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E C L A C
Economic Commission for Latin America and the Caribbean

REFERENCE FRAMEWORK FOR ANALYSING WATER RESOURCES MANAGEMENT ACTIVITIES */

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Contents

Summary

This document deals with the management of major water projects or activities for the large-scale management of water resources. The terms "large-scale management" or "major water projects" designate the adoption of some decisive action in respect of the resource. Such projects or activities may include:

- Major hydroelectric energy projects
- Irrigation projects covering areas of between 5 000 ha and 100 000 ha
- Water supply projects for urban areas in connection with large reservoirs or intakes drawing in large volumes of surface and/or ground water
- River-training projects in conjunction with flood-control measures or measures to improve navigation (canalization, construction of dams, dikes, etc.)
- Flood-protection projects
- Multi-purpose projects, such as, for example, combinations of:
  . energy production and irrigation,
  . irrigation and drinking water supply,
  . energy production and drinking water supply,
  . flood protection and energy production, combined with irrigation, etc.

Projects of this kind involve measures which affect the balance of water resources and may have a supraregional impact, since in most cases such projects are carried out on rivers which possess major catchment areas and draw surface water from other catchment areas. Their impact is not only felt in the immediate area of the project, but also on the hydrology of the area downstream from the project. If the rivers involved cross departmental boundaries or national frontiers, it is necessary to draw up bilateral agreements prior to the project; the decision to carry out a project cannot be

taken and implemented solely by the institution responsible for the project area.

The management of major water projects involves:

- both the institutional responsibilities and limits,
- and the management of the project itself.

However, the term "management" is not to be confused with "administration". Major water projects require heavy investment, which is only justified when the projects themselves are of the greatest possible benefit to the national economy. In this respect water projects are comparable with industrial projects, and consequently require a similar management structure. On the basis of this premise, an example of a structural organization for project management is included.

Chapter I

OVERALL CONDITIONS FOR WATER RESOURCES MANAGEMENT

1. The economic, social and political context

Water is the most essential of resources. Water provides the very basis for all forms of life in a region, and is consequently of fundamental importance for the social and economic conditions in the region as well as for its economic development. Consequently, the use of water resources is of global social, economic and political interest.

Water is traditionally one of the mainstays of the social order and of the regional economy. Among its uses are:

- The consumption of drinking water which satisfies a vital human needs. In this respect, water is a food.
- The domestic use of water, of fundamental importance in everyday life (hygiene, daily washing, etc.).
- Its use as a means of transport and communication on surface waters, such as rivers and lakes.
- Its utilization for fishing, in order to produce food.

When development progresses in an area or region and the use of water exceeds traditional levels, orderly management of the river basin is necessary (see figure 1). This is where water resources management comes into play.

The varied uses of water for productive purposes, such as:

- the operation of mills
- the operation of hydropower plants
- the extraction of water for agricultural purposes
- the extraction of water for use in small industry, etc.,

require proper co-ordination to preserve the social order and simultaneously promote economic development. Political institutions, which must also have an interest in regional development, are necessary to maintain this order.

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An essential requirement for orderly use of a resource is knowledge of the quantity and quality thereof. For this reason, the politicians responsible must establish administrative structures to take into account the quality and quantity of the water and to co-ordinate its use in accordance with demand. In order to do so, it is necessary to analyse the demand for and type of use. While the type of use and demand essentially reflect economic interests, social interest lies in the protection of the quality and availability of the water resources in order to satisfy vital needs.

