have enormous repercussions on human health, the environment and production, so that they must be approached in an outstandingly technical manner. The high cost of the works involved, together with the long lead times of water projects, make it all the more necessary that management should be in the hands of experts whose tenure does not depend on political changes. Finally, the water management process requires that many different agents should act in a coordinated manner in spite of their differences of approach and the fact that some of them are not aware of the effects of their decisions on the hydrological cycle. This is why it is so important to have stable co-ordination mechanisms and, at the very least, a permanent river basin center or authority.

2. Characteristics of water and river basins

A river basin is an area which is defined by nature itself, essentially by the limits of the run-off areas of surface water converging towards a single watercourse. The river basin, its natural resources and its inhabitants have physical, biological, economic, social and cultural qualities which endow them with their own special characteristics. Physically, a river basin represents a natural area of collection and concentration of surface and ground water and therefore has an essentially volumetric and hydrological connotation. At the same time, both the river basin and, above all, the water collected in it represent a source of life for mankind, though it can also be a source of danger when extreme natural phenomena take place or it is affected by pollution. In mountainous areas, watersheds are natural arteries for communications and trade integration, either along the rivers that run through them or along the ridges that separate them. In other words, there are close-knit mechanisms of interaction among their inhabitants which endow them with special economic and social conditions.

In river basins with a big flow of water and wide, relatively flat valleys, the line of the river also becomes an area of interrelation of the inhabitants, especially through the use of the river for navigation, transport and communications. The territory of the river basins facilitates relations among those who live in them, even though they may be grouped together in different communes or other politico-administrative subdivisions, because of their common dependence on a shared water system and road network, and because they face common dangers. When there are no systems for reconciling the interests of the various actors who depend on a river basin, there are bound to be conflicts among them.

All this is particularly true in inhabited mountain watersheds, but it is also true in broad river basins where there are water use projects that benefit the inhabitants as a whole and thus create a sense of interdependence among them.

In river basins, it is all too easy to see the negative effects of human actions on the environment, especially in the form of water pollution. This is recognized, for example, in the explanation of the reasons for the establishment of river basin agencies in France: it is noted that water is an element which serves as the home and sustenance of the animal and vegetable kingdoms, and that watercourses or bodies of water and their banks form a very special biological whole. Thoughtless human actions affecting any one of their component elements upset this precarious balance, and the entire natural environment suffers as a result. Consequently, harmonious management of water resources requires: (i) above all, recognition of the fact that a watershed or hydro-geological basin forms a single unit; (ii) awareness that recognizing and preserving this unity is an essential condition for satisfying in the best possible manner the water demands of the different users; (iii) definition of specific objectives appropriate to each area or territory, and execution of the works and actions needed to attain such objectives; (iv) acceptance of the idea that all users have a legitimate right to water and that, consequently, each of them is also subject to corresponding even-handed limitations on their own water use.

A river basin is a natural unit which lends itself well as an administrative area for the coordination of management processes designed to ensure sustainable development. Water management processes, however, involve their own forms of complexity.
3. The river basin as a territorial option for directing environmental management processes

The territory covered by a river basin is not, of course, the only area within which development actions can be directed and coordinated in order to take account of environmental considerations. The limits of the surface waters which form the river basin do not necessarily coincide with those of the ground water, obviously do not cover the areas of the seas and oceans where much of the hydrological cycle is generated, and are not so relevant in relatively flat areas or extremely arid regions.

The use of the territory of a river basin for environmental management purposes is therefore merely one option, whose validity will depend on the geographical characteristics of the environment. It is an important option from the environmental standpoint because, as already noted, it furthers coordination among the users of a single shared resource, such as water, and above all facilitates monitoring of progress in pollution control, through its effects on water quality. This does not mean, however, that the territory of a river basin is the only space needed for management of natural resources or the environment in general. This observation is important for doing away with the mistaken belief held by some persons that the entire development of a region or its environmental management can be carried out solely on the basis of limits corresponding with those of river basins. It could be said that taking account of the limits of river basins is a necessary condition for incorporating environmental aspects, especially those relating to water and its "associated" resources, but it is not sufficient as an area of jurisdiction for managing human development.

In this sense, it is vital that all management projects at the river basin level should be carried out with due regard to their relations with management systems that operate on the basis of other limits, especially political and administrative ones, among which the municipalities are of prime importance. It must be clearly understood that in order to carry out river basin management processes successfully it is essential to coordinate the actions of the various public and private authorities operating in the area of the basin.

Thus, river basin management projects which take account of the municipalities, such as that carried out with the participation of 74 such authorities in the River Chicamocha basin in Colombia (Acero Suárez, 1993), have a much greater chance of success if the municipal authorities are responsible for the execution of some actions in the project. Likewise, a municipal programme to improve the environment or prevent negative effects on it must also take into account the influence of river basins partly or wholly corresponding to its area of jurisdiction.

At the level of larger river basins, the same relationship should exist between the authorities of areas with political and administrative limits and those of areas with natural limits. Thus, for example, those in charge of a project for the development or integrated management of a major river basin should co-ordinate their activities with the authorities responsible for the development of the broader regions in which the river basin is located. There have been many cases in which the lack of such co-ordination has resulted in one of the two authorities (i.e., the river basin or regional authority) absorbing the other, or else there has been a situation of permanent conflict between the two.

4. Classification of approaches to river basin management

Management at the river basin level has made a great deal of progress in the regions, but despite these advances there is still no consensus on definitions that spell out the objectives of that management. The lack of conceptual clarity on the subject impairs the exchange of ideas and experiences, particularly between professionals of different countries, causes overlapping of functions and hinders the formulation of policies and laws on the subject.

