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MANAGEMENT AND WATER RESOURCES IN LATIN AMERICA
AND THE CARIBBEAN

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Summary

In most countries of Latin America and the Caribbean, a stocktaking has begun on the effectiveness of the management of the water control systems that have been built in the last forty years. At the same time, in the current discussion of means to overcome the general unfavourable economic situation much emphasis is being placed on the need to increase the effectiveness of the management of the public sector. There exist numerous proposals for reform of the public sector but there are no generally accepted solutions either for the public sector, as a whole, or water control systems, in particular.

The present study is the latest in a long line of studies by ECLAC in the area of water management. In contrast to earlier studies stress has been placed on the need for improvement in the quality of management independently of the administrative form of the management system. The hypothesis underlying the study, although not explicitly, tested, is that an improvement in management quality, through the better preparation of managers, can make a major contribution to improvement in the operation of water systems.

The core of the study is the presentation of four case studies,

- (i) Irrigation in the Province of Mendoza, Argentina.
- (ii) Water management and regional development in the río Bogotá Valley, Colombia.
- (iii) The Tinajones irrigation project, Lambayeque, Perú.
- (iv) Water management in the Valley of the río Limarí, Chile.

From the case studies a series of conclusions are reached on the nature of the most significant external and internal factors that have influenced the management of the systems studies. Finally, some suggestions are made for improvement in the present system of management, particularly, for the preparation and training of managers.

MANAGEMENT AND WATER RESOURCES IN LATIN AMERICA AND THE CARIBBEAN

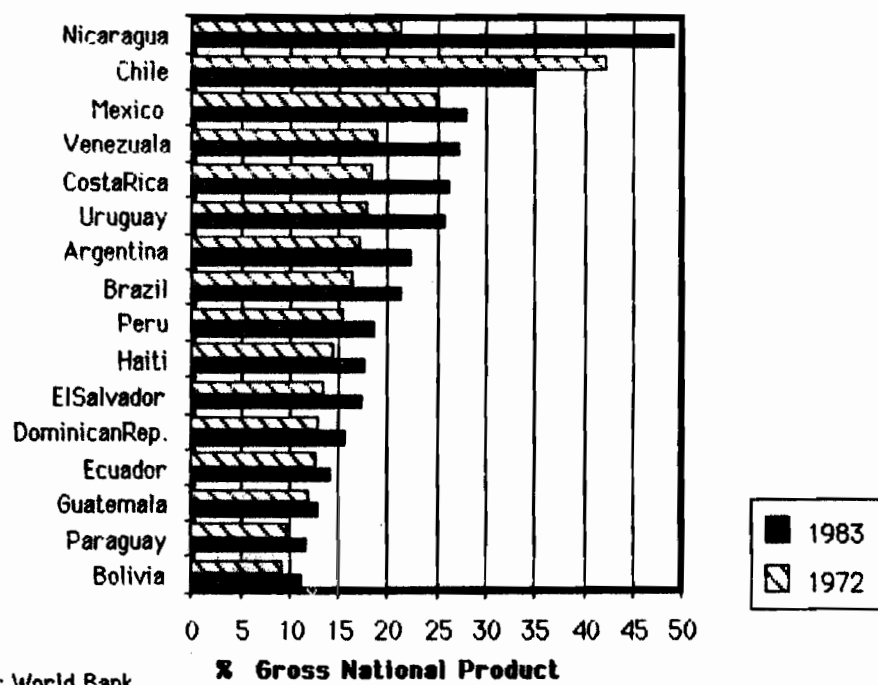
I. A MEANS FOR DEVELOPMENT

In the quest for growth, for higher levels of income and improved standards of living, Latin America and the Caribbean have given considerable attention over the last four decades to the harnessing of the water resource. One example of what has been achieved can be seen in the fact that, in the years since 1945, the volume of water held in reservoirs, a useful if imprecise index of the expansion in the control of the water resource, has increased more than twenty-fold.^{1/} Similar growth has occurred in the area of land under irrigation, in the generation of hydro-electricity and in the supply of water to population and industry. In general, the regulation and control of river flows has increased to such an extent that even the largest natural hydrologic systems in the region are subject to considerable interference in their natural flow regimes and water control works have become perhaps the most ambitious efforts made to manipulate nature in the support of man's activities.

Now, after such a major expansion in the effort to benefit from the large natural endowment in water of the region, a stocktaking has begun in most countries on the effectiveness of the management of the water control systems that have been built. There is anxiety that the gains anticipated from this investment in the control over the flow of water have not been realized to the extent originally proposed and expected. Moreover, there is criticism that in many projects heavy costs have been incurred in the loss of alternative environmental opportunities; costs not justified by the benefits really being obtained. Such criticism is not new but has taken on renewed force with the advent of a general and prolonged recession in most countries of the region.

At the same time, outside the confines of water management, in the current discussion of policies to overcome the generally unfavourable economic situation much emphasis is being placed on the need to increase the effectiveness of the management of and the rate of return from investments already made, particularly, investments made in the public sector.^{2/} Public sector investment, and the role of the government as a whole in the economy, has continually grown until very recently in nearly all the countries of Latin America (Figure 1). Investments in the control and regulation of river flows have expanded parallel to, and as part of, the general expansion of the public sector and of the role of the government in the economies of the countries of Latin America and the Caribbean. Investments in water-related projects have formed a large proportion of total public investment.^{3/} The crisis perceived in public sector management is, therefore, of considerable relevance to the management of the water resource. Equally, the size of water resource related investments means that improvement in the performance of water projects could have an important impact on the performance of the public sector as a whole.

Despite the high level of concern for the reform of the public sector, there are no generally accepted opinions in the region on what reforms will achieve the improvements in management performance demanded either in the public sector, in general, or the field of water resources, in particular. There are, to be sure, many opinions advanced as to the reasons for the poor performance on the institutions of water sector as managers of large public investments.^{4/} There are numerous proposals for reform, including the transfer of the maximum of economic activities from the public sector to private ownership, the decentralization of decision-making authority in government away from the capital to the regions, the creation of autonomous public corporations not tied to the bureaucratic traditions and norms of the civil service and many more, either singly or in combination. In examining the experience of the region, it is possible to find examples of the application to water resources management of almost all the reforms that are being proposed. However, the results obtained through these reforms, although not always inappreciable, have not been such as to suggest that any general solution has been found to the problem of the low productivity of water resource systems in Latin America and the Caribbean.^{5/}

Figure 1: CENTRAL GOVERNMENT EXPENDITURE

II. THE PRESENT STUDY

The present study is the latest in a long line of studies by ECLAC of water resources in Latin America and the Caribbean focussing on questions relating to the management of water resource systems. In the course of this work various proposals have been made for technical improvements in management, particularly, on the need for integrated management covering all water uses, on the need for a broader view of what is water management so as to better specify the issues involved and finally on the need for decentralization of decision-making and the incorporation of the users and the local population in the decision-making process.^{6/} More recently, however, in this work it has been realized that any solution to the problem of the efficiency and effectiveness of water resources management goes beyond any technical adjustments, "...integrated water resource management in Latin America and the Caribbean is not going to occur overnight. In spite of some examples of such management, their universal extrapolation appears to face intractable institutional constraints. It goes without saying there are no easy solutions. One conclusion is obvious, little help is forthcoming from recommendations for comprehensive planning, more legislation, new co-ordinating agencies with greater authority, super ministries etc.^{7/}

The issue of management failure facing most water resource management systems in the region may be too complex to be resolved by the application of one formula or another for reform of administrative systems but this does not mean that all hope of change should be abandoned. Hence, the justification for undertaking this present study where stress has been placed on the basic need for improvement in the quality of management independently of the administrative form of the management system. The hypothesis behind this study, although not explicitly tested, is that an improvement in management quality, through the better preparation of managers, can make a major contribution to improvement in the operation of water resource systems.

The overall objectives set for this study reflect, with an appreciation of the difficulty of the task of achieving administrative change, a long-term view of the process required for such change or reform so that better productive performance can be obtained from water resource systems. The overall objectives of the study are:

(i) improvement in co-operation between national bodies responsible for the operation of water resource management systems in Latin America and the Caribbean;

(ii) improvement in the management of large water resource systems through the training of managers, with special emphasis on the operation and maintenance of infrastructure works and the conservation of resources.

However, in order to achieve these objectives a number of subsidiary goals were established within which the most important was the obtaining of a greater understanding of the current issues facing management. For this purpose a series of case studies were made to provide a contemporary appraisal of the situation in selected water systems.^{8/} The case studies were constructed to cover the following aspects of each water system evaluated:

(i) the description and definition of the water system included in the study and of the region in which the water system is located;

(ii) the description of the existing institutional arrangements for the administration of the water resource, including the wider institutional framework in which the administration of the water system is placed;

(iii) the identification of the most important factors, both internal and external to the water system and its institutional structure, which have influenced management performance;

(iv) the evaluation of the performance of management against the goals and objectives set;

(v) the identification of measures that if adopted would improve management performance, emphasizing where improved training might be the appropriate solution.

Four case studies were made, each in a different country, covering a representative variety of management situations and including all water uses and all the major water management issues currently being faced in Latin America and the Caribbean. The four water management systems that have been studied are:

- (i) Irrigation in the Province of Mendoza, Argentina;
- (ii) Water management in the valley of the Rio Limari, Chile;
- (iii) Water management and regional development in the Rio Bogota Valley, Colombia;
- (iv) The Tinajones irrigation project, Lambayeque, Peru.

III. THE CASE STUDIES

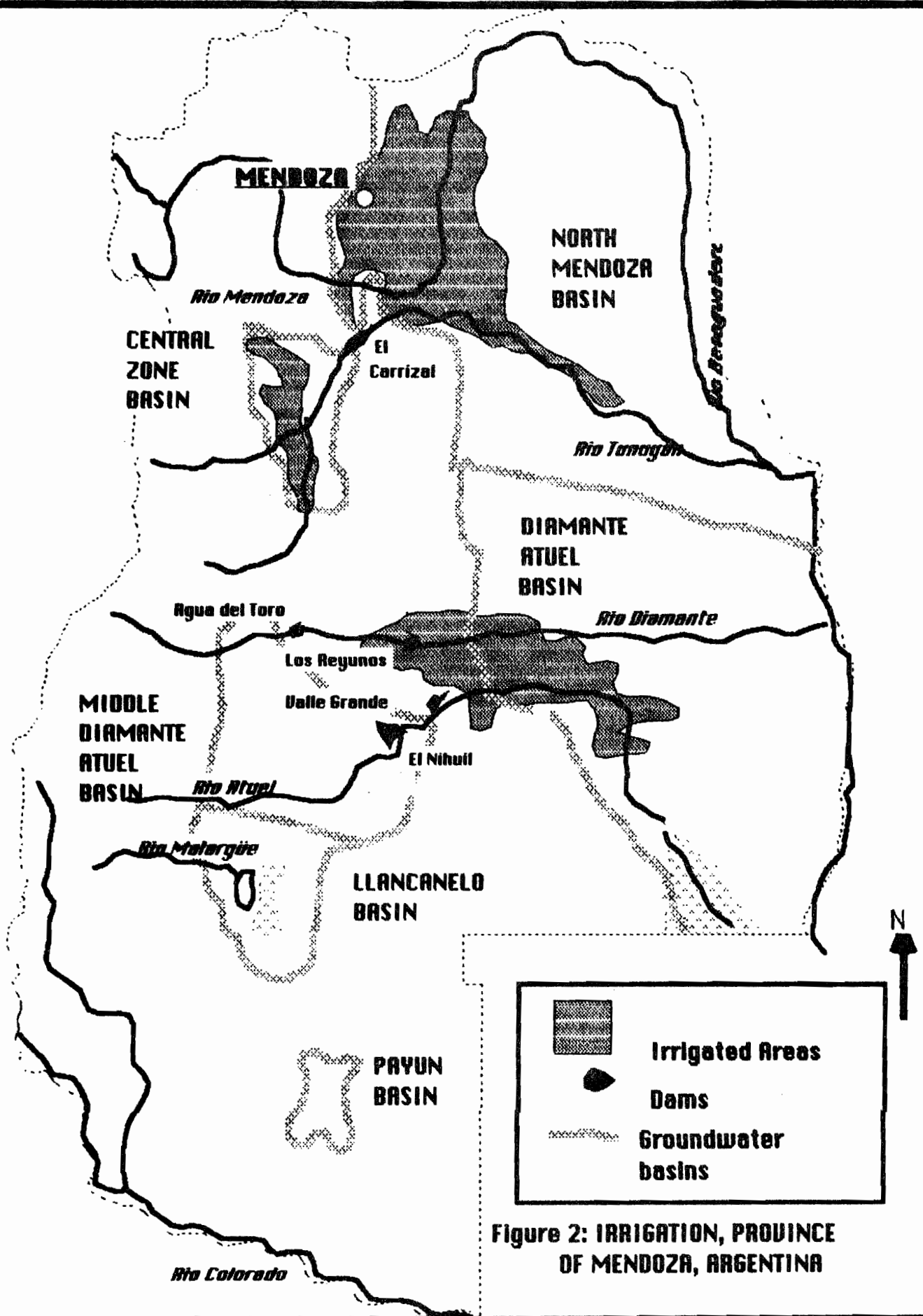
The case studies were designed so as to bring into focus the general appreciation of water management issues which lies behind this study. The analysis to be presented is based on the evidence provided through the case studies. These were chosen to be representative but, obviously, they are not an exhaustive selection of the water management situations extant in the region. The cases show marked differences in the water resources systems that are being managed, in the form of administration and the type of institutions active in management, in the constraints faced, in what are considered the most significant current problems but there is a commonality in the general recognition that a crisis has been reached in management. The management of water systems has failed to adjust to the demands being placed upon it and there is a general need for the improvement of the management of water systems.

1. Irrigation in the Province of Mendoza, Argentina 9/

The development of irrigation in Mendoza constitutes without doubt one of the most interesting water management case histories in Latin America and the Caribbean. It was the earliest example, in modern times of the deliberate use of the water resource to achieve general economic and social development in Latin America. The original legislation governing irrigation, and water use in general, in the province was a model in its time and established a very particular and successful mix between public and private responsibility for water management. The result was the creation of an irrigation based society in Mendoza with a very profitable agriculture, as its core, centred on the production of wine.

(a) The nature of irrigation in Mendoza

The irrigated areas of Mendoza are oases in an arid region. The annual rainfall is never greater than 200 mm. and in most areas less. The major irrigated areas are located on the Rio Mendoza and the Rio Tunuyan in the north of the province and on the Rio Diamante and Rio Atuel further south (Figure 2). All four rivers are tributaries of the Rio Desaguadero which does not reach the sea.