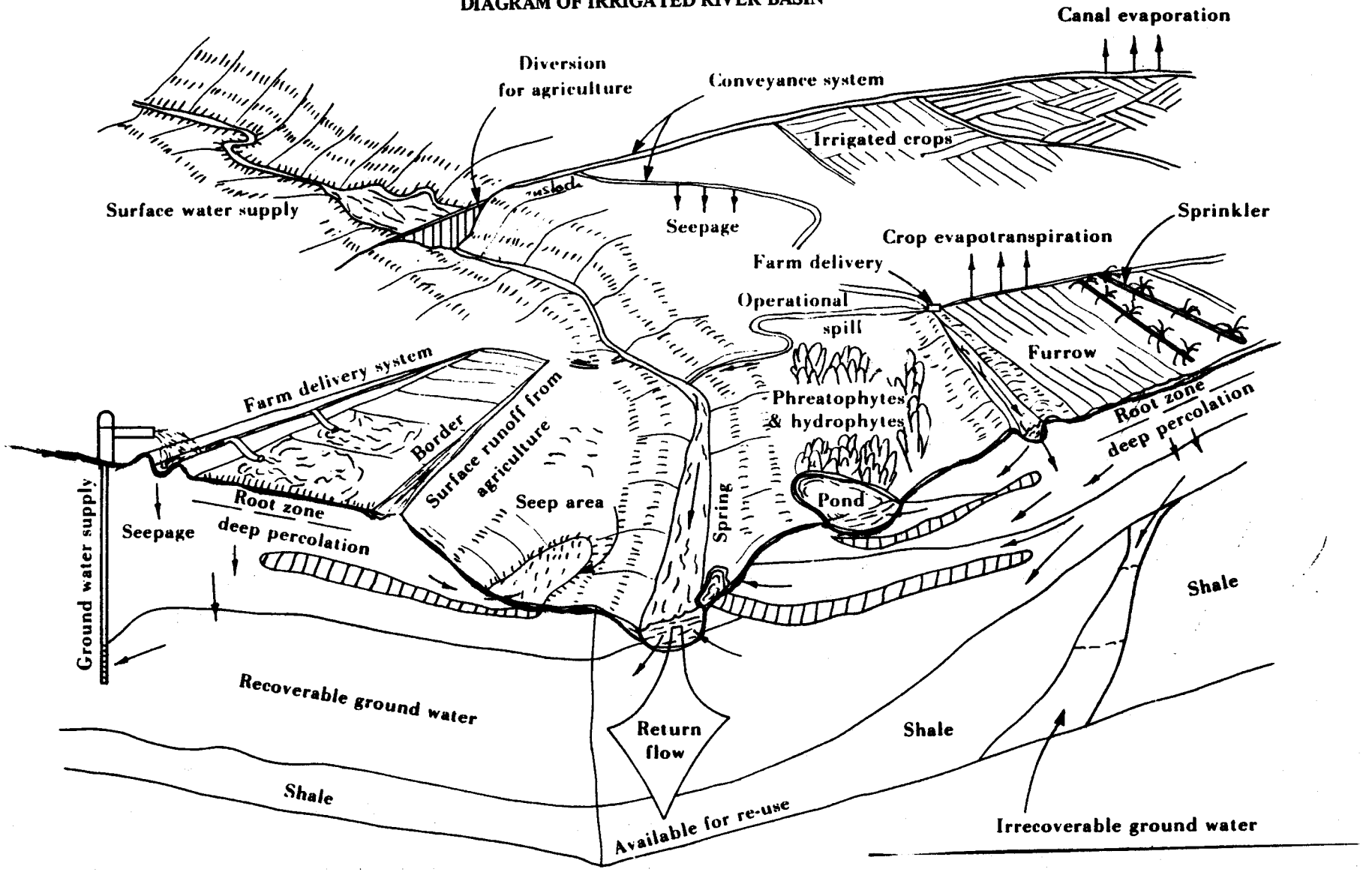
Orderly management of water resources is an essential condition for any political and administrative activity if conflicts of interest are to be avoided. Those responsible must be required to give priority to protection and conservation of water over and above economic interests, in other words they must restrict the economic use made of water in order to ensure its conservation.

2. The legal and institutional context

In view of the above, it is essential to draw up a water code regulating the use of water in detail. While governments have promulgated laws, decrees and legal norms in all areas of public life, there are many States where this has not been done in respect of water. Unless a body of water law already exists, it must be drawn up by political institutions before a start is made with the use of surface and/or ground water either by private funds or under State control. Such legislation must clearly and precisely establish the rights and obligations of the user and respect and take into account the rights of traditional use. It must also describe and establish the necessary procedure for granting such rights as well as the essential restrictions.

Legislation in respect of water must be drawn up in accordance with the specific circumstances of each State. Depending on the circumstances in the different States (in a federal system) or departments (in a centralized system) it is equally possible to draw up either fundamental legislation compulsory throughout the nation together with various regulations for its

Figure 1
DIAGRAM OF IRRIGATED RIVER BASIN



Source: U.S. Department of the Interior/United States Department of Agriculture, "Irrigation Water Use and Management, An Interagency Task Force Report", Environmental Protection Agency, June 1979.

application, or uniform legislation for the whole of the State. The breakdown into basic legislation and regulations for its application possesses the advantage of being better able to take into account the particularities of a region. Nevertheless, this requires decentralized administrative authorities.

To ensure orderly use of water (surface and ground water) it is necessary to grant water rights to the different categories of users, and to include certain conditions regarding the use and conservation of the resource. These conditions must provide a basis for making the user responsible in the case of failure to meet the legal requirements or in the case of misuse of the resource. It must also be possible to deprive the user of water rights. Experience has revealed that these conditions are only taken seriously by large industrial firms when legislation makes it possible to severely sanction managers responsible for misuse or failure to observe decrees, guidelines, conditions, etc.

It has to be insisted that politicians should compel industrial organizations to give priority to protecting water resources without which life is not possible.