Inconsistencies in the use and meaning of many of the terms relating to river basin management suggest the convenience of defining and classifying such concepts. Table 1 summarizes and classifies concepts related to river basin management in Latin America and the Caribbean. A matrix format is used to set out the stages of the management process as they relate to the objectives defined by the elements and resources covered by the management. This lay-out was chosen to enhance understanding of the actions that may be coordinated in a
river basin, and the purpose of such co-ordination. Moreover, it was considered useful to clarify other complexities arising from differences in terminology between English and Spanish; hence the decision to include entries in both languages; it is hoped that understanding of the Spanish term may be enhanced by a comparison with the original concept.

The table sets out two groups of factors, indicating the terminology used for each case:

**The stages in a river basin management process (1, 2 and 3):**

**Preliminary stage (1):** studies, formulation of plans and projects.

**Intermediate (2):** the investment stage for river basin development with a view to the use and management of its natural resources for purposes of economic and social development. This stage corresponds to the notion of "development" as in "river basin development", "water resources development" (the corresponding term in Spanish being "desarrollo de cuencas" or "desarrollo de recursos hídricos" or "desarrollos de recursos hidráulicos").

** Permanent (3):** the operation and maintenance stage of structures and management and conservation of natural resources and elements. This phase corresponds to the notion of "management" (a term, which, has as many as four meanings in Spanish: "gestión", "administración", "ordenamiento" and "manejo"). In general, "water resources management" is translated as "administración de recursos hídricos", and "watershed management" as "manejo de cuencas"). It should be noted that Spanish does not normally make a distinction between the concepts "watershed" and "river basin", both of these being translated as "cuencas hidrográficas", although some effort has been made to differentiate between the two by using terms such as "cuenca fluvial" and "hoya hidrográfica" to refer to "river basin", and "cuenca de alta montaña" or "cuenca de captación" to render the idea of "watershed".

**Natural resources and elements that are considered in the process of river basin management (letters a, b and c):**

**First group (a):** all the elements, resources and infrastructure for development of a river basin.

**Second group (b):** all the natural elements and resources to be found in a river basin.

**Third group (c):** only water resources.
This form of terminological analysis is unusual and it is hoped that it may be helpful in classifying concepts of the objectives of river basin management. The table shows clearly that the most complete type of management at the river basin level is indicated in column (a), under the heading "river basin development" at the intermediate stage and "environmental management" in the permanent phase. This approach amounts to applying regional development and environmental management techniques at the river basin level. It is an approach that gained currency in Latin America following the success of the Tennessee Valley Authority (TVA) in the United States, an approach that attracted followers in Mexico, Colombia, Brazil and Peru.

Agencies responsible for this type of management are usually referred to as water corporations or commissions. Most originated and developed out of major investment projects. The intermediate river basin management level is shown under column (b) and includes activities aimed at the coordination of the development ("natural resources development") and management of all the natural resources to be found in a river basin ("natural resources management"). This level of systematic management of all natural resources in a river basin (management of the use of a river basin according to its capacity and purpose) has not been applied comprehensively in the region. There are no systems or entities that facilitate coordination of the activities of use and management of the natural resources in a river basin. However, there are many watershed management programmes and projects ("manejo de cuencas"). Watershed management has become a sub item or part of this integrated approach to natural elements and natural resource management.

The traditional approach to watershed management aimed at regulating the run-off of water (a concept that originated and was first applied in the United States) is part of the approach to natural resource management. Watershed management is therefore a mixed activity, linked to management and conservation of all natural elements and resources as well as water management itself.

The third level of management, which is shown in column (c) is geared towards co-ordination of investments in water resources development and subsequent management thereof. It can be oriented towards integrated water resources management or towards sectoral water management. Sectoral management is the only known level of river basin management in the countries of the region and it is at this level that most of the studies and investments in hydroelectricity, irrigation and drainage, drinking water and flood control are conducted. Some steps towards integrated water resources management have been taken but more in theory than in practice.

In Latin America and the Caribbean, it is normal for the intermediate phase ("development") geared towards planning and execution of investment projects, in particular hydroelectric projects, to be governed by strong
systems of sectoral management. This is largely due to the fact that it is a phase that normally benefits from substantial financial backing, political support and interest on the part of the banking sector. Conversely, the permanent phase, ("management"), involving the day-to-day management or administration (for example, of water, use of flood-prone areas, pollution control or use of hillsides and operation and maintenance of waterworks except in the hydroelectricity sector and some drinking water services) was and still is generally very poor. This is the phase oriented towards integrated water resources management that needs to be improved on all fronts.

5. Advances towards integrated river basin management

Advances towards integrated river basin management in the countries of the region have been neither uniform nor stable. Management systems have been changing erratically giving rise to many cases where in the past, management, at least of water resources tended to be "more integrated" than at present. Even some sectors and public utilities, such as those related to drinking water supply and energy, had had more control over an entire river basin than at present after having been privatized and fragmented.

In its initial stages, coordination of activities at the river basin level was limited. Work was done at this level in order to solve problems as they arose and satisfy specific or sectoral demands for water, supplying water for population centers or irrigation, controlling flooding and building hydroelectric power stations.

The next step was to operate and maintain the structures thus constructed. This management was limited to the existing structures without any particular interest in multiple use of water resources or in managing the river basin area except for their own purposes, that is to say the natural resources of the river basin. Thus a series of water management systems were implemented in the region, many of which were developed solely for sectoral water use.

In the late 1940s, corporations and commissions, as in Mexico, were set up for the integrated development of river basins, that is, for regional development at the river basin level. These corporations set out from the construction of water projects to embrace extensive areas under their jurisdiction and to invest in a number of sectors. They were mainly created under the influence and image of the TVA. Around the 1970s, emerges the concept of "watershed management" mainly with the aim to reduce silting up in dams and to control land slides or flooding. There are very few instances in which all the natural resources of the river basin are managed. Integrated agricultural, forestry and livestock projects have helped to improve this aspect but do not compensate for the lack of a well coordinated system for the management of the natural resources of river basins or watersheds.