The irrigation systems vary between the three areas. Those in the north and centre are without regulatory structures. In the more southerly irrigation areas there is an elaborate system of regulation with a series of hydroelectric dams and compensatory structures to ensure the irrigation supply. It is estimated that there are some 3 000 kilometers of canals serving more than 500 000 hectares, not all of which is under cultivation at the present time (Table 1). In recent years, particularly around the city of Mendoza, a considerable number of canals are now within the urban area.

In the last twenty years the supply of water from superficial sources has been augmented through the extensive use of groundwater. The expansion in the number of wells reached a peak around 1970 and occurred with very little public control although with considerable public support (Figure 3).^{10/} More recently, with higher river flows than the long term average and with a significant decline in the area under irrigation, the use of groundwater has declined and a large number of wells are out of use.^{11/}

(b) The development of irrigation

Agriculture in Mendoza is based on the production of grapes for wine. At the present time this accounts for around 75% of the total value of agricultural production. This dominance of grapes for wine is, however, a phenomena of this century. The original development of the region was based on the production of forage and grain crops for the feeding of livestock and export to Chile. This changed at the end of the nineteenth century with the construction of the railway linking Mendoza to Buenos Aires. The railway not only brought new markets but also mass immigration.

The expansion of irrigation was coupled with change in the structure of agriculture which led to the increasing domination of the production of wine for the growing domestic market. By 1930, the present agricultural structure had been established and the availability of water for irrigation began to be the most important restriction on further growth.

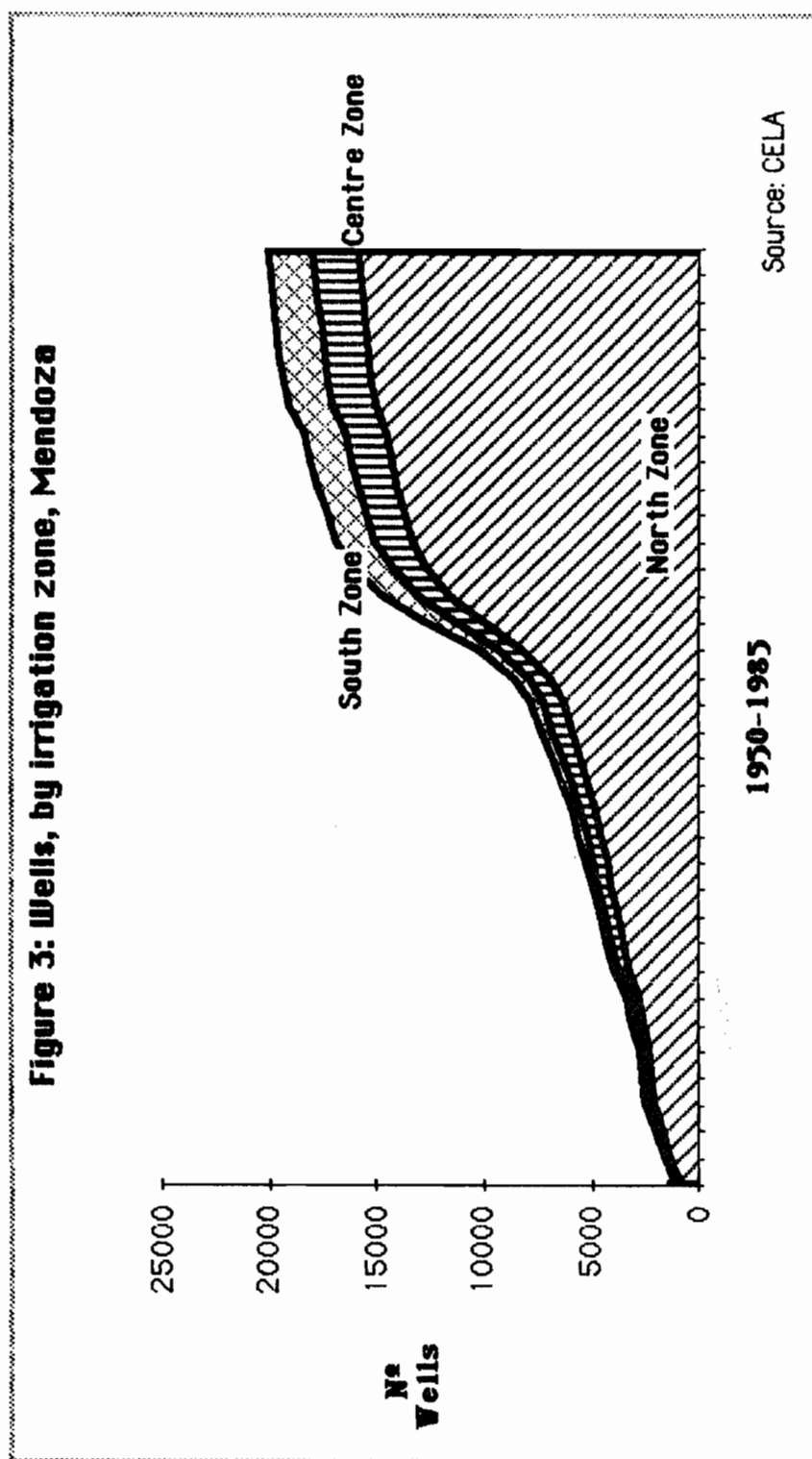
The third period from 1930 through to the early 1970's the pressure on the water resource was alleviated by the increasing use of groundwater. In the northern most irrigated zone, around the city of Mendoza, there was increasing competition from other water uses. In the southern zone, the supply was also augmented by the building of regulatory structures as part of

Table 1 : Province of Mendoza, Irrigated Areas

Zone	Cultivated Area, 1974 (Has)	Cultivated* Area, 1985 (Has)	Area with Irrigation Rights (Has)	Length of Canal (Km)
North	197.201	183.701	198.088	1152
Centre	62.746	42.866	37.629	383
South	107.181	79.712	287.487	731
Total	367.128	306.389	523.204	2266

Source: CELA

* estimate



the development of hydro-electric generating systems by the national government.

Throughout this period from the coming of the railway to the early 1970's the development model upon which the water using system was built led to sustained economic growth and the generation of high regional incomes. Naturally, there were periods of recession but growth was always resumed. In the last 15 years, however, the model has failed as its base, the domestic demand for wine, has declined due to both the continuing crisis in the Argentinean economy which has led to lower incomes and a change in consumer habits to a substitution of wine with beer and soft drinks. The importance of agriculture in the regional economy has suffered secular decline (Figure 4).

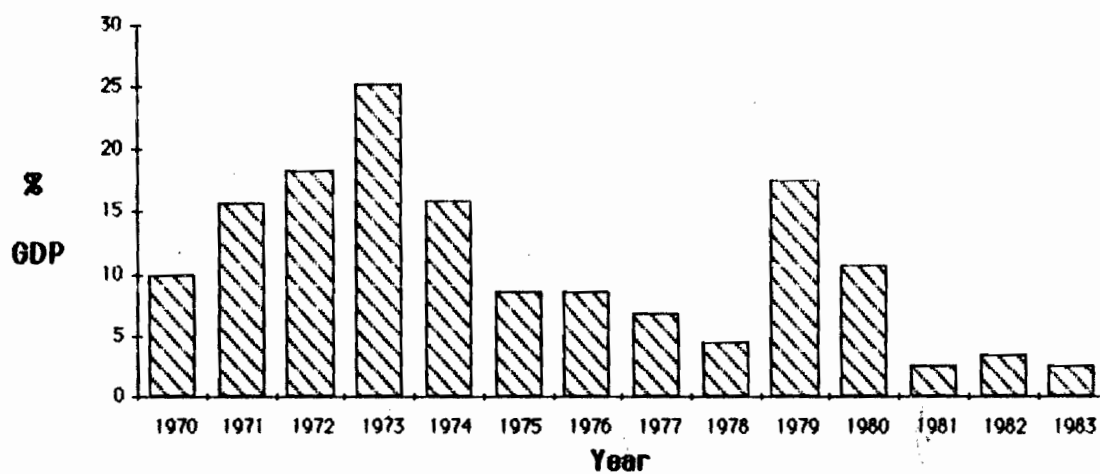
(c) The administration of water

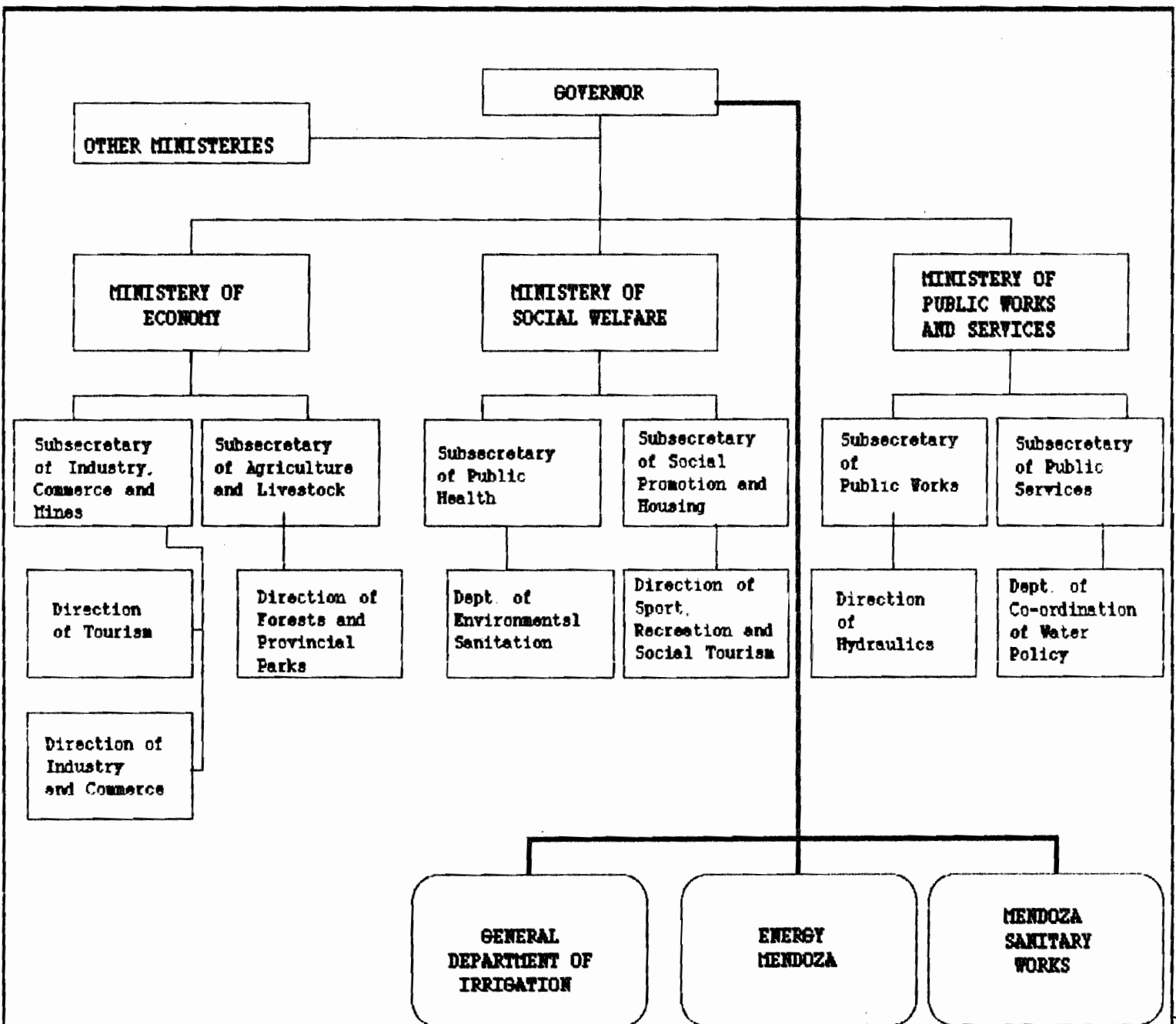
Constitutionally, the administration of the water resource in Argentina lies under the responsibility of the provincial governments. In the case of the Province of Mendoza, the provincial government using this constitutional facility has dominated the management of water in the province despite a national tendency to centralization for most of the last half century. It has done so through a very particular system for the administration of water.

Superficially, the water management system in Mendoza is apparently similar to that found elsewhere in Argentina, and in Latin America and the Caribbean. A diffuse set of bureaucratic institutions within the provincial government with partial and overlapping responsibilities together with the added complication of a similar set of agencies acting within the province from the national, federal, government (Figure 5). In fact, the management of water has been dominated by two complementary institutions, the Departamento General de Irrigación (DGI) and the Inspecciones de Cauce. It is these two institutions, with strong user participation that have dominated the management of water in the province despite the limitation of their formal roles to the supply of water for irrigation. The DGI is responsible for the complex of works which include the river, the diversion structures and the main canals and more recently, groundwater basins while the Inspecciones de Cauce are responsible for the secondary irrigation network.

The two institutions are inter-related but independent and occupy a very special constitutional position within the province. They are autonomous

Figure 4 : Contribution of Agriculture to Gross Domestic Product, Mendoza, 1970 - 1983





Source: CELA

Figure 5: Province of Mendoza, Organization Chart of Institutions Involved in Water Management

and raise their own revenues. The DGI is managed by an Administrative Tribunal and a Superintendent, responsible for day to day administration, appointed directly by the governor of the province with the approval of the Senate. The decisions taken by the Superintendent can be appealed to an Appeal Council, the Tribunal minus the Superintendent, and from there directly to the provincial supreme court. The members of the Administrative Tribunal are representatives of the different irrigation regions and are chosen from farmers, normally from the Inspecciones de Cauce.

The Inspecciones de Cauce, of which there more than 700, are managed by elected representatives of the farmers of each cauce and are responsible for the operation and maintenance of the secondary irrigation network. They are also the judge, of first recourse, for the resolution of conflicts. The inspector is assisted by delegates when the number of farmers so warrants. All these positions are honorary. The Inspecciones de Cauce have their own budget but it must be approved by the Administrative Tribunal along with that of the DGI.

The other water uses in the province are all secondary to the use of water for irrigation and there has not prospered, as yet, any proposal for institutional change towards more integrated water management. Recent modifications in national policy through decentralization of institutions responsible for drinking water supply and sanitation and for hydro-electricity to the provinces will, perhaps, change the possibility of greater integration in management. The autonomy of the major use organizations would suggest, however, that many obstacles remain.