The environmental dimension began to be taken into account in Latin America only at the end of the 1970s, that is, five to seven years after the United Nations Conference on the Human Environment held in Stockholm in 1972. First came environmental impact studies, and later environmental quality analyses. To a large extent, environmental management at the river basin level did not go beyond the phase of studies, planning and proposals for forming organizations.

A look at table 1 is necessary to understand this development and to identify the different steps in management that cover the entire river basin depending on the phase of execution and the resources to be managed. The table shows a total of seven steps (intermediate and permanent phases) for river basin management: three geared to river basin development and four to the control, administration or management of the environment, natural resources or water resources.

The chronological order followed in Latin America in coordinating actions at the river basin level is as follows: (i) the question of water control and use in river basins is approached through the construction of water projects ("water resources development"); (ii) the question of the management of water in river basins is tackled ("water resources management"); (iii) there is then a direct transition to "river basin development"; (iv) the question of "watershed management" is taken up, especially with a view to controlling the erosion that affects existing dams and preventing landslides and mudslides; (v) there is then an attempt of a direct transition, more in theory than
in practice, to consideration of the question of "environmental management"; and (vi) there is a tendency towards creating capacity for integrated water resources management as a more practical approach. What stands out in this evolution is that there has been an abrupt decision to co-ordinate, at least on paper, environmental management at the river basin and regional level, without yet having fully coordinated the measures for the development and management of all natural resources of a river basin or at least integrated water resources management. It will be remembered, however, that if natural resources are not managed in a coordinated manner, not even water, than it will be impossible to undertake environmental management. The first step should then be to manage the water resources in an integrated manner and then the other natural resources associated with them.

6. Functions of a river basin organization

The management of coordinated actions to achieve various types of goals at the river basin level is normally undertaken by river basin organizations known variously as authorities, agencies or committees. The scope of the organization depends on the objectives it is set: these may range from regional development, to natural resource management or multi-purpose water management. Irrespective of the organization's level of coverage, ideally consideration should be given to environmental, social and economic aspects. Accordingly, the philosophy that determines these organizations functions should be based, among other things, on:

⇒ **Water/environmental criteria**, i.e., it should be designed on the scale of a hydrological unit and establish as a principle respect for the environment and its physical and environmental dynamics

⇒ **Social criteria**, any negotiations which take place between actors and users of the river basin should seek to foster equity and minimize conflict, as well as provide for the safety of the inhabitants.

⇒ **Economic criteria**, to promote economic growth through the efficient use of the river basin's natural resources.

Before defining the functions of a future river basin organization, it is necessary to identify which organizations individually and collectively administer the river basin's water resources at present, and how efficiently they perform this task. Then it is necessary to ascertain how reassigning some or all of these functions to river basin organizations could enhance water management. Only a limited number of functions related to water management should be assigned directly to the river basin organizations. The important thing is that river basin organizations should neither replace nor duplicate the functions performed by other institutions; in addition, they need to show profitability from the social, economic and environmental standpoints.

**Coordinating function:** the river basin organization should serve as a "coordinating forum" for water resources management using water/environmental criteria. The extent of the organization’s executive power, i.e. its rights and responsibilities, should preferably be stipulated in the water law. In carrying out its duties, the new organization should respect those organizational and functional multipurpose water management structures already in existence that operate efficiently.

**Administrative function:** in order for the river basin organization to accomplish its administrative functions, it is vital that the law require internal administrative regulations to be drawn up for each of them.

**Allocative function:** if the river basin organization has the power to allocate functions and responsibilities to other bodies or users with a view to improving multipurpose water use, the law should state exactly how this is to be done. In order to gain the users' commitment, the legislation in force should provide for and facilitate their
participation in water resources management, since clearly not all actors will be willing to submit to rulings by a river basin organization and will thus oppose the creation of such an organization at least initially.

**Consultative function:** aside from its coordinating role, the river basin organization should be able to provide advice to other bodies involved in water management at the river basin level which so desire, as well as undertake specific studies. One essential aspect of this function consists in providing the agency responsible for granting water use rights with information on the water balance in the river basin.

**Monitoring function:** the river basin organization should be charged with monitoring water courses in the river basin from their source, over their entire length, and in respect of all their uses. This requires the existence of standards in respect of water quality and quantity which serve as the legal framework for the task of monitoring compliance. Standards and regulations will only be observed if, in addition, arrangements to penalize non-compliance effectively have been put in place.

**Arbitration function:** since the river basin organization is a coordinating body with participatory management, it is also considered to be the most appropriate entity for acting as arbitrator in disputes that arise between actors over water use, as well as for preventing disputes. Public entities in charge of water management have at their disposal a simple method for initiating the organization of activities. All they need do, in the case of each river basin, is set up a center devoted solely to gathering all available information on studies made of the river basin, maps and other existing documents, to which the general public can then have access. In this manner, both users and the general public can significantly increase their participation in water management, without the need for substantial expenditure or a rearrangement of the functions performed by already existing organizations. The initial task may simply consist of facilitating the coordination of water management initiatives in the river basin, without attempting to modify the duties of each organization currently responsible for managing the water resources of the basin. This co-ordination process should help identify (i) the areas of activity for which no one has responsibility; and (ii) whether the authorities charged with performing a particular task are properly trained and equipped to do so.

7. **How can the failure of river basin management processes be prevented?**

 Attempts to establish water resource and river basin management systems usually fail because proposals for the creation of the pertinent organizations, whether in the form of authorities, agencies or any other body, are presented in a relatively superficial manner. Generally the aim is to give systems a holistic focus. Hence they should: (i) be economically efficient, self-sustaining and competitive; (ii) have a social orientation, promote social equity and be environmentally responsible; and (iii) involve both public and private sectors, provide for civic participation and take a conciliatory rather than an authoritarian approach. In essence, the objective is to create a superior body responsible for fostering sustainable development.

Experience shows that the creation of any organization that performs at least some of the basic functions, such as preventing, reducing or solving disputes among water users, should be a gradual process. The initial step should be to gather information on: public policies in regard to water resources and the economy; the features of water resource and river basin management; the characteristics of water management systems and the actors involved; and the most appropriate methods of operation for public or private organizations responsible for managing water and natural resources in a river basin.

Viewed from this perspective, it may be very useful to analyze policy declarations in terms of a methodology sequence which seeks to direct management procedures towards sustainable development. It is suggested that in order to execute actions, it is necessary to (Dourojeanni 1997):
⇒ Identify the actors involved in the management process
⇒ Analyze the actors' criteria (policies, principles, etc. Identify any problems relating to these criteria
⇒ Identify what the actors' objectives are;
⇒ Define the spheres within which it is hoped to attain these objectives,
⇒ Identify constraints on the attainment of these objective, propose solutions for overcoming these constraints
⇒ Decide on the strategies to be applied in order to achieve solutions;
⇒ Design programmes and projects for carrying out the selected strategies and evaluate them; and execute both one-off and ongoing programmes and projects.

In accordance with this sequence, policy formulation takes place mainly at the stage when criteria for action an the actors' objectives need to be specified. These criteria are for the most part declarations of intent. By contrast policies for executing actions can only be formulated once the solutions and strategies have been designed. Thus water policy formulation needs to be undertaken step by step, in a systematic way, so as not to overlook aspect; critical to successful implementation.

Water policy formulation in the countries of the region has seldom been carried out in a rigorous way. Generally speaking, policy formulation is ad hoc, and does not follow any established procedure. Water policies in the region have at various times emphasized the preparation of plans the formulation of laws, the creation of new entities, and so on. However, it is a matter of concern that the vast majority of these proposals are not properly harmonized. The measures taken in this context are piecemeal, their objective, limited to, for example, avoiding inconsistency with an economic system, reinforcing other laws, mitigating specific conflicts that arise from time to time among users, satisfying the demand of certain groups of voters or facilitating a particular decentralization project. In such circumstances, the water policies formulated are normally incomplete. For example, decentralization in some countries has led to profound contradictions between development policies and water policies, with the result that river basin organizations attached to the central government sometimes find themselves subordinate to two or even three authorities, because the river basin under their control has been divided by regional boundaries.

Water policies should fit neatly with national development) policies, but it should also be pointed out that both water resources and processes to develop them have certain features which, if neglected, give rise to huge contradictions.

The unique features of water as an economic resource demand, if not a dominant role for the State, at least joint management by the State and users of supply at the river basin or interconnected system level. This is the only way to resolve any conflicts that may arise, to make resources available to deal with shared problems and to control externalities, natural monopolies and other aspects that require regulation.

Because the consequences of water management policies in force are often unknown, it is difficult to come up with way to improve them. In other words, if there is a lack of information about how water development policies are currently working (causes and effects), it is hard to decide what to do to make them more effective. Many countries do not maintain an up-to-date register of laws dealing with water resources and river basin management. Countries also sometimes lack a register of users of river basin or water systems, as well as an inventory of studies on each system or of investments made in hydraulic-engineering works in each basin. It is not known to what extent policy declarations and official rulings on functions are implemented in practice. A large number of government agencies do not have sufficient resources to perform the tasks they are set. Until now, most water policies that stem from changes in economic policy remain little more than declarations or policies of intent. In many cases, without any deeper analysis, policies of intent have become laws of intent, and this has generated serious gaps, especially in terms of instruments to implement the laws. In several cases, the spirit of the policy bears little relationship to the provisions of the law or to the results it achieves.
8. Procedures for creating a river basin organization

Despite all the arguments in favour of integrated river basin management, or at the least water management at the river basin level, it is clear that the countries of the region still face sizeable obstacles to the creation and operation of water or river basin organizations. Proposals along these lines still encounter stiff opposition, often due to rivalries between different agencies or because of conflicts with regional laws and authorities. Even many of the organizations that have been in operation for quite some time face strong opposition. Probably the most important factor that slows the creation of river basin organizations or hampers their operation is the lack of clarity about their roles (which generates sources of potential competition with other authorities), their economic viability and the methods which will be used to fund them. It appears that proposals sent to legislatures or debated in public are not sufficiently detailed. Most proposals formulated by the executive fail to specify sources of revenue, ways in which the actors should participate, the costs and benefits involved, the role of the public and private sectors, adjustments that may be introduced for a particular category of river basin, feasible investment programmes and the form that dealings with national and regional authorities should take. All this casts doubts on the viability of the proposals.

It is possible to conclude that only limited tangible results have been achieved in the field of integrated river basin management and in the administration of the river basin or at least its water resources. The gradual deterioration of water quality, the degradation of soil and vegetation in river basins, the overexploitation and pollution of groundwater and the general lack of control over water supply in river basins all provide evidence that integrated river basin management is not practiced.

Initiatives in the management area aimed at improving the supply and quality of water are more often due to individual groups of users than to any authority. Spontaneous co-ordination efforts are also undertaken in the face of catastrophes such as floods or droughts but there is generally no traditional approach or school of thought with respect to the issue despite the progress achieved. The likelihood of finding positive solutions is even further complicated by the lack of economic data on the value of water use or of historical records on water management in each country, the dearth of information on the growth of conflicts over water development and the lack of clarity with respect to the roles of the different actors involved in water use, including government river basin management agencies, and inadequate knowledge of their true ability to act.