(d) The effectiveness of management within the DGI

The DGI is one of the oldest water management institutions in Latin America and the Caribbean. In general terms, the DGI has been and remains a successful institution but it shows signs of its age and of problems of adjustment to changing circumstances. The success of the DGI has undeniably been linked very closely to the success of the economic model applied in the province, the production of wine, primarily, and fruit, to a secondary extent for the domestic market. This has allowed the DGI to develop a strong base, an institutional position and role that permits it to meet periods, such as

the present, when a strong challenge is provided to the basis of Mendoza's irrigation society.

The DGI is only responsible for the supply of water. It has no competence over the use of water within the farm. It suffers a reduction of its income when farm production is depressed. Institutionally, it is an agent of the water users although for major works income is derived from general government revenues. The current depression in the wine industry and changes in its structure, with a considerable transfer of income from producers to distributors, has considerably reduced the income of the DGI. This in turn has affected its capacity to improve the efficiency of the captation and distribution of irrigation water.

Since 1974, the DGI has been given the added responsibility of regulating the use of groundwater. Institutionally, however, this added task has not been absorbed. The use of groundwater remains fundamentally uncontrolled and there is a lack of knowledge of the extent of the resource, its quality, the effects of exploitation and of actual use.^{12/} Less than 1% of the staff of the DGI are employed in the administration of groundwater. The proportion has not changed since the formal responsibility for groundwater was assigned.

The slowness of the response of the DGI to the addition of groundwater to its area of institutional concern is symptomatic of a wider problem of adaptation to changing circumstance. There are a number of areas of management of irrigation where reform appears to be relatively urgently required without entering into questions related to wider aspects of water management. The areas requiring reform include, at least,

- (i) the basic legal structure;
- (ii) the system of information;
- (iii) the budgetary and tariff system, and
- (iv) the organizational structure.

Under the constitution and the water law of the province of Mendoza, there are considerable rigidities in the concession of water rights established originally to give clear water rights which now act as barriers to the maximum productive use of water both among and within farms. The water right is assigned to a specific piece of land and in a specific amount which is charged whether used or not. The impact of this on the efficiency of water use has been aggravated by the failure of the DGI to use its authority over

groundwater. The DGI has no policy for the joint use of surface and groundwater.

Similarly, the system of information on water users has become with time an obstacle to efficient management. It is maintained by hand and possesses multiple registrars which are not integrated. For example, there are separate registers of superficial and groundwater use. In its present form it cannot be used as a management tool to achieve greater efficiency in total water use.

The budgetary system used in the DGI and the Inspecciones de Cauce are not compatible. The budget of the DGI permits the identification of the inputs, in terms of staff, equipment, services etc., but not the output. The budgets of the Inspecciones de Cauce are very variable and many do not prepare formal budgets so that the total relationship between expenditures and the results obtained cannot be seen. The budget, as it stands, does not permit measurement of the efficiency of the DGI, either overall or of its various parts, neither does it permit a rational discussion of the size and direction of expenses or comparison of the costs of different alternatives of expenditure. In general, the absence of controls on operations through the budgetary process means that other more bureaucratic controls have to be placed on operations which hamper activities and render them inefficient.

These characteristics of the budgetary system are coupled with a tariff system which gives the tariff the nature of a tax rather than a price. This extends to the farmer the lack of relationship between expenditures and output and reinforces the inefficiency in the water management system. The tariff is paid on the basis of the extension of a water right not whether the right is exercised or not. There is no incentive in the tariff system for the user to increase the efficiency of water use on the farm.

Finally, and most importantly, the whole administrative system has become inadequate in the face of the changes which have occurred in the demand for water and the wider regional economy. The basis of the institutions for water management in Mendoza was widespread user participation. The subdivision of agricultural holding has led, however, to a considerable dilution of the degree of participation as the number of users within individual inspecciones has grown. The growth of other water uses, especially the transport of urban and industrial wastes has considerably complicated the nature of water management in Mendoza and neither the

Inspecciones de Cauce or the DGI are structured to cope with this problem and other institutions have not been created. The management of groundwater remains unresolved despite the modifications to the water law in the mid-seventies and is an added management complication which has adversely affected interest in participation in the institutional system.

The DGI despite its impressive record has not adjusted to the contemporary challenge of the changing circumstances of water management in Mendoza. Its very success as an institution stands in the way of change from outside. There is a need to manage all water uses, to better integrate the management of superficial sources and groundwater within irrigation, to increase the resources dedicated to soil conservation and recuperation,^{13/} and the management of water pollution remains unresolved. This last issue may not directly be the responsibility of the DGI but, as an institution, it has not incorporated the consideration of the impact of pollution on irrigation into its strategies or considered how the issue might be best handled from its viewpoint.

2. Water management and regional development in the Rio Bogotá Valley, Colombia ^{14/}

In contrast with the other case studies, the water system of the Rio Bogota is not dominated by the use of water for irrigation. It is the city of Bogota which places the most significant demands on the water resource for public water supply, the generation of electrical energy and the transport and dilution of domestic and industrial wastes. There is, however, an important secondary use of water for irrigation. The character of the institutions responsible for the management of the water resource also distinguish this case study from the others. The central water management institution is, potentially, a river basin authority and the intervention of other institutions in water management is secondary to the actions of the authority, the Regional Development Corporation for the Sabana of Bogota and of the Ubaté and Suarez Valleys (CAR).^{15/}

(a) The Bogota water system

The Rio Bogota rises at some 3 400 m in the Cordillera Oriental of Colombia and enters the Rio Magdalena, after a course of 270 kms, at 280 m of

altitude. Its drainage basin, of 5 996 km², divides into two unequal and contrasting parts. The larger upper basin, 4 305 km², is the Sabana of Bogota where the city of Bogota is located and it has a relatively temperate climate with a moderate to heavy rainfall. The smaller lower part of the basin has a humid tropical climate. The Bogota water system extends beyond the drainage basin of the Rio Bogota to include adjacent high valleys from which water is diverted to the Bogota basin. The Chingaza project, a diversion from the river Guatiquia is already in operation and a similar diversion is contemplated from the area of Sumapaz to the southeast (Figure 6).

These diversions are the latest additions to an existing complex water system which consists of various control and diversion structures within the basin mainly concentrated in the upper part. The total storage within the Rio Bogota basin is some 1 168.1 million m³, of which 226.2 million m³ correspond to the Chuza reservoir on the river Guatiquia. The most important control structures are the sluices at Achury, Espino and Alicachin. The first is the major source of Bogota's public water supply while from the others water is pumped to reservoirs for subsequent generation of hydro-electricity.

The major uses of the Rio Bogota water system are for drinking and industrial water supply for the city of Bogota, the system has a capacity of 27.66 m³/sec from various sources, for the generation of electricity, with a total installed capacity within the water system of 559.7 mW, for the transport and dilution of domestic and industrial wastes, with only limited treatment prior to discharge, and for irrigation.

Most use is concentrated in the upper basin. The water supply for Bogota and the irrigation diversions are made upstream of the city. The main sewerage discharges occur as the river passes the city and slightly further downstream. Only hydro-electricity generation occurs on a large scale outside the upper basin, the main generating stations are located parallel to the Tequendama falls between the upper and lower basins. The lower basin is largely agricultural and places no major demands on the river.^{16/} There is some use of the river for irrigation in the lower basin but only 6 069 hectares are under irrigation here compared with 30 600 hectares in the upper basin.

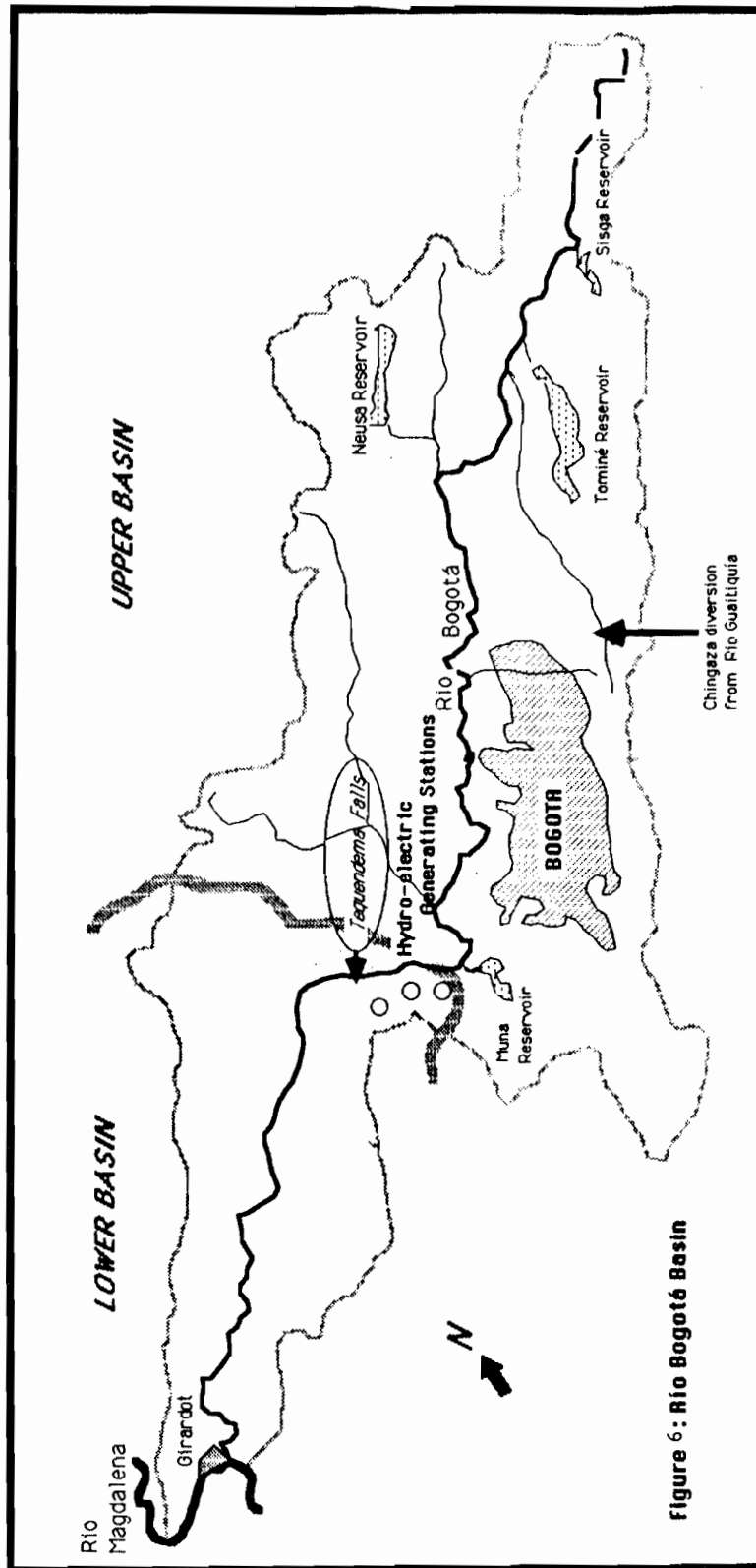


Figure 6: Rio Bogotá Basin

(b) The water management system

Few public agencies intervene in water management in the Bogota Valley, unlike the situation in other cases included in this study and generally in Latin America and the Caribbean, even more unusually there is one agency which has responsibility for integrated resource management, the regional development corporation, the CAR.

The CAR was formed in 1961 for the purpose of promoting economic development in the upper part of the valley of the Rio Bogota. Amongst the responsibilities assigned was that for the management of renewable resources. This responsibility was taken away in 1968 when the National Institute for Natural Resource Development (INDERENA) was created. Ten years later, in 1978, further administrative modifications led to the reassignment of responsibility for the management of renewable resources to the regional development corporations, including the CAR.^{17/}

The prime responsibility of the CAR is the promotion of the economic development of the region under its jurisdiction, recently extended to include the whole of the Rio Bogota basin.^{18/} It does also have, however, the function of administering, on behalf of the nation, all waters in public use. To this end the CAR has authority to grant concessions, to regulate, and, if necessary, to suspend the use of all surface and groundwaters within its region of authority. This authority includes all diversions, the concession of rights for hydro-electricity and responsibility for watershed management.

The major users of water are the Bogota Water Supply and Sewerage Company (EAAB) and the Bogota Electric Company (EEEB). Both companies are owned by the municipality of Bogota, the Special District of Bogota. The municipal ownership of the two major user agencies together with the participation of the mayor of Bogota, the president of both companies, on the board of directors of the CAR signifies a relatively auspicious environment for inter-institutional co-operation and co-ordination.

There is, however, only a restricted formal system of co-ordination between the CAR and these two major user agencies. The three institutions have formed the Co-ordinating Committee for the Río Bogota, Ubaté and Suarez. This committee, originally established in 1967, has as its prime function the integrated management of the reservoirs of the Bogota water system but it

also considers and makes recommendations on studies and works to improve the use of the water resource, including channel straightening and dredging and specific proposals for new reservoirs, as well as recommendations on hydrographic surveys and watershed conservation measures. The committee meets twice a month.

The two municipal companies co-ordinate, to a certain degree, their activities directly between themselves. The influence of other agencies within the municipal government over the two companies is, however, very limited due to their size and power.

Within the national government, the National Planning Department, has responsibility over both the regional development corporations and the activities of electricity supply and water supply companies. It can, therefore, intervene to achieve co-ordination between the three institutions, the CAR, EAAB and EEEB, particularly when major projects are under consideration.

An interesting and important characteristic of the CAR is the possession of its own income from a special tax on property equivalent to 2.1/2 thousands of the assessed value. The income from this tax has increased in the last few years and in 1985 was 90% of the total income of the CAR (Figure 7). In general, the CAR devotes the bulk of its income to investments, mainly in public works within the municipalities of the region but a third, on average, have been related to water management and pollution control.

The administrative structure of the CAR provides for a Board of Directors and an Executive Director. The former represent different local and national interests while the latter is appointed directly by the President. Internally, the CAR is organized in three subdivisions, administration, operations and technical (Figure 7). In addition there exist three offices which report directly to the Executive Director, including the Planning Office.