A large number of river basin organizations will be created in the region in the near future. This means there will be huge demand for training and cooperation activities to put them into operation. At present, there is little material available; in order to rectify this situation, it will be necessary to produce teaching materials similar to those currently being prepared with the aim of improving the management skills of municipalities and local governments. Today governments must rise to the task of advising a huge number of river basin organizations at the same time, enabling them to equip themselves, even in a private-sector environment, with staff, communications systems and operations and control systems.

The most obvious strategy for creating river basin organizations, in view of the evident initial lack of resources, is to set them up on a step by step basis. To that end, a number of principles can be followed, some of which are listed below:

⇒ Begin by creating water management organizations rather than river basin organizations. The functions of river basin organizations are broader and are more difficult to reconcile with those of regional development authorities. Water management organizations are restricted to administering water resources and natural resources associated with the river basin's water resources, so have fewer conflicts over spheres of competence with national and local authorities.

⇒ Water management organizations should, therefore, have responsibility only for multipurpose water management and natural resources management, for the purposes of protecting and conserving water quality and containing extreme phenomena. In practical terms, they should administer the supply of water resources in the river basin.
Water management organizations should be created gradually, under the terms of a general law, in such a way that energy and scarce resources are concentrated in the task of organizing users in a number of high-priority river basins, while experience is built up in this field.

Water users should from the outset have a hand in designing the water management organization to which they belong. The water management organization should be comprised of the users themselves along with local and central government representatives and should be assisted by a technical support team employed on permanent contract and which acts as secretariat.

The State may start by organizing a relatively small water resources management system with the abovementioned characteristics for priority river basins; however, from the commencement of operations, such a system should be able to rely on a fixed source of income, such as a land tax.

This organization, which may be called either an agency or an authority, should seek to ensure that the users organize themselves according to the watercourse or channel from which they draw, to register them as users and potential members of the board or committee overseeing the water resources of the river basin and to become eligible for technical support and loans.

It is necessary to determine the exact nature of the relationship between the water management organization and the regional and local authorities.

The role of municipalities or districts in water management in each locality should be clearly established, and functions and resources assigned to them.

The regulation of users, with reference to water volumes, quality, location, regime and other factors, may be undertaken by private consultants, experts and lawyers, who are duly trained and accredited by the State. The regulation of current water uses should be a precondition for the granting of water rights.

Using the funds it collects, the water management organization should, in coordination with the public and private sectors, equip the river basin with systems to measure water quantity, quality and frequency, undertake studies and give users assistance in technical and financial matters.

Decisions concerning special charges and investments should be made by users' representatives and other members of the river basin board. As measurements of water quality and quantity become more complete, it will be easier to determine forms of collection, the level of payment for pollution and the allocation of costs and benefits in each project.

9. Future tasks

All river basin authorities should be established at once by a general water law, as in Brazil and Mexico. They should cover the whole territory of the country. Their functions and responsibilities should be modest at the initial stage and gradually expand, as their capacity improves and as water users become convinced of the need to have such organizations. Experience of Mexico suggests that, although, they can be created in a relatively short time, their consolidation usually requires a much longer period of time as well as a continuous support from the central government. Thus, a start can be made by setting up authorities to manage the water of a river basin rather than river basin authorities proper, since fully-fledged river basin authorities have broader functions which are harder to reconcile with those of the regional development authorities. Water authorities should be only concerned with the management of the water and associated natural resources of the basin, and so will have fewer conflicts of authority with national or local government bodies.
The water authorities of a river basin should therefore: only be responsible for integrated water resources' management, for the co-ordination of multiple water uses and for the conservation of the natural resources of the river basin, in order to protect and conserve water quality and forestal and control extreme phenomena. In practice, they should manage the supply of water resources in the basin. The actual establishment of each river basin water authority should be carried out gradually, under the terms of a general law, so that efforts and scarce resources can be concentrated to assist the organization of users in some river basins of priority importance, while experience is being gained in the matter.

Water users must participate from the beginning in the formation of the water authority of the basin to which they belong. This authority must be made up of users themselves and representatives of the local and State governments, and it must be backed up by a permanent technical team that will serve as its secretariat. The State can begin its activities by organizing relatively small water management bodies for priority river basins. These bodies would have the features described earlier, but at the beginning of their operations they would have a steady source of income, based perhaps on a landed property tax (for example, 50 U. S. cents per year for every US$ 1000 that a property is worth).

Such a body, which might be called an agency or corporation, should call upon the users to organize themselves by watercourses and canals in order to be registered as users and potential members of the water board or committee of the basin and to become eligible for technical support and loans (watershed initiatives). The formal registration of users, with details of the volumes of water involved, quality, location, flow regime, etc., could be carried out by private consultants technicians and lawyers, suitably trained and recognized by the State. The formal registration of current uses of water and the establishment of water balances should be prior requirements for the granting of water use rights.

Decisions on special charges and investments will be taken by the user representatives in conjunction with the other members of the water board of the basin. As the measurements of water quantity and quality become more complete, it will be easier to determine the best ways of levying charges, exacting payment for pollution, and allocating the costs and benefits of each project. With the funds collected in this way, the water authority of the basin, in co-ordination with the public and private sectors, should gradually equip the basin with systems for measuring the quantity, quality and periodicity of the water, as well as carrying out studies and helping users in technical and financial matters.

This discussion can be considered as an introductory essay on the topic of public policies for fostering sustainable development and integrated water resources management through river basin management. The next task will consist of analyzing, expanding on and consolidating aspects that are still being debated, such as:

⇒ Formulation of policies on the granting of "water rights" as a means of promoting water markets; in other regions, water resources are increasingly being seen as public property, with the trend being to manage them using a more community-based approach for the benefit of all users and not just the holders of "water rights".

⇒ Definition of the respective roles of the State and the private sector in the management of natural resources, particularly water resources. Of particular importance are the strategies for the transfer to private users of water management tasks traditionally carried out by the State, bearing in mind that many users are still disorganized and lack an integrated river basin management culture.

⇒ Definition of the way in which river basin entities will be organized areas where the population of the river basin is largely marginalized, informal and poor, and lacking both traditional organizational structure and property rights.

⇒ The economic and financial rationale and the identification of sources of financing for undertaking, at a minimum, coordination activities among the users of water resources in a river basin. It is important to note that water resources management at the river basin level, if performed properly, is a complex task.
River basin organizations must therefore be assured of the continuity of their actions, particularly as regards technical staff, who must be suitably trained, well paid and sufficiently well equipped to carry out their functions.

⇒ The process of identifying decentralization and regionalization mechanisms, as well as, expanding the roles and skills of municipalities, remains at an early stage in many of the countries of the region. Water management organizations at the river basin level are dependant on whether the regional and local authorities are organized to participate in river basin committees.

⇒ There is still no clear differentiation made in respect of "water management systems" at the national level. Currently there are no true "water resources associations or higher councils" operating at the national or local levels. The roles of organizations overlap and interagency co-ordination is plagued by serious problems. All this makes it difficult for river basin organizations to operate, as do loopholes in the law and disputes over budgetary authority. Consequently, it is necessary to clarify each institution's role in water management at the national and regional levels.

⇒ In order for river basin organizations to function, various institutions need to work efficiently. The comptroller's office, the judiciary, the police, the civil defense organization and the banks are just some of the exogenous actors that could be mentioned in this connection. Where such institutions are marked by inefficiency, a lack of resources or corruption, each river basin organization must take action directly or insist that each institution perform its functions properly.

⇒ Another key aspect is the need to standardize and update registers of water users along with measurement and assessment of water use. Until registers are updated to show allocation of water rights as well as information on water measurement and distribution systems, little can be done to improve the distribution and regulation of water quality; it would be worse still to grant water rights in the absence of such information.

⇒ Many other issues need to be addressed, including: ways to respect the traditional water management systems of long established indigenous communities; methods of involving new districts in water management tasks; the possibility of setting up municipal watershed systems; the overhaul of training programmes on the topic of river basin management; and, in general, the need to exchange experience on legal, economic, scientific and social matters.

These issues deserve to be taken up and debated in the appropriate forums. They are just some of the aspects that need to be resolved if water management at the river basin level is to be improved.

10. Recommendations for improving proposals for the establishment of river basin management bodies

In principle, it is possible to correct the disjointed and poorly based manner in which management solutions for improving natural resource use are usually put forward.

Since this article deals with bodies at the river basin or watershed level, the most salient aspects relating to these management systems are presented below. The main factors conditioning the structure of a natural resources management body at the river basin level are: (i) the size and the ecological, climatic, geomorphological and physiographic features of the basin; (ii) the organization and level of development of the municipalities, the main types of users and their political power and representative ness, and their form of participation in local government; (iii) the degree of knowledge of the natural elements and resources of the basin, the length of time that water records have been kept, and the level of knowledge of the functioning of the ecosystems; (iv) the prevailing organization of management in the basin, by management levels (scientific-environmental, economic-productive, technico-regulatory and politico-social); (v) the endogenous and exogenous actors
operating in the basin (their number and socio-economic features); (vi) the legal aspects of the possession or use of the natural resources, properties, etc., and the way in which users are currently grouped in the basin; (vi¡) the level of equipment of the basin in terms of roads, communications, transport and other forms of services infrastructure; (vi¡¡) the possibilities for the participation of other bodies in management and the degrees of co-ordination and operational capacity (with the legal system, the police, research and training, laboratories, the construction sector, etc.); (ix) the level of public and private activity in the basin (existing bodies and functions of both endogenous and exogenous actors); and (x) the economic enhancement of the natural resources found in the basin, as well as the variety of natural elements not yet economically valued (bio-diversity, scenery, exclusiveness).

The aspects which are influenced by the above factors and which also give its special nature to a river basin body include the following: (i) the functions of the body (coordination, supervision, planning, execution, administration, consensus-building, consultation, control), together with other attributions connected with whether or not it has the faculty to impose decisions for the settlement of disputes among water users in the basin; (ii) the sources of finance to which the management body has access: property taxes, water charges, fines for pollution, public treasury, regular payments, project funds, donations, sale of services, etc.; (iii) the location, size and equipment of the management body (offices, transport equipment, computer facilities, information systems); (iv) the type and number of staff and the internal organizational chart, which will reflect the complexity and type of management conflicts encountered in the basin; (v) the rules for its operation and functions and the annual budget required for the functioning of the body and for investment in projects; (vi) the degree of autonomy with respect to the State and the Board of Management of the body, to which the head of the body must be answerable in respect of the management results; (vii) the degree and form of participation of the actors involved in the management of the basin or affected by such management (Water Parliament, river basin committee, etc., in respect of which it is important to know their composition and the relative weight of their participation); and (viii) the status of the body as compared with the other bodies operating in the basin: its capacity for co-ordination and control and its leadership potential.

The size of a body responsible for directing integrated actions in a river basin must be determined in accordance with the above factors. This by no means exhaustive list of aspects that must be taken into account seeks to avoid situations where the formulation of proposals to improve the work of public or mixed bodies responsible for the management of the environment, natural resources or water alone is based, as has been customary in the past, on hunches, makeshift measures, emotional reactions or political expediency rather than on rigorous analysis. For example, customary actions include proposing the establishment of a committee to study the situation and issue findings; putting forward a plan -preferably a "master plan"; changing the names of the relevant public bodies; separating or dividing institutions or parts of them; moving offices; changing the heads of departments every time there is a change in the top authorities; creating new posts or authorities of trust; ordering a commission which enjoys the confidence of the top authorities to change the legislation in force, placing all the responsibility for management on the shoulders of users and abandoning the responsibilities of the State, or vice versa; requesting support from some international agency or bilateral aid through a project; requesting a line of soft credits or bilateral donations; inviting groups of experts to attend workshops or seminars to discuss the salient questions and engage in lobbying; modifying the scope of environmental management, and decentralizing or centralizing management authority.