(c) The effectiveness of management in the Bogota water system

In comparative terms, the management of the Bogota embodies a series of innovative features which could be applied with benefit elsewhere in Latin America and the Caribbean. The system does show, however, some areas in which

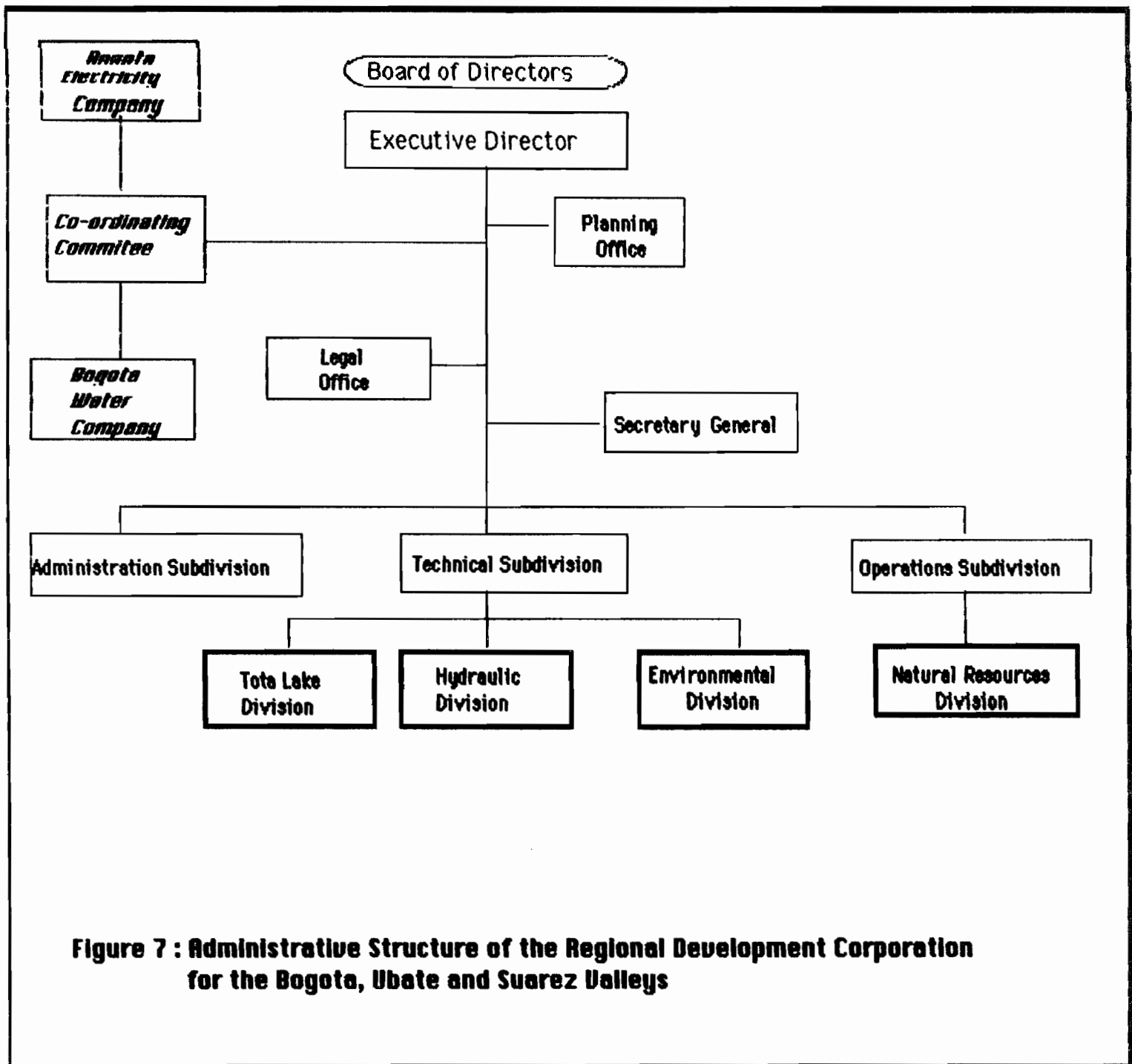


Figure 7 : Administrative Structure of the Regional Development Corporation for the Bogota, Ubaté and Suárez Valleys

improvement could be made. The most critical areas appear to be the following,

- (i) the effectiveness of the CAR as a management institution;
- (ii) the interrelationship between the CAR and the major water users;
- (iii) the degree of efficiency in the overall management of the water system.

The effectiveness of the CAR in the practical aspects of resource management, belie to some extent the authority which it formally possesses. Reasons for the apparent failure to assert authority over the other actors in the water resource management area, for example the delays in the preparation and publication of a regional development plan, appear to be partly due to internal inefficiencies. More important, however, may be its intermediate position between the centres of political authority in Colombia, the central government and the large municipalities, in this case, Bogotá.

It has been recognized by the CAR that modifications are required to its internal administrative structure. Unfortunately, the proposals that have been made have not been implemented due to the change in government in Colombia. The present structure of the CAR results in a considerable fragmentation of activities, noticeably those activities related to the planning and co-ordination of resource management, in general and to water management, in particular (Figure 8). The present assignment of responsibilities between the operations and technical subdivisions seems to have no particular rationale and there is an argument for a reorganization to better reflect the difference between operations and planning.

In establishing the policy for water resource development and management the CAR does not take full advantage of its position as the regulator of water use. For example, the Hydrologic Committee is limited to the consideration of only ongoing routine management issues related to the existing reservoirs in the valley. It does not have the resources to achieve more than this and has not been treated by the CAR as an occasion for establishing its authority in regard to the EAAB and the EEEB. To the contrary, on the committee the CAR has tended to act as the representative of just another water use, irrigation, as the Irrigation District has no direct access to the committee. This has led to the Committee being used to resolve temporary differences of opinion about the allocation

Figure 8: CAR Income & Expenditure, 1985

EXPENDITURES = \$2244 millions

Investment
External Debt Service
Domestic Debt Service
Transfers
General Expenditures
Personnel

INCOME = \$2180 millions

Investment Income
Balance of Resources
Internal Credit
Other Income
Taxes
Government
Other Sales
Sales of Services
Licences

-2000 -1500 -1000 -500 0 500 1000 1500

**Colombian Pesos
(millions)**



of the resource rather than the instance for more widely based and longer term water management.

Part of the institutional difficulty of the CAR in relation to the EAAB and the EEEB can be explained through the difficulties facing the CAR in attracting qualified personnel. The salary scale of the CAR is approximately 53% lower than that of the EEEB and a similar discrepancy exists with the EAAB.^{19/} The differences in salary levels considerably affect the effectiveness of the CAR as a management institution and prevents it developing a strong staff of the kind required for the senior management institution.

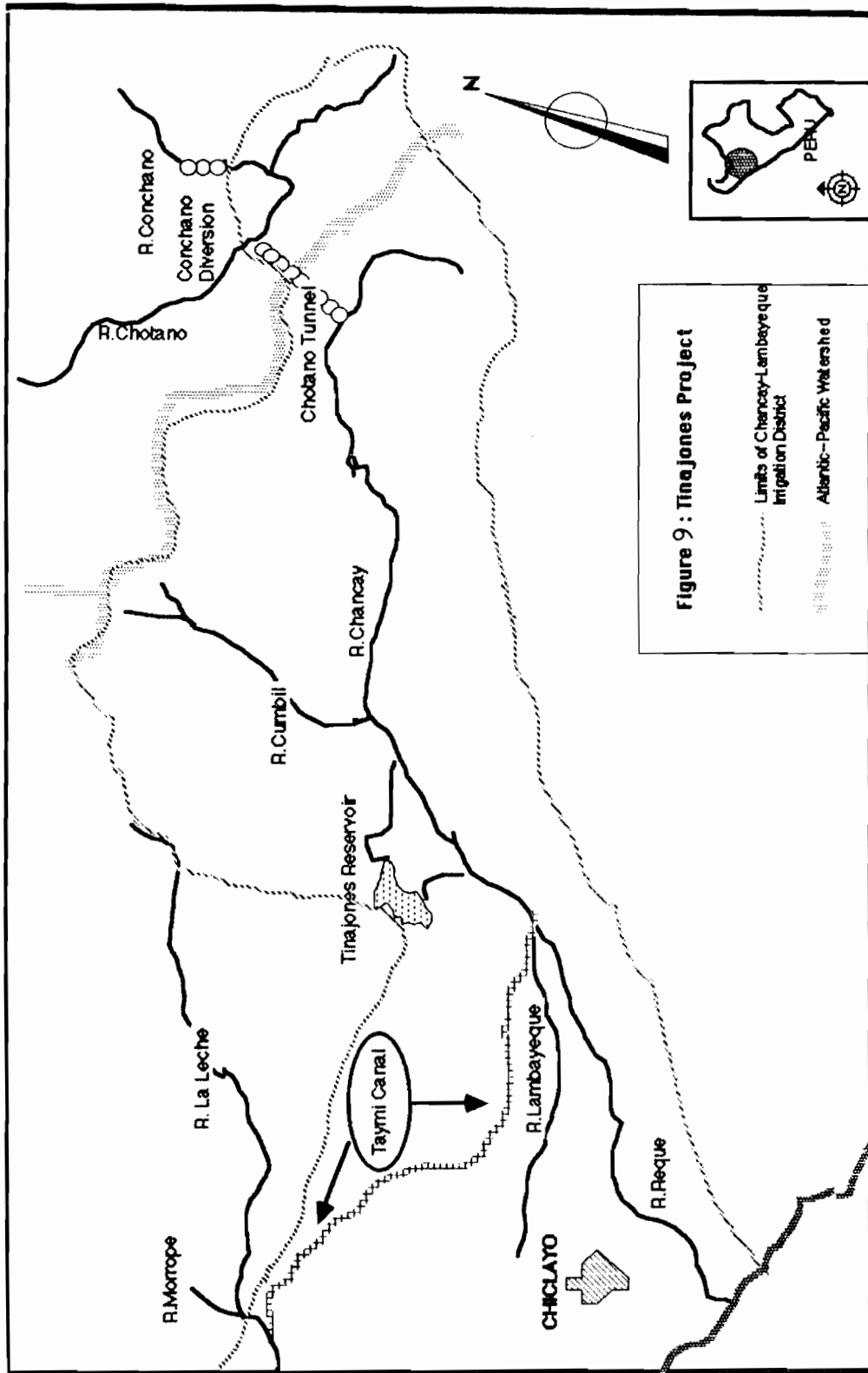
Despite what appears to be the existence of an appropriate institutional structure for integrated water management within the Bogota water system, little has really been achieved in this respect. The major sign of this has perhaps been the failure of the existing management system to react in any coherent form to the water quality problem. This is not to claim that action has not been taken. Both the CAR and the EAAB intervene actively in water quality management but there is an absence of a system wide approach to the issue. Similarly, the use of water for irrigation, in potential conflict with energy production downstream due to evapotranspiration losses, is not being discussed and considered within a system context.

3. The Tinajones irrigation project, Lambayeque, Peru ^{20/}

The Tinajones irrigation project is one of the most important in Peru. It is located in Northern Peru on the Pacific Coast in the basin of the rivers Chancay and Reque (Figure 9). The irrigated area covers some 97000 hectares, equivalent to 12.8% of the total area irrigated in the coastal region of Peru. In the years between 1970-1979, the project area produced from 27% to 35% of the total national production of sugar and from 15% to 32% of the total national production of rice, as well as important quantities of cotton, beans and corn.

(a) The Tinajones project

The present Tinajones project was built between 1965 and 1980 and only represents part of the works envisaged in the original project proposal. Irrigation in the Chancay-Lambayeque Valley is much older, however, than the



construction of the modern project. Irrigation flourished before the Spanish Conquest and many of the pre-Colombian works were abandoned although irrigation continued throughout the colonial period. More recently various projects have been executed to improve irrigation in the valley of which the present Tinajones project is the last and by far the most ambitious. The project consists of both the construction of new works and the reconstruction and modification of existing works.

The project is made up of a series of works for the capture, diversion and storage of water (Figure 9). The most important include tunnels to transfer water from the rivers Conchano and Chotano, which drain to the Atlantic, to the river Chancay; from the Chancay water is diverted along a 16 km canal with a capacity of 70 m³/sec to a lateral reservoir, Tinajones, and from the reservoir another canal leads the water back to the Chancay. This water is then distributed, in part directly and in part by a series of canals from the Chancay and the Reque for irrigation. The most important canals are the Lambayeque and the Taymi serving 26% and 37% of the cultivated areas respectively. There is a complementary but uncompleted drainage system. The project is not finished and a second stage remains to be built which will involve more transfers from the Atlantic watershed, additional reservoirs as well as improvements in the distribution system.

Agriculture in the area of the project is dominated by 40 large farms which since the agrarian reform of 1969 have been in the hands of empresas asociativas but almost 30% of the cultivated area is in small farms. Medium-sized farms and minifundios are of lesser significance although the latter account for over half the total number of farms (Table 2). The most important products are rice and sugar (Table 3). The production of sugar is concentrated in four agricultural-industrial complexes but the production of rice and other crops is diffused through the whole irrigated area to an extent which considerably complicates water management.

(b) The administration of the project and the water resource

The administration of the Tinajones project and the water resource of the Chancay-Lambayeque valley has undergone continuous change and reform during most of the period in which the present water system was constructed and put into operation. During the whole period of the project, however,

Table 2 : Number, Size and Holding System of Farms, Tinajones Project
(1976)

Size (Hectares)	Number	Percentage	Area (Hectares)	Percentage
less than 3	10846	55.8	16334	9.1
3 - 15	7994	41.2	53015	29.6
15 - 50	386	2.0	9794	5.5
more than 50	116	0.6	10196	5.7
sub-total individuals	19342	96.4	89339	49.9
Asociativas	80	0.4	89860	50.1
Total	19422		179199	

Table 3: Main Crops, Area and Yield, Tinajones Project
(Average 1970—1979)

Crop	Area Harvested ('000's Ha.)	Yield ('000's tons)	Tons per Hectare
Rice	23.8	117.6	4.9
Sugar Cane	17.1	284.6	16.7
Beans	6.7	4.1	0.6
Corn	4.6	12.0	2.6
Cotton	4.0	5.8	1.5
Total including others	66.5	424.1	n/a

there has existed a clear distinction between the management of the project and of the management of the irrigation system which the project serves.

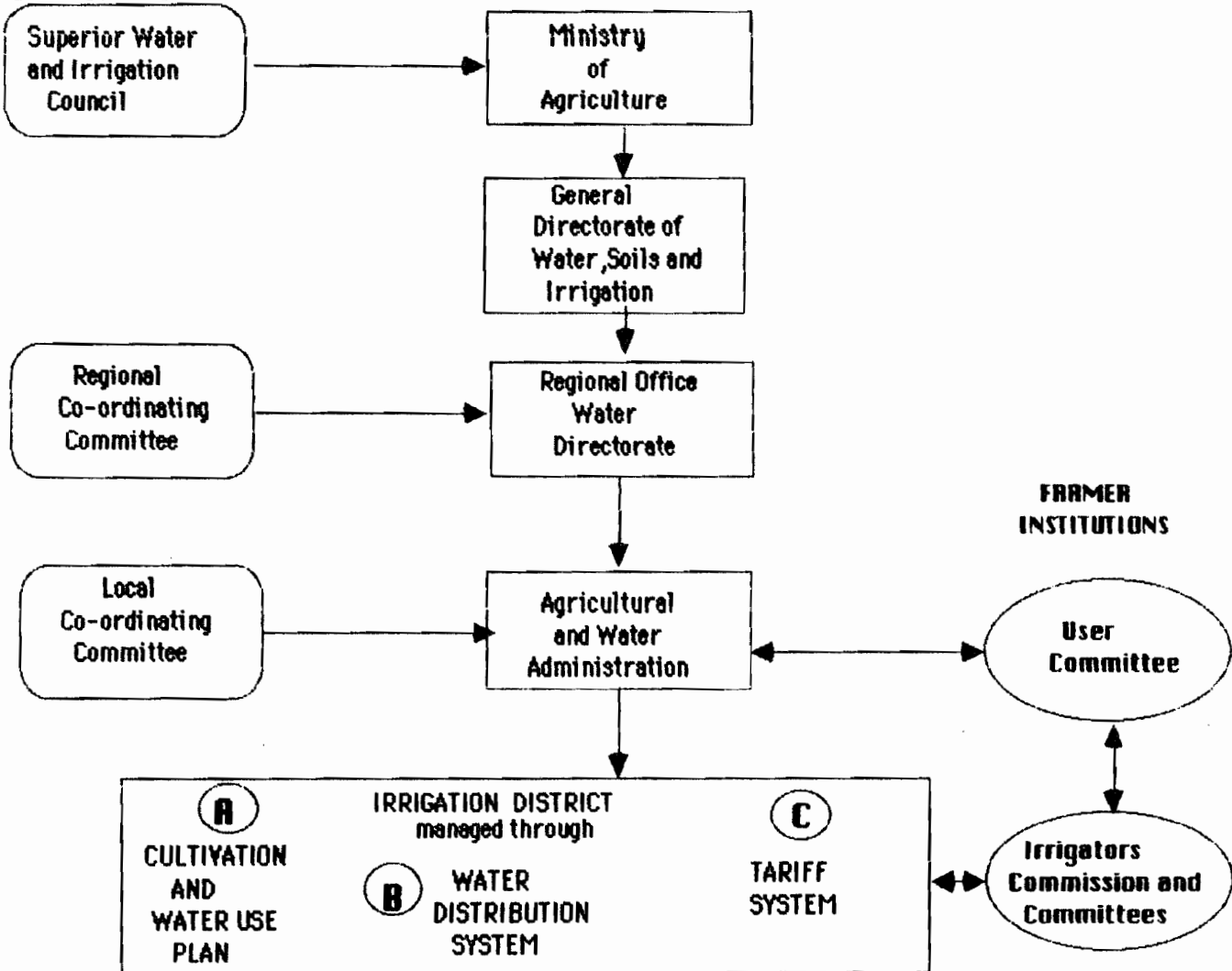
At the time that the current Tinajones project was initiated an autonomous project authority was established, the Executive Commission for the Tinajones Project (CEPTI), under the Ministerio de Fomento y Obras Públicas.^{21/} CEPTI consisted of two parts, one responsible for the construction of the project and the other, the Administrative Council, responsible for the development of irrigation. The latter did not function well and the CEPTI assumed total responsibility which led to a relative neglect of the wider aspects of water management and a concentration on construction alone.

This situation persisted from 1965 until the agrarian reform of 1969. With the agrarian reform the CEPTI became part of the new Ministerio de Agricultura y Alimentación under the Dirección General de Aguas e Irrigación. These reforms and the loss of autonomy considerably slowed down progress on the project until a further reform in 1973 re-established the autonomy of the project management within the Ministerio de Agricultura.^{22/} The new autonomous project management authority was restricted to authority over the construction of works. The broader aspects of water management were the responsibility of the Dirección General de Aguas e Irrigación and the II Agrarian Region.

In 1982, further changes occurred with the creation of a new project authority, within the regional development agency, formed from representatives of the President, the Lambayeque development corporation and users of the irrigation district. This authority reports directly to an authority for autonomous corporations within the cabinet.

The successive changes in the project authority have been paralleled by change in the general policies adopted towards irrigation and water management. The major innovations in these areas occurred with the agrarian reform, which among other changes, nationalized water rights, established the obligation that all water users pay for the water used on a volumetric basis, created the irrigation district as the basic unit for the administration and distribution of water with a responsibility to formulate a plan for cultivation and irrigation, and created the necessity for all water users to obtain a licence. The system of administration for the Chancay-Lambayeque district is typical of that now prevalent in Peru (Figure 10).

INTER-MINISTERIAL CO-ORDINATION



**FIGURE 10 : Water Management Institutions and Mechanisms,
Tinajones Project**

The Tinajones project lies within the Chancay-Lambayeque irrigation district. The district is divided into sub-districts, the regulated irrigation district Chancay-Lambayeque, in the lower valley and served by the project, and the unregulated irrigation sub-district, in the upper valley. Each water user is registered by the district as to the location of the land, the water right and the area to be irrigated. The registered users are organized by district and sub-district of irrigation into juntas de usuarios (user committees) which include delegates from all users of water, both irrigation and non-irrigation users. These committees are responsible for the representation of user to the water authority, for the co-ordination of all actions for the development of the water resource, the maintenance of the irrigation network, the establishment and collection of tariffs and other activities.

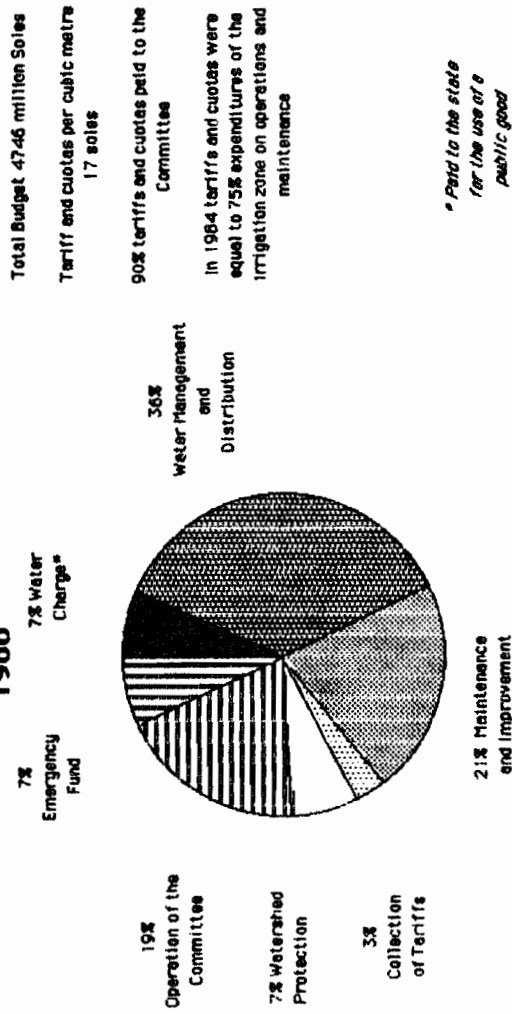
In turn the irrigation users are organized into Comisiones de Regantes established at the irrigation sector or sub-sector level. The board of directors of the commission consists of representatives of the empresas agrícolas asociativas, the campesino communities, and the medium and small farmers. Within the commission in turn there are Comités de Regantes which nominate delegates to the commission. These last two form one institution, the committees have no resources of their own, responsible for the basic community and individual participation in the management of the irrigation district, including the maintenance of the on-farm and related canal systems.

The basis of the management of the irrigation district is the plan of cultivation and irrigation by means of which the administrator, in discussions with the juntas attempts, not very successfully, to reconcile the demand for and supply of water. Once this reconciliation is achieved then the supply of water should be controlled through the sub-sectors, user by user.

The maintenance of the system of irrigation is the responsibility of the Junta de Usuarios but some of the major works, the Tinajones reservoir, are maintained directly by the project and district administration. The maintenance of the secondary system corresponds to the Comisiones de Regantes.

The financing of the maintenance and operation of the irrigation district is obtained in part from the Ministry of Agriculture, mainly the salaries of the staff of the irrigation district, in part from the project authority and in part from user tariffs and quotas (Figure 11).^{23/} As in

Figure 11 : Water User Committee Budget 1986



other areas of administration, the means of financing have been modified on numerous occasions. Since 1981, however, emphasis has been placed on the tariff collected through the Junta de Usuarios as the main means of meeting operation and maintenance costs of the secondary distribution system. The amounts collected have not met these costs although the relation between costs and tariffs has been improving.^{24/}

(c) The effectiveness of management within the Tinajones project

The first stage of the Tinajones project will be declared completed when the drainage systems for the Valle Nuevo, the area to the north-east of the town of Lambayeque, are completed in 1987. It can be said that, although there are successful aspects to the project, there is evidence to support a critical view of the effectiveness and efficiency of the overall management of the water system which encompasses the project.

In examining the record of water management since the inauguration of the construction of the project the following comments can be made,

- (i) there have been considerable deviations from the original conception of the project;
- (ii) slowness in the execution of the project, and
- (iii) inconsistencies in both the project and the water system between the activities planned and the activities executed.

These characteristics of the management of the construction project have had a considerable impact on the evolution of the management of the water system as a whole. For example, the project, as originally conceived, included not only the construction of the reservoir and associated works, but also the remodelling of the secondary irrigation system. This has not been done with the exception of one area and resulting in considerable inefficiencies in the distribution of water and to uncontrolled growth of the irrigated area. Similarly, the slowness of the construction process produced a considerable delay in the building of drainage systems. The lack of drainage systems has been an important contributing factor to the salinization of much of the land.^{25/}

The division of responsibilities within the water system on the one hand for the management of the project and on the other for the use of water has led to large inconsistencies in the taking of decisions. To take only

one example, the project was originally planned to serve only 68 000 hectares but there are now nearly 100 000 hectares actually irrigated. This expansion has led to the use of water in areas not included within the project boundaries and outside the region subject to management. It has been one of the contributing factors to the failure of the use of the Plan for Cultivation and Irrigation as the major management tool for the operation of the water system.

The division of responsibilities has created a weak system management much subject to outside interference and influence from all levels. There is in reality a lack of control of farmer behaviour but equally management has been passive to the imposition of the policies of other government institutions which have a negative impact of the efficiency of the system. Rice has become the dominant crop in the Chancay-Lambayeque Valley largely as a result of the National Rice Programme. The Plan for Cultivation adopted for the project foresaw some 20 000 hectares under rice cultivation. In fact there has been more than twice this area under rice in most years which places very high demands on the supply of water. The expansion was possible, in part, due to a succession of humid years. A set of events that cannot be expected to continue.

The water management system in the Chancay-Lambayeque Valley has continuously suffered from severe financial restrictions. This contributed greatly to the slowness of the construction of the project despite the support received from the Federal Republic of Germany.^{26/} More recently, the lack of financial resources has contributed to the inefficiency of operations and maintenance. There is evidence, however, that this problem may be on way to resolution as the role of the user associations strengthens.

The total sum of the management difficulties of the Chancay-Lambayeque system are a synergistic result of a whole series of actions and failures of actions. There is far more than one cause or one solution to the present situation which is of a water system out of management control. It is not the case that the system is a failure. In many areas it is a success but it is not as yet a water system under control.

4. Water management in the Valley of the Rio Limari, Chile 27/

Water management in Chile has undergone a series of reforms in recent years directed towards increasing the role of the private sector in management which somewhat mark off that country from the rest of the region. The case study of the Rio Limari has been made therefore within the context of relatively detailed review of the evolution of water management policies in Chile. The Rio Limari has been developed in recent years largely for irrigation and the basin is one of the few in Chile with extensive storage structures built specifically to supply irrigation agriculture. There are other demands on the water resources of the basin but they are very much secondary to irrigation.

(a) Water use in the Rio Limari Valley

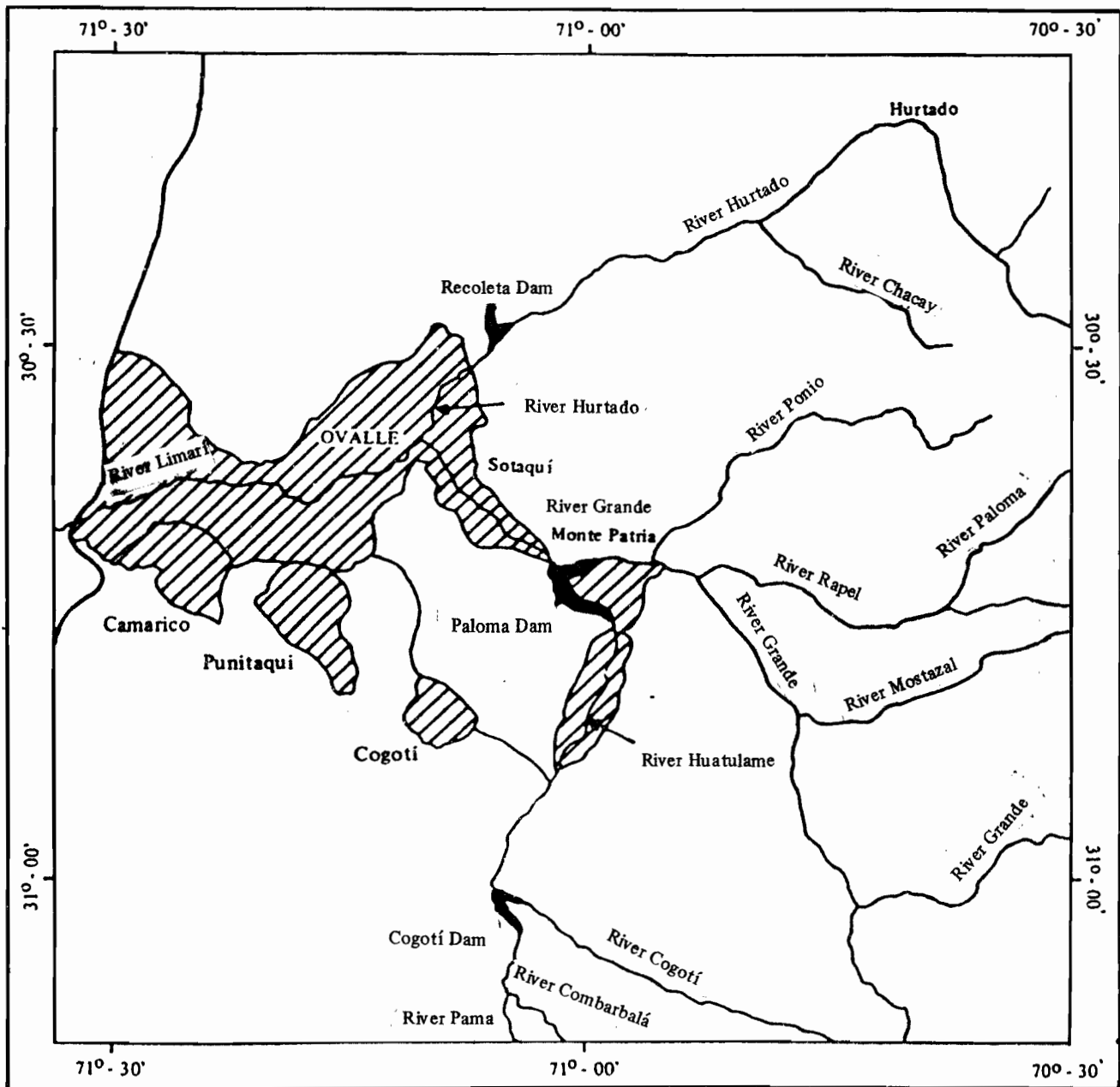
The Rio Limari basin lies some 400 km to the north of Santiago in the Fourth Region. The area of the basin has fundamentally a semi-desert type climate, average rainfall varies from 114 mm near the coast to 232 mm in the Cordillera of the Andes, with relatively moderate temperatures. The natural vegetation consists of shrub with larger varieties close to the watercourses, further inland there are large areas of xerophytic vegetation, including cactus.