Each of these measures may be potentially excellent, but in order for this excellence to become a reality it is necessary to comply with a number of requirements, and this is rarely done. These requirements include the following: (i) recommendations must be properly based on analytical studies which take account of the existing situation and all the aspects involved in making a change in the management system; (ii) the moment at which the proposal is made must be politically suitable and must be decided upon in accordance with the interests of the country; (iii) the actors participating in the water management systems must be aware how important and necessary it is to cooperate in order to ensure that that water resource is managed in an integrated manner; (iv) the users themselves must be capable of financing the management process with their contributions; (v) specific tasks must be assigned, and the agreements reached among those involved in the various levels of water
management must be perfectly clear. In order to assist in the correct formulation of proposals for the establishment of river basin management bodies, it is suggested that the questions posed in Box 1 should be answered first, as these are the kinds of questions that need to be settled before proposing the establishment of any watershed management body or putting forward solutions regarding bodies which have been set up but are not yet operative. In Latin America and the Caribbean there are many items of legislation which have become a dead letter because they were not fully or properly prepared, and the lack of clarity has given rise to negative reactions even before the system has come into being, especially when the relevant functions and attributions have not been properly spelt out.

11. Recommendations for improving policy formulation for integrated water resources management

There are some basic considerations that must be respected if it is desired to formulate policies for the management of the environment, of natural resources, or of water alone which have a modicum of coherence. If the policies themselves are not coherent, then neither will be the actions of the management bodies responsible for putting them into practice.

In principle, it is obvious that not every declaration of principles necessarily qualifies as a policy, whether of intention (politics) or of execution (policy proper). In order for it to qualify as such, it must contain certain basic rules, organizational principles, and basic procedures.

It is also necessary that a declaration of proposed changes or the announcement of new policies should take clear account of the advantages and disadvantages of the application of the existing policies. In no event should a new policy make the situation worse or undermine the effectiveness of another recently announced policy. It is also important that the hypotheses which form the basis for a policy of intention should be proved with rigorous exactitude, using for example the methods described in the sequence of management procedures for sustainable development (Dourojeanni, 1997). Fulfillment of this requirement is essential in order to move from mere politics to real policies.
In environmental matters (including water and other natural resources) it is necessary to understand the restrictions imposed by the behavior and needs of the environment in general and water in particular, and to incorporate them in the declared water policies. The natural system does not change its behavior simply because human society decides to change its type or form of government or its economic or trade system. Beyond all doubt, declarations of environmental policy, and especially of water policy, must take account of the prevailing economic policies and the functions of the public and private sectors. This is vital for determining the policy instruments to be used and the type of organization needed to apply them.

In policy declarations concerning the environment in general, the management of natural resources, or that of water alone, it is necessary to specify what system of organization will be applied and above all what economic instruments and under what conditions will be used to make that system work, whether it be public, private or mixed. One of the conditions demanded by the environment is continuity of action: environmental management systems must last longer than the term of office of a particular government. It is therefore necessary that policy declarations should be accompanied by a draft Bill or rules designed to give the management system the necessary continuity and ensure its financing, effectiveness, adaptation and legitimacy.

In order for environmental policy to be successful it must be understood by the population at large. In this respect, it is important to give the public details of those who took part in the formulation of the policy and those who will be involved in its subsequent application, as well as the way in which decisions were taken. Clear details should also be given of the role of each actor and his relative part in the process of application and observance of policy instruments. At a time when there is a trend towards the application of a social market
economy, it is essential that the economic and environmental objectives should be mutually compatible. Both types of objectives can be attained at the same time, provided that the behavior of the economic and ecological systems is clearly established and that suitable harmonization mechanisms are designed.

In order to enlarge on this latter point with regard to a single element, such as water, some ideas put forward in a study by Erhard Cassegrain and Margat (1979) are reproduced below.

First of all, when dealing with water resources the reasoning applied with regard to the optimum economic yield differs from that corresponding to water use: the optimum economic yield in a market is obtained by giving full play to competition and rivalry, but the optimum economic yield in the multiple use of water resources is obtained through a calculated and reasoned objective process involving the participation and agreement of the actors taking part in it, including the State.

This does not mean that the application of economic instruments is not useful and highly important for attaining the objectives of optimum water use, especially at the sectoral level. Such instruments serve to correct and promote the efforts of users as a whole, and above all to obtain resources for combating the effects of natural phenomena that affect all users, such as floods and droughts, for draining away rainwater from urban centers, for reducing pollution, and for avoiding misuse of the territory and its resources. Demand for a natural resource such as water has a dual effect on its supply. On the one hand, water is extracted from the environment (rivers, wells) and used in various ways, while on the other hand it is returned to it in different amounts and qualities (to the same or another river or to the water table). This dual interaction does not apply to all the resources traded in the market, so that in the case of water it is not enough to consider only the efficiency of its extraction and use: the efficiency with which it is returned must also be taken into account.

As noted earlier, water management involves the handling of conflicts among users competing for the same resource, many of whom have no idea of the way they interact and thus mutually benefit or prejudice each other. Environmental management, and that of water in particular, must help to forestall and avoid such conflicts as far as possible by studying the interrelations of the actors and suggesting negotiations or environmental trade-offs among them. In the formulation of environmental policies, especially with regard to water, a natural system such as an ecosystem or river basin or a resource such as water is often arbitrarily split up; for management purposes, by user groups; by the sectors responsible for its control; by consumptive or no consumptive types of use; by the source where the water is obtained (surface or ground water); by sections or stretches of rivers, or by other criteria.