The 13 461 km² of the basin varies in relief from the 3 000 m peaks of the Andes, with narrow rocky valleys occupied by mountain torrents, through small "interior" valleys to the llanos and terraces of the central part of the basin and continue to the sea. It is in this latter area that the bulk of the population and the main agricultural area are found.

The water system of the valley consists of the Rio Limari and its main tributaries, the Grande, Hurtado and Huatulame (Figure 12). On each of these principal water courses there exists a water control structure which together form the Paloma hydrologic system along with the respective canal networks. The main system is divided, therefore, into three interrelated subsystems,

(i) The Recoleta subsystem consists of a reservoir on the Rio Hurtado, six main distributor canals and the corresponding secondary network. The dam was put into service in 1934 and was the first compacted earth walled dam built in Chile. Some 14 000 hectares are irrigated from the canals served by

Figure 12
MAP SHOWING LOCATIONS



the Recoleta reservoir and the Rio Hurtado with some additional water drawn from the Paloma reservoir (Figure 13).

(ii) The Cogotí subsystem is formed from the Cogotí reservoir and dam on the Rio Huatulame, one main canal and the appropriate secondary distribution network. The Cogotí reservoir, built between 1935 and 1940, was designed to hold the winter rains until the following growing season. The area irrigated is approximately 10 000 hectares but again the water obtained from the Cogotí reservoir is augmented by a canal from the Paloma reservoir (Figure 13).

(iii) The Paloma subsystem includes the reservoir and dam constructed on the Rio Grande, and the corresponding main and secondary distribution canal networks. The Paloma subsystem was built as a unit in the 1960's and is the newest and largest single irrigation work in Chile.

The functions of the Paloma dam and reservoir are twofold, one to act as a means of inter-annual storage of the flows on the Rio Grande and, second, to assist in the seasonal regulation functions of the Recoleta and Cogotí reservoirs. The area directly served from the Paloma reservoir is more than 24 000 hectares (Figure 13).

In addition to the irrigated areas below the dams, there are more than 10 000 hectares in the upper watersheds supplied from direct diversions or local rainwater collection and storage. The supply of water to these small areas of irrigation in the upper tributaries does not directly compete with the lower basin demands as the water supplied would otherwise be lost.

Other water uses in the basin are restricted to a small hydro-electric plant on the Rio Los Molles and water supply and waste transport for the urban centres. The small scale of these demands eliminates any significant conflict of interests with the dominant irrigation demand.^{28/}

The main agricultural products of the basin are fruit, vegetables and alfalfa. The main directions of growth lie in the production of table grapes, for export, and tomatoes and other vegetables, for example the area under table grapes has expanded from 1 000 to 2 500 hectares in the last five years.^{29/}

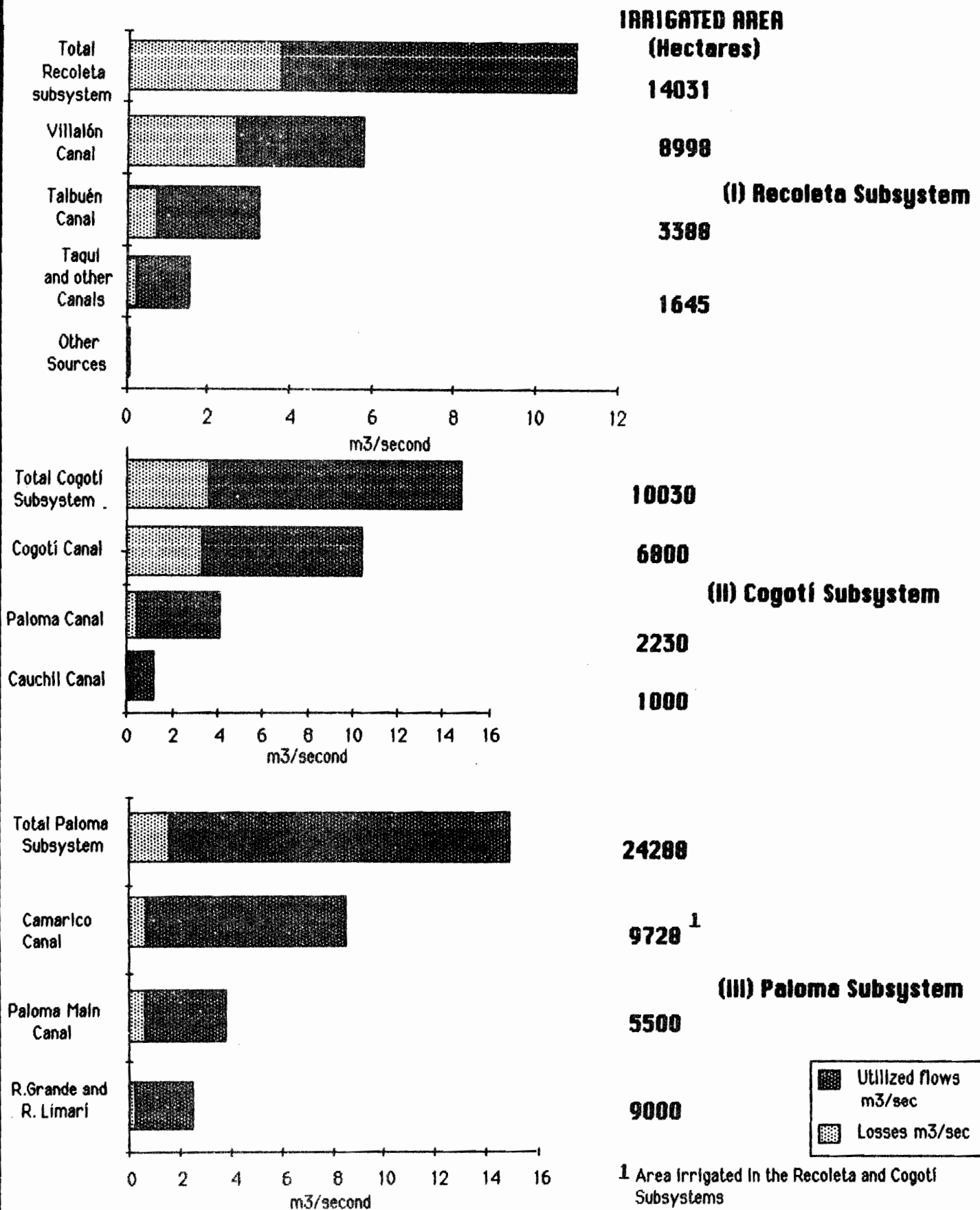


Figure 13 : Limarí-Paloma System Water Flows and Irrigated Areas

(b) The recent trends in water management in Chile

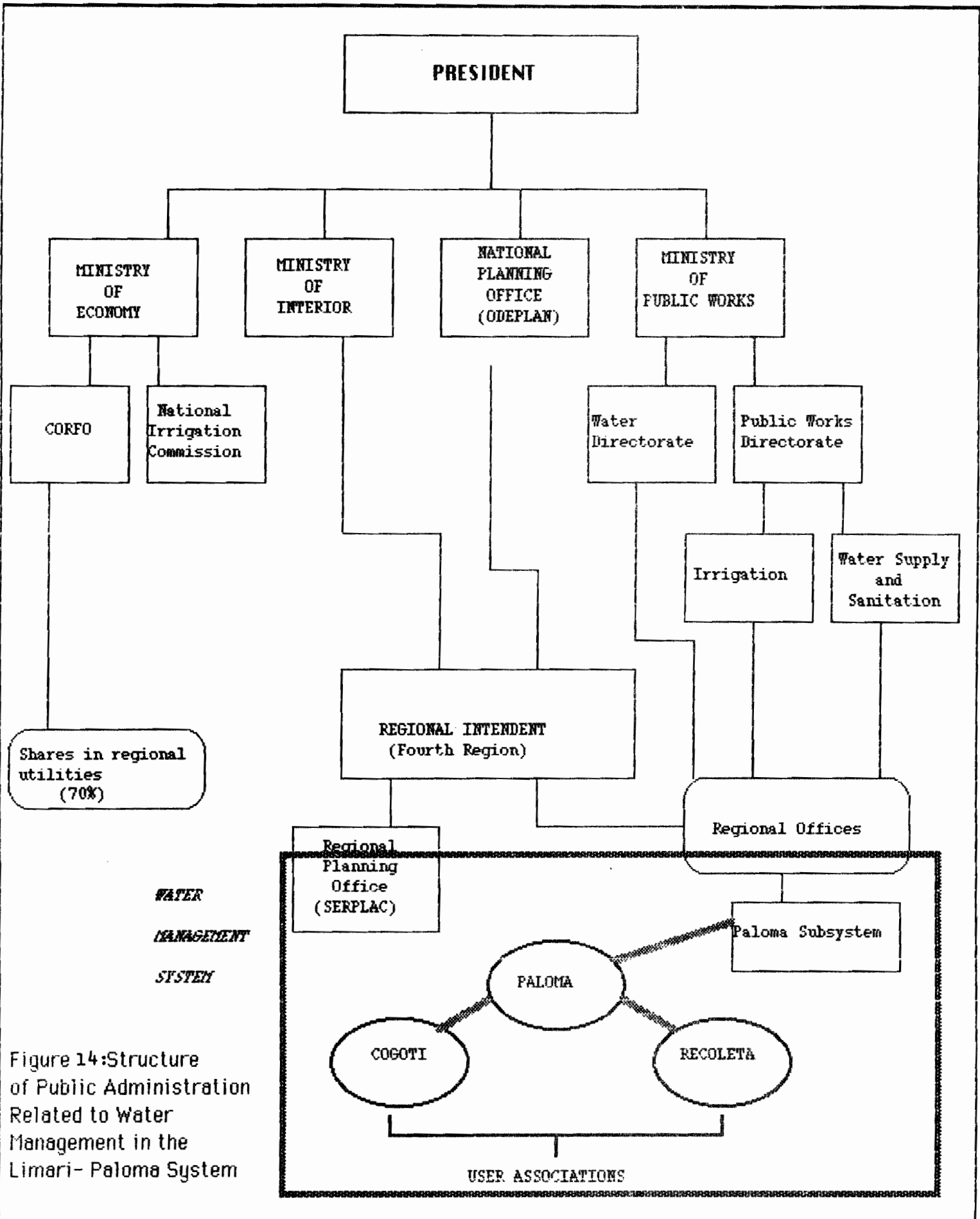
The management of the water resource system in the Limari basin, as elsewhere in Chile, differs from that found in general in Latin America and the Caribbean by the importance of the role played by the private sector. In fact, in the Limari basin, the public authorities have maintained a larger presence than in other similar basins in Chile.

Under the modifications introduced to the Water Code in Chile, promulgated in August, 1981 a large part of the responsibility for water management has been passed to water users.^{30/} Under the present Water Code, the function of the state is limited to the original granting of the water right which once granted becomes a private good freely traded on the market. There exist, however, various restrictions on the exercise of the private right to use water imposed by other areas of legislation.

The General Direction of Water of the Ministry of Public Works is the agency responsible for the granting of water rights. In order to perform this function the Direction also has responsibility for the national hydrometric network, research into the nature of the water resource, supervise the use of water and the construction of certain types of control structures and other works in public water bodies and oversee the activities of the Juntas de Vigilancia.^{31/}

A variety of other government agencies intervene in water use and have an influence on private management decisions but none, with the exception of the Directorate of Irrigation which still operates a few structures and canal systems, are water management agencies. There are state agencies responsible for policy in water related areas, the National Planning Office (ODEPLAN) and the National Commission for Irrigation, for example, while others are major water users, such as the Water Supply and Sewerage Service (SENDOS) and the publicly owned electric power companies (Figure 14).

In any river basin, therefore the most important water management institutions are the user groups, the Comunidades de Aguas, the Asociaciones de Canalistas or if there is no irrigation canal Organizaciones de Usuarios and the Juntas de Vigilancia. The authority and responsibility of these user groups increases from the comunidades which are informal to the Juntas which manage the natural water bodies. The owners of water rights are obliged to form user associations to manage the resource. The associations elect a



directorate, appoint staff where appropriate and have the right to raise a tariff to meet the costs of operation. In addition the Juntas de Vigilancia can in times of drought restrict the right to use water and redistribute the supply between users.

In the Limari basin, the reformed system of water management is in full operation with one major qualification. The Recoleta and the Cogotí reservoirs and their related canal systems belong to and are operated by their respective associations of users, Asociaciones de Canalistas, and there exist committees, Juntas, for the major water courses. The associations have their own technical staff. The Paloma subsystem, however, remains in the hands of the Irrigation Directorate and is managed by it but in close collaboration with the user associations responsible for the other interrelated subsystems and the provisional committee for the Paloma system. The committee or Junta for the entire Paloma system has only a provisional status. Despite its provisional nature, however, the Paloma Committee, formed from the six canal associations, does perform its task of distributing water in the valley as a whole, resolving conflicts between the different associations and, in general, acting as the agent for basin wide water management. Its effectiveness is reduced, however, by its extra-official status.

Each of the associations of users is financially independent. Each must cover the costs of operation through user charges. An exception to this is the cost of operation of the Paloma system which is entirely met by the Directorate of Irrigation and water is not charged to the users. The total cost of operating the system in 1985 was some 150 million Chilean pesos (US\$ 814 000). The highest expenditures were for the operation of the Paloma subsystem (Table 4). In general the annual operating costs are met from tariffs but longer term maintenance requirements and new capital expenditures have not been incorporated in the calculation of the tariffs. In the case of the Recoleta subsystem even operating costs are not being met due to the problems related to the introduction of a marginal pricing system. The tariff has been divided into two parts, one fixed but the other varying with the amount of water used. Users have not paid the variable charge which departs from tradition and the tariffs applied elsewhere in the Limari basin.

Table 4: Summary of Operational Expenditures, Limari-Paloma System, 1985

Organization	Expenditure (millions of Chilean Pesos)	%
<u>Total Limari-Paloma</u>	150.6	100.0
Paloma Subsystem	102.3	68.0
Reservoir administration	78.1	51.9
"Junta de vigilancia", Grande and Limari Rivers	19.4	12.9
Camarico Canal users association	4.8	3.2
Recoleta Subsystem	25.5	16.9
Recoleta reservoir users association	25.5	16.9
Cogotí Subsystem	22.8	15.1
Cogotí reservoir users association	20.4	13.5
Punitaqui Canal users association	1.3	0.9
"Junta de Vigilancia", Huatulame River	1.1	0.7

Source: Based on information provided by the different organizations

(c) The effectiveness of water management in the Limari basin

In the Limari Basin, as in other irrigated areas of Chile, there is occurring a notable intensification of agricultural production. Paradoxically, this is being accompanied by a reduction of water use due to lower water demands from the new crops, especially compared with alfalfa, and an increase in the efficiency of water use at the farm level.^{32/} The production of table grapes, in particular, and of vegetables demand a heavy investment in land preparation and this is often accompanied by the adoption of improved methods of water application, including drip irrigation.^{33/}

The improvement in water use efficiency at the farm level have not been attended by a similar improvement in the efficiencies of the operation of the water structures. In the basin, the Recoleta and Cogotí subsystems show high water losses both from leakages at the dams, it is estimated that at the Recoleta dam 30% of the water stored is lost through filtering, and losses in the distribution system. The capacity of the users to tackle these problems is restricted by the lack of finances due to the reluctance of the users to raise tariffs. This reluctance is underlined by the difficulties encountered in the Recoleta subsystem in attempting to introduce a tariff more closely related to use.

In part, the inefficiencies observed in the operation of the Limari-Paloma water system have been inherited from the past, and reflect the relative neglect of the agricultural sector in Chile for the last half century, but in part they show the problems to be anticipated when major reforms are made in public policy. The user associations have been given a new and much more significant role in water management and this new role has yet to be properly assimilated and understood. At the same time, the actions of the government have changed and the new direction of public intervention too has yet to be consolidated.

In irrigation, the main thrust of public action now occurs through the National Irrigation Commission, not the Irrigation Directorate which is only responsible for the administration of the few remaining irrigation systems in the public sector and the evaluation of potential projects. The Commission, established in 1983, has been responsible for the definition of present policy and is also charged with the management of the law for the Promotion of Irrigation which provides subsidies, 75% of the cost, to the private

sector for the improvement of existing works or the construction of new projects. The first call for the presentation of projects under this law was only made in 1986 and few projects have as yet received support. The existence of the fund has awakened considerable interest amongst the water user associations.

In the Limari basin, there has been considerable interest in the promotion law and the Recoleta association has presented three projects for canal improvements and the Cogotí association is preparing projects. The other water user groups are also studying the possibilities provided by the new legislation. The national association of water user associations, criticizes, however, the excessive paperwork, the rather restricted funding available, and the continuing existence of many areas, like the Paloma subsystem, where the users have no water rights. Despite these restrictions, it is undeniable that the initiative is a laudable one and will probably be very successful if the evidence from other sectors of the economy where similar policies have been applied for some time, forestry for example, is any guide.

There are undeniably deficiencies in the management of the Limari water system. There exists, however, an environment such that positive change can be expected as the recent reforms in public policy in Chile towards water management, in general, and irrigation use, in particular, begin to take root. This is particularly the case when account is also taken that a decentralization policy of the decentralization of the determination of regional economic and social policy is also being pursued which too can be expected to have a major impact on water management.

IV. A COMPARATIVE ANALYSIS OF THE CASE STUDIES

The authors of the case studies were asked to assess the most significant external and internal factors that had influenced the management of the water systems they were studying. The distinction between external and internal influences was made in an effort to isolate in the performance of the water system, in the sense of the degree of achievement of whatever goals had been set, those factors which could be controlled by the system management. In both making this distinction, between external and internal factors, and in

attempting to judge management performance it is necessary to recognize the rather different degrees of autonomy possessed by the management institutions in the different case studies. It should also be noted that all the cases studied show a complex management organization. There is no single institution responsible for management in any of the four water systems included in the study. Management responsibilities are diffused among ministries of government, regional organizations, municipalities, public companies and the private sector.^{34/}

The particular complex of agencies involved in management varies notable among the cases. In Tinajones, for example, most of the entities which make-up the management system are parts of central government ministries, only in the last few years, has any important role been given to any other institution in system management.^{35/} This is in contrast with the management system in Mendoza where the most important management institutions are autonomous public entities or private user organizations with minor roles for the institutions of both the provincial and the national governments. In Bogotá it is the municipality which plays the dominant role both through its public utilities, the EAAB and the EEEB and through its membership of the board of directors of the CAR. While in Limari, the public sector dominant following the agrarian reform, is being replaced by newly revived user organizations representing all water users.

1. External factors

The emphasis in this analysis will be placed on the internal factors affecting management performance but the influence of external factors must be given consideration. The most important external factors were seen to be the nature of overall government policies, of specific economic policies adopted by the government, general political uncertainties, changes in administrative structures and natural events such as droughts and floods. The relative importance of these factors varies among the studies but influences were noted in each case. Overall economic policies were mentioned as being significant in the Bogotá and Limari studies while specific policies in the support of rice growing and grape growing were emphasized as important external influences, respectively, in the Tinajones and Mendoza studies.

An important aspect of government action in policy areas outside the specific confines of water resource management is the issue of policy discontinuities. Discontinuities or policy reversals can be very disturbing for the encouragement of stable management action. These can clearly be seen in the vicissitudes of the management system for Tinajones, but is equally an issue in the other case studies. It is an issue, however, that goes beyond the terms of reference of this study in the sense that it is a characteristic of all government actions and not specific to water management.

2. Internal factors

Taken as a group the four case studies show, despite the attempts to impose uniformity of analytical criteria, considerable differences in the history of the development of the water systems studied and in the nature of the issues dominating their current management. It is not surprising, therefore, to find in the assessment of the most critical internal factors made by the authors that they are rather specific to each water system. At the same time, however, if an attempt is made to abstract a little from the specific characteristics of each study it is possible to distill more general and more widely applicable observations of the nature of the concerns encountered in the case studies which reflect more generally the issues currently being faced by water management in Latin America and the Caribbean.

The major concerns expressed in the case studies which appear to illustrate wider management issues can be synthesized in the following manner,

- (i) the slowness of the decision making system;
- (ii) a tendency to reduce the definition of the water management system to the construction of physical water control and distribution works;
- (iii) a preoccupation with the solving of immediate short run issues at the cost of a longer term view of operational and economic efficiency;
- (iv) a lack of consideration, particularly in irrigation projects, of the fact that water systems are social institutions as well as productive enterprises;
- (v) the maintenance of inappropriate or obsolete management structures and practices;
- (vi) the adoption of a generally passive managerial style;

(vii) the absence of any rational strategy for the preparation and training of water system managers.

It is recognized that these observations on water management in Latin America and the Caribbean are not necessarily new but the cases studied have been specifically structured so as to catalogue the characteristics of current management rather than to examine an aspect of operations such as efficiency or consideration of environmental quality, etc. Not all of the four cases studied show all the characteristics listed above and the relative importance varies among the cases. Moreover, the particular form that any one of the characteristics takes varies considerably from one water system to another.

The concentration on what might be perceived as shortcomings of existing management practice in this discussion is not intended to negate the benefits that have been gained from each of the water systems included in the study. In each case study there are large areas of successful achievement. The very existence of the systems is, itself, a very strong witness to this and in each case there is ample evidence of the income and other benefits that are generated by the operations of the system. At the same time, however, each individual case provides similarly ample evidence that many issues remain to be resolved and that there remains much room for improvement in management.

3. Slowness in decision-making

Slowness in the taking of decisions of any kind can considerably reduce the effectiveness of any activity. An activity as complex as water system management can suffer considerable disruption if decisions are not taken within the necessary time span. Among the case studies perhaps the most obvious example of the effect of delays in decision-making is that of the construction of the Tinajones project and of the delays in the building of the different component parts. These delays led not only to an increase in the costs of construction but due to the tardiness in the construction of the different components to the creation of problems that otherwise could have been avoided. For example, the salinization of many parts of the irrigated area would not have occurred if the secondary canal systems and the drainage systems had been built within the original time schedules.

Tinajones is not, however, the only case where the issue of slowness in decision-making can be observed. In Mendoza, the issue of the redefinition of the overall objectives that are sought through the irrigation system, although external to the DGI area of responsibility, has been postponed so long that the exhaustion of the existing model has contributed to the depth of the general economic crisis affecting the province. The DGI cannot, of course, be held responsible for overall economic management but indirectly has contributed to this brake on development. For example, the absence of a reform of the legislation governing water rights to incorporate elements to encourage efficient use has hampered not stimulated change in the patterns of agricultural production. Equally, the failure to adopt timely measures to generate sufficient resources to maintain and improve the irrigation system has contributed to the overall decline in the relative efficiency of the agricultural economy.

In Tinajones slowness in decision making can be related to the over dependence of the management system in Tinajones on the centralized Peruvian public administration, an example of the water system suffering from the negative impact of bureaucratic rigidity and lack of autonomy of the system management. Even though there was a special management organization for the construction of the project this entity lacked essential independence and competence. In contrast, in Mendoza, there has always been a powerful autonomous institution responsible for the irrigation system but it too has reacted very slowly to a changing environment. The DGI possesses most of the characteristics normally recommended for the achievement of effective and efficient management but has failed to deliver management of that quality. The difficulties cannot lie, therefore, only in the lack of autonomy and freedom from centralized bureaucratic control. There are other requirements, such as openness and flexibility, if more effective and responsive management is not only to be achieved, as it perhaps can be claimed was achieved by the DGI earlier in its history, but maintained through time.

4. Reductionism

It is a common criticism of water management that the concern of the agents of management is restricted to the construction of works. Further it is said that little heed is paid to the very different issues faced in operation of

water systems and of the effective insertion of systems into general economic and social development. Reductionism of this type can be seen in the case studies expressed in various ways. Concentration on the management of the physical system, because it raises less controversy, lies perhaps behind the tardiness of the CAR in developing a plan to guide resource development in the Bogotá valley, it can be seen in the neglect of the farmers in Tinajones, and overconcentration on works in the past is one of the factors that influenced the introduction of change in the policy towards water system management in Chile.

The study of the Limari system also exemplifies a precise instance of reductionism. The Paloma dam and canal system is the most modern and efficient irrigation system in Chile. In part, it serves, however, a group of farmers who benefitted from the agrarian reform but who did not receive water rights with their land. The effect of this failure to assign water rights means that the management of the Paloma subsystem is not in conformity with the reigning policy and legislative situation either in Chile, as a whole, or in the remainder of the Limari system. The farmers, without water rights, do not pay the costs of operating, maintaining and improving the subsystem as do the farmers who are users of the other subsystems nor can they legally participate in the management process. In fact, an effort has been made to permit the users to participate in management. The efficiency of the water system will remain less than optimum as long as the farmers served directly from the Paloma reservoir are not treated equally in respect of both their rights and responsibilities with those of the rest of the Limari system.

5. Preoccupation with the short run

It is not surprising that the managers of water systems fix their interest in the short term when, as shown in more than one of the case studies, the longer term, due to the greater probability for arbitrary external interference, appears to be completely beyond their control. Not only due to the interferences arising from the uncertainties inherent in economies with high rates of inflation which create obstacles to all economic and financial planning but also in arbitrary changes in specific water policies and indeed the particular management environments of water systems. The existence of

uncertainties need not be translated, however, into neglect of the longer view in water management but unfortunately it so often has.

From the case studies, it is not clear which are the most important political or economic uncertainties to which water management is subject but it is clear that institutional stability in itself is not sufficient when there is macroeconomic uncertainty. The DGI in Mendoza has suffered no serious institutional modification since it was founded but any focus on the longer term that such stability might permit has been vitiated by the general climate of political and economic uncertainty both in the province and in Argentina, in general. The penetration of the general uncertainty into the DGI management has contributed to the difficulty of achieving reform and of reacting to the changing situation in which the DGI has had to act. It has perhaps encouraged conservative management and discouraged innovation.

In Tinajones, constant change in administrative structures has only added to the difficulties of the management of a project which has been developed with radically changing agricultural policies centred originally on large private landholdings, then on collective farming, following land reform, and now on individually owned medium and small farms. The results of the administrative change have been to disrupt decision-making throughout the history of the project and, specifically now, to lower the hierarchical position of the Technical Administrator of the Irrigation District in relation to the Director of the Agrarian Region and also to permit the Regional Development Corporation to take initiatives in irrigation works without consultation to the detriment of effective and efficient operation of the system.

6. Neglect of the social aspects of water system management

The concentration of the construction of works translates into the more widespread issue of the neglect of the social aspects of water system management. There is a social aspect to water management which does not imply distraction from the necessity to concentrate on the prime role of a water system as a productive enterprise and economic efficiency. There are sporadic signs in the case studies that some consideration is being given to the social aspects of water management. The increased concern with the water system as a social institution is not so much reflected in the structure or

staffing of the different public institutions involved in management as in the part played by users in the management process.

In three of the cases studied the users and the private sector have clear management responsibility. In the Mendoza and Limari cases the management institutions responsible for the operation of major works are user controlled. In Tinajones the users have had an expanding role and their institutions now share management responsibility with the Agricultural District and the DEPTI. Only in Bogotá is there an absence of direct participation of the users in management.^{36/} Management is solely in the hands of the public, national and municipal sectors.

User participation, or even better user control of management, is perhaps the best means of ensuring that the water systems fulfill their role as social institutions, as well as achieving economic efficiency. In the Limari system a considerable increase in efficiency of water use has been achieved without direct government intervention. Similarly, the development of groundwater in Mendoza was, although heavily subsidized, a private action. This is not to negate that government has a role to play in water management but this role does not have to be dominant. It could be shared as one among many users or redefined to be a provider of technical advice rather than as the dominant management institution.^{37/}

7. Maintenance of obsolete management structures

Despite, at times, periods of almost frenetic changes in lines of administrative responsibility, there is a noticeable tendency in the case studies for management structures to be maintained long after their utility has been exhausted. In the case of the structure of the Inspecciones de Cauce in Mendoza the maintenance of the structure has become a serious impediment to improvement and reform. There are 720 Inspecciones, many with only very rudimentary methods of management, and although they were as originally conceived a means of increasing user participation, their number means that they no longer serve this purpose due to the crisis affecting the system. Moreover they have no jurisdiction over groundwater, and therefore, exclude many users, which has become a permanent and important feature of the irrigation system in Mendoza.