The natural system is thus arbitrarily split up, leading to the likewise piecemeal management of a naturally integrated system. According to Erhard-Cassegrain and Margat (1979), it is not enough to rationalize the delivery of water to each user in terms of quantity and quality: it is also necessary to take into account the way in which the user will return it to the environment (quantity, quality, place and time). The return of the resource can have negative as well as positive effects and vice versa: for example, a large flow of domestic waste water will reduce the concentration of chemicals due to liquid industrial effluents and will also serve to transport them.

The concept of "water economy" does not depend automatically on the reduction to the minimum of the amount of water extracted from the system or used in a given process. If the water is re-used in other processes, it may be more economical to use more water in the first process. Thus, for example, in some areas the use of little water for irrigation will result in higher costs and increase the content of salts in the ground, but if the water can subsequently be collected, treated and re-used, it could be more economical to use more water in the first process.

It is not enough merely to assign water use by sectors (domestic, agricultural, industrial): it is also necessary to take account of the interactions involved, since there is a conflict between each type of demand and the supply system (ground water for irrigation, river water for industry, sections of rivers for irrigation associations, extraction of materials from the river bed for municipalities). This means arbitrarily splitting up the physical units of the supply systems a function of the different uses, as in the case of dividing up a river into sections assigned to different user groups but ignoring the implications of their interdependence along the whole river. In
this type of approach, water demand is sometimes projected only in terms of types of resource supply (demand for ground water for the cities, demand for river water for industry).

Demand is almost always evaluated in terms of quantity and not quality, as though the two could be separated. It is forgotten that the two factors interact at each of the points where water is returned to the main system, and it is also forgotten that extracting or returning water involves changes in its quality and in the capacity of the environment to absorb certain pollutants.

The value of water as an input in a production process is usually assigned without taking account of the interactions that exist between its extraction, use and return. When a value is placed on water, for example, no cost is fixed as a pro-emptive measure to take account of the pollutants that will be emptied into a watercourse when certain amount of water is returned, and no charge is made for the use of water as a vehicle and sometimes as a diluents for wastes in addition to its use in production processes.

The costs of negative external effects or externalities, such as the contamination caused by the use of water as a vehicle for wastes, are ultimately internalized in accordance with the principle that the polluter must pay. Usually, however, this rule is applied when an industry has already been damaging the environment for several years and users begin to complain. In order to avoid this situation, preventive actions are needed both in terms of collecting payment and in applying anti-pollution measures. Between the time when water is polluted and the time when action begins to be taken to cleanse it, there tends to be a period of inaction. What happens is that the authorities do not take into account from the beginning that the user is not only employing water in his production processes, but is also using it as a vehicle for his wastes. This use could be calculated and charged for from the beginning, for example by estimating the alternative cost to the factory of using trucks instead of water and watercourses to carry away its wastes. This problem is getting worse and worse because water supply management systems, which are also fragmented, have no co-ordination machinery. Some bodies (such as Ministries of Health) deal with water quality, others (such as the municipalities or ministries responsible for the mining sector) deal with the extraction of aggregate for construction purposes, others are concerned with river defenses, others with ground water, still others with the granting of water use rights, and so forth. The lack of co-ordination leaves many gaps in the management. The situation is also explained by the fact that many plans prepared by these bodies merely extrapolate the fragmentation in question. For example, each sector projects its own demand, but it does not consider the effects that this demand will have on the river basin, on supply, or on the various other demands. Consequently, very few proposals for reducing demand come from sectors which prepare their plans independently. All the sectors demand the maximum, and if they can they pro-emptively appropriate as many water use rights as possible. They fight not only for what they need today, but also for what they might possibly need tomorrow.

Thus, hardly any sectoral policy seeks to change demand trends by, for example, relocating industries to more suitable places: it merely tries to satisfy the demand. No provision is made for possibly acting simultaneously on both supply and demand, because there is no integrated water management system which depends primarily on the users themselves and which can put forward measures that will be of benefit at the individual and collective level in order to achieve economies of scale.

When there are no integrated water management development policies, the technical rationale is confused with the economic one, which in turn is confused with the financial rationale. Instead of adopting a criterion with regard to the selection of objectives which serves to solve situations of competition (it should be recalled that water management is basically conflict management), in the end criteria are adopted which are useful and sensible for individual sectors but make no sense for the whole, to such a point that they may end up causing bigger losses for the sectors themselves (higher costs for water regulation and catchments, for the control of extreme phenomena and for combating pollution). Efforts to maximize the economic and water-related benefits of each sector independently of the others militates against the achievement of maximum benefits for the whole, and the final result is economic, social and environmental losses for all. The situation becomes confused if the water economy is understood as a "material economy" of this resource. It would seem rational to save water and thus reduce consumption, and it would also seem rational to select the water supply solution which is cheapest
in the financial sense, but these two concepts are contradictory and sometimes incompatible when seen as part of a single objective.

When there is no integrated water resources management system it may also happen that the benefits generated by one actor for other water users (such as reduction of the effects of floods or droughts thanks to the construction of a hydro-electric power station dam) are not recognized or paid for, although those affected complain and sometimes obtain compensation when there are negative effects. Thus, water management and economic management must be considered from the top down, in an integrated manner and not piecemeal. If the analysis is only carried out in respect of separate parts, it may mistakenly be concluded that materially optimizing each separate water use will lead to optimum economy. In practice, however, the best economy will be obtained by analyzing the system as a whole.

The most suitable economic management instruments can only be selected by taking account of this integrated nature of the system.

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