The management systems in the other cases are perhaps of too recent origin to show such a clear example of structural obsolescence. The tendency can, however, be discerned as policies and structures become inappropriate and are not adjusted to the changing economic and social environments of the water systems. There remains in management a heavy emphasis on construction, for example, in Tinajones, when what is required is optimum operation of the water system already built. The CAR, has placed considerable emphasis on opportunities for new works, particularly for irrigation, which do not challenge the other organizations involved in the management system rather than on the development of its clear mandate to manage the water system, along with other renewable resources.

Only now in Tinajones is the management adjusting to the fact that the objective of management is now operation of what has been built rather than more construction. The project may not have been built as planned, some new works may be necessary but a system exists and needs operation. It is not clear that such a perspective has really been assimilated in the system management. There are other reasons for the somewhat complex management arrangements found in Tinajones but in part, at least, it is product of the survival of agencies and offices from an earlier phase of the system's existence.

8. Passive style of management

Institutionally, at various points in time, the management of the water systems included in this study have shown what can only be described as passivity in confronting the wider political forces which have affected their activities. This remains the case even when allowance is made for the difficulties confronting water system managers in attempting to influence policies adopted on the basis of wider political considerations. For example, the DGI has maintained a very passive stand towards the development of groundwater. Even when given the responsibility and authority to control groundwater use, as an institution it has moved only slowly to assume these powers. This is despite the fact that the development of groundwater has had a profound impact on other objectives pursued, the construction of control works on the Rio Mendoza, and its finances, the use of groundwater is not covered by the tariff. The development of groundwater also signified the

intromission of other agencies in water management, the national government encouraged investment in wells and pumps through tax concessions and subsidized electricity, but the DGI did not react to defend its preeminence.

Authority over the control, use and administration of renewable natural resources was delegated to the CAR by INDERENA in 1970, and again in 1978, including the authority to administer, control and monitor all waters of public use both surface and groundwater and to undertake watershed management and conservation. Sufficient authority for the CAR to dominate water management but it has not achieved dominance. It has remained content to share management with the most powerful areas, the EAAB and EEEB.

In Tinajones, some of the difficulties faced in water management are directly related to the development of the growing of rice in the region. The original crop plan called for some 20 000 hectares to be planted in rice but with the pressure of the high prices paid for rice through the National Rice Programme in most years the area has been twice this. In addition, the high price of rice has led to a dispersion of production throughout the whole area complicating even more the management of water for irrigation. This situation is recognized as a problem but the system management does not appear to have made any systematic attempt to resolve the contradiction.

These examples illustrate a more general characteristic of water system management to practice a passive stance in respect of the wider social issues which impact on the system. In each case quoted the passivity of management has had greater consequences than simply subjecting the system to outside interference. It has seriously reduced the prestige and effectiveness of management and complicated the struggle to control the water system. In part, reductionism is an attempt to escape from this dilemma of the necessity for management for the sake of rational use of the water system to confront outside pressures by abstaining from including within management responsibilities more than the operations of works. But works must be operated to meet demands and demands are determined by use which in turn is socially conditioned through the play of economic and political forces.

9. The absence of any strategy for the training of water system management

In general terms, the case studies show that the organizations involved in the management of the water systems studied appear, at least, at the

technical level satisfactorily staffed. There are difficulties and although it is not possible to know from the kind of study made here whether the staff employed are appropriate for the tasks they must perform but there is a suspicion that this is not always the case. Without being unduly optimistic, it can be repeated however, that technically the water institutions seem to be able to satisfy their requirements for staff and to have developed arrangements for training.

Serious weaknesses do seem to exist, however, for staffing at the management level. There is no evidence that in any of the cases studied there is any means for providing the training of managers. Managers are at the senior level appointed politically, as in the case of the Superintendent of the DGI or the Executive Director of the CAR, or are technicians promoted from the staff. The Limari-Paloma system is an exception in that there is currently a diffuse management structure. Otherwise, however, these conditions hold in Chile, as elsewhere. Capable individuals can be obtained both through political appointments or the promotion of technicians and the individuals appointed may have received some management, as opposed to technical, training. It is, however, a hit and miss system.

It would seem not unreasonable to conclude that although external factors have had and will continue to have an important influence on the effectiveness of water system management so does the quality of the managers. It would equally seem reasonable to consider some more rational strategy for the selection and preparation of managers. At the most senior level political appointment is probably an unavoidable procedure but even here facilities could be provided for preparing managers once appointed. At the technical level, the provision of a more rational and systematic means of training for management would seem to be an urgent necessity.

This brief comparative analysis shows that there is a significant group of management issues which are common to the four cases studied. This would, also, suggest that, to the extent the cases are representative of water systems in Latin America and the Caribbean, the management issues identified are generally to be found in the region. The issues provide, therefore, a basis for the consideration of co-operative action to attempt to resolve them or, at least, to ameliorate their impact on the effectiveness of management.

V. POINTS FOR FURTHER DISCUSSION

From the evidence provided by the case studies, the state of water management in Latin America can be said to be relatively satisfactory. There are sound and experienced institutions in all four of the case studied, the institutions are properly if unevenly staffed but they do not always appear to be appropriately structured for the operation and management of the water systems for which they are responsible. The case studies also show that there is much room for improvement in the end product of the management systems formed from these institutions, the quality of the management provided. The water systems studied all give ample evidence that the operation of the system is below optimum efficiency and that, many issues inherent in water system operation are being poorly handled or even ignored in their management process.

It is recognized that many factors which affect the efficiency of system operation are to some extent external to any reasonable definition of the area of responsibility of water system management. The management institutions of water systems obviously cannot be expected to be responsible for overall economic and social development policies or for the occurrence of extreme natural events. They are undeniably responsible, however, for attempting to mitigate the impact of these and other phenomena outside their control on the water system. In the cases studied this has been one of the serious lapses of management which has brought with it considerable difficulties for the optimum utilization of water systems.

Even accepting that there are many facets of water management and even more of the environment in which water management is carried out, falling outside the control of those whose interest and responsibilities are limited to the operation of water systems. For example, many of the informal rules which govern the interpretation and perception of public policies and decisions are established at other social and political levels.^{38/} But water management institutions should be capable of reducing the adverse impact of disinterested or short-sighted general government policies and decisions on their own areas of responsibility for the water systems under their charge. It is possible that the removal of many aspects of system management from the public sector, in itself, could improve the decision-making process through creating a more open and transparent tradeoff procedure. Equally, the

limitation of the public sector to those areas of responsibility where wider social considerations make public responsibility inevitable could ease the difficulties of the public institutions involved in water management in confronting conflicting government policies and, thereby, somewhat reduce the demands that are currently placed upon managers.

There remain, however, many other factors related to the management of water systems which are clearly internal even to the most minimal definition of the responsibilities of system management. The case studies demonstrate that in both the making of decisions and in their implementation once taken the institutions of the sector have not always acted effectively or responded well to the possibilities offered. It appears, at times, that there is a vacuum in authority or a refusal to take responsibilities clearly given, as to cite only two examples, with the management of groundwater in Mendoza or the development of a plan for resource management in Bogotá. It does not appear from the case studies that, in general, these characteristics of management can always be attributed to the structure of management institutions. They can be observed in all four of the cases and in the cases the institutional structures show considerable variation. It seems rather that the explanation must be sought elsewhere.

It is often commented that within the water sector the quality of management of institutions declines from hydro-electricity, through water supply and sanitation to irrigation and the management of the resource, itself whether the concept of comprehensive or integrated basin management is applied or not. This is not the conclusion one would necessarily reach from the examination of the case studies but from other evidence it is clear that in general electrical utilities make rather greater use of trained managers.

Stress has been placed in the literature on proposals for improving management through institutional change. This study suggests, however, that the achievement of greater productivity from water systems cannot only be obtained through the route of institutional reform. The cases show varied institutional structures and provide no evidence that one structure is intrinsically superior to others or that any reform would suggest a panacea has been discovered. The need would seem to be rather to find a means of making the management of water systems more dynamic, more susceptible to change, more interested in the real issues that challenge system management, such as, productivity, sustainability, the encouragement of user

participation etc., independent of the particular institutional form applied. It would seem that some advances might be achieved if those responsible for system management were more aware of the kind of possibilities open to them, if they knew more of experiences elsewhere, if they were better trained for the task of management and not always required to learn through experience.

In attempting to improve the management of water systems, there would seem to be a place for consideration of the better preparation of managers through appropriate training. By this means, a further way may be available to correct some of the weaknesses in the current state of water system management, illustrated by the case studies. A situation, which it bears stressing yet again, has not or cannot be adequately explained through reference to the structural problems of organizations nor to the existence of informal rules affecting institutional interrelationships both within the water sector and the relationship of the sector to the rest of society.

Notes

1/ ECLAC, The Water Resources of Latin America and their Utilization, Estudios e Informes No. 53, Santiago, Chile, 1985, page 37.

2/ See, for example, the discussion in L. A. Hammergren, Development and the Politics of Administrative Reform, Westview Press, Boulder, Colorado, 1983.

3/ Between 1971 and 1982, to cite only one relevant statistic, loans from international banks for projects related to water resources in Latin America and the Caribbean amounted to some US\$ 8.7 billion (in 1975 dollars).

4/ The range of reasons cited includes corruption, incompetence, under politization of decision-making, regional conflicts, inappropriate institutions, low salary scales in the public sector, over expansion of the public sector, etc.

5/ The term system will be applied in this report equally to a single project or a number of related projects on the same or different water bodies where they are operated as one unit.

6/ See for example the recommendations made in, United Nations, Economic Commission for Latin America, Water Management and Environment in Latin America, Pergamon Press, 1979, pages 123-138.

7/ A. Dourojeanni and M. Nelson, "Integrated Water Resource Management in Latin America and the Caribbean: Opportunities and Constraints", International Association on Water Pollution Research and Control, 4th International Conference on River Basin Management, Sao Paulo, Brazil, 13 to 15 August, 1986, Proceedings, page 227.

8/ It is commented in the literature that there is an absence of evaluation of the lessons provided by the work that has already been accomplished in water management, see for example the comments in Robert W. Kates and Ian Burton (ed.), Geography, Resources and Environment, Volume I, Selected Writings of Gilbert F. White, The University of Chicago Press, Chicago, 1986, page 254.

9/ Based on Centro de Economía, Legislación y Administración del Agua, "El riego en Mendoza: determinantes económicos, sociales, institucionales, legales y administrativos de su gestión", Mendoza, 1986.

10/ The expansion in the use of groundwater was encouraged through a heavy subsidy for the sinking of the wells and in the price charged for electricity. See Kenneth D. Frederick, Water Management and Agricultural Development: A Case Study of the Cuyo Region of Argentina, Johns Hopkins University Press, Baltimore, 1975.

11/ Annual flows in the Río Mendoza:

Year	m ³ /sec
Average	41.35
1980	46.47
1981	49.89
1982	57.20
1983	82.35

12/ The research, that has been done on groundwater, has been done by other institutions.

13/ In the last 10 years in only two have significant amounts been budgeted for capital equipment by the DGI. Soil conservation and recuperation is very demanding in earthmoving machinery.

14/ Based on Jaime Saldarriaga, El Sistema de la Cuenca del Río Bogotá, Bogotá, Colombia, December, 1986.

15/ The Corporación Autónoma Regional de los Ríos Bogotá, Ubaté y Suarez (CAR).

16/ The river is highly polluted despite the oxygenation permitted by the falls.

17/ In January, 1987 further modifications have been introduced in the legislation governing regional development corporations which apparently changes their responsibilities.

18/ Through the Law 62 of 1983.

19/ In 1986, the salary of the Executive Director of the CAR was \$286 000 compared with a salary of \$410 000 received by the manager of the EEEB and the difference was maintained at all salary levels.

20/ Based on Julio Guerra, Estudio del Proyecto de Irrigación, Tinajones, Lambayeque-Peru, Lima, 1986.

21/ La Comisión Ejecutiva del Proyecto Tinajones (CEPTI).

22/ The project management suffered a name change to the Dirección Ejecutiva del Proyecto Especial Tinajones (DEPTI).

23/ Expenditures on operations and maintainance in 1984 were distributed as follows,

DEPTI, for major works, 1 974 million soles

Zona Agraria, 1 505 million soles

Of the latter 1 124 millions were met from tariffs and other user charges.

24/ In 1984, the collection of tariffs equalled 75% of the total expenses of operation and maintenance for minor works.

25/ The degree of salinization has varied with the availability of water but has been estimated to have affected 13% of the area in 1963, 32% in 1968, 40% in 1975 and 32% in 1980. By 1980 drainage had been built in some irrigation sectors.

26/ The construction of the Tinajones Project was both financed and technically assisted by the Federal Republic of Germany. For many years German experts were attached to DEPTI.

27/ Based on Jaime Baraqui, "Water Management in the Valley of the Río Limari, Chile", Santiago, Chile, November, 1986.

28/ Any possible conflict between irrigation and other water uses would easily fall within the margin of the water lost due to inefficiencies in the distribution systems.

29/ In 1985, of the 54 000 hectares of agricultural land in the valley, 6 180 or 11% were used for fruit production but produced over 35% of the total agricultural income.

30/ The innovative significance of this should not be over stressed. The user had traditionally played a large role in water management in Chile. Nearly all irrigation schemes were privately constructed and operated even following the agrarian reform.

31/ The Juntas de Vigilancia are the senior user water management institutions.

32/ Efficiency of water use on fruit is 71.55 compared with 26.8% on alfalfa.

33/ Estimated area, by crop, with improved irrigation

Crop	Area (hectares)	% Total Area
Annuals	480	6.3
Fruit	6 180	100.0
Vegetables	1 300	85.0
Alfalfa	0	0.0

34/ At times, external or foreign institutions also intervene in management such as the multilateral lending agencies or bilateral aid agencies.

35/ Through the incorporation of user institutions management is returning to the pattern prevailing before the agrarian reform.

36/ Indirectly users perhaps are represented through the Special District, the municipality of Bogotá.

37/ The use of groundwater in Mendoza provides an illustration of the difficulties inherent in absence of effective public participation in management.

38/ See the concluding discussion in A.Dourojeanni and M.Nelson, op.cit., pp.227-228.