Consequently, legislation in respect of water must be divided into:

a) The Water Law
b) Water Administration Law
c) Regulations and standards.

Those aspects which are to be regulated by the Water Law are shown in table 1. Table 2 shows the regulations which are to be established by the Water Administration Law and table 3 shows the subjects and priorities for standardization in respect of water resources management.

In most countries there is no ministry which is solely responsible for the protection and use of water. Traditionally, the tasks were shared out between a number of ministries, administrations or institutions. Generally speaking, it is possible to conclude that the following ministries or bodies are responsible for particular sectors of water projects as far as the protection and use of the resource is concerned:

- Ministry of Planning
- Ministry of Finance
- Ministry of Agriculture
- Ministry of Energy and Mining
- Ministry of the Economy

- Ministry for Environmental Protection
- Ministry of Health
- Ministry of the Interior
- Ministry of Foreign Affairs (in the case of international rivers)
- Regional water authorities, departmental administrations or federal State governments, etc.

In the case of special measures, there are also project management authorities, as well as bodies for energy supply, water supply, irrigation associations or water associations and river basin authorities. Generally speaking, it is necessary for major projects for the development of water resources to be co-ordinated among all the above authorities and institutions. The different institutions have highly varied interests, which makes it difficult to take decisions in respect of a particular project and may delay the project for decades if there is no precise legislation relating to the development of water resources and water management.

Consequently, it is absolutely necessary to insist that precise areas of competence be established within the framework of water legislation and administration, as these may speed any decision-making process. Nevertheless, confusion between such areas of competence hampers and impedes the management of projects and decision-making.

The project management authorities are institutions set up for the implementation of specific projects. In general they are responsible for the administrative management of specific projects from the stage of planning and construction to that of operation and maintenance. However, in many cases their competence is extremely limited, in other words, they depend on the instructions issued by the ministries involved. Above all, they are not financially independent. In the past this has in many cases led to a failure to take important decisions within the necessary deadline. Their financial dependence on the State budget had extremely harmful consequences. It is therefore essential that the project management authorities possesses the necessary competence within the framework of the water laws and relevant administrative instructions, in order to be in a position to carry out its functions in an independent manner.

This implies that the relationships and responsibilities must be clearly and precisely marked out. Decentralized structures are better able to achieve this than centralized systems. However, the choice of one or another of these

Table 1

CONTENTS OF THE WATER LAW

1. The national water code
   - Scope of jurisdiction
   - General principles
   - Administrative obligations
   - Definitions

2. Water ownership and water rights
   - Public ownership of the water resources
   - Private ownership
   - Water rights

3. Water Use
   - Principles of water use
   - Usage affecting the natural water resources
     . Authorization
     . Groundwater
     . Surface water
     . Costal water
   - Specific purposes of water use
     . Drinking water
     . Irrigation
     . Industrial use including hydropower
   - Wastewater discharge
     . General
     . Sewerage systems
     . Treatment requirements
   - Reuse

4. Protection against pollution
   - General requirements
   - Disposal of sludge and similar waste
   - Garbage disposal and dumps
   - Protected areas

5. Dams and other water-related works
   - Dams
   - Other works and constructions

6. Water rights register and land ownership
   - Water rights register
   - Water-related incumbrance and servitudes
   - Expropriation and option on purchase
   - Land ownership

(Table 1 conclusion)

7. Charges, fees, contributions
   - Pricing for water use
   - Connection charges
   - Other dues

8. Water-related incentives and subsidies

9. Water resources research and development
   - General
   - Data bank
   - Co-operation between agencies
   - Participation in sectoral planning
   - Water resources planning

10. Water administration
   - General
   - Water emergency measures

Table 2

NATIONAL WATER CODE
WATER ADMINISTRATION LAW
ADMINISTRATIVE POWER AND AUTHORITY

1. General

   - Range of application
   - Definitions

2. Permits and licenses

   - General
   - Application proceedings
   - Decision on applications
   - Special provisions and conditions
   - Revocation of a permit or license

3. Rights and duties of the officials

   - General
   - Rights concerning private properties
   - Measures of enforcement
   - Duties of the officials

4. Liability for damages

   - Damages caused through administrative action
   - Damages caused by the concerned person
   - Damages caused by disregarding the regulations
   - Third parties damages

5. Formal regulations

   - Effective date of application
   - Future provisions

Table 3

STANDARDS

1. Definition
2. Importance of standardization
3. Present situation and analysis
   - Applied standards for water
   - Standard organization and procedures
   - Analysis
4. Conclusions and recommendations
   - Subject and methods of standardization
   - Process of standardization
   - Enforcement of standards

(Table 3 conclusion)

EXAMPLES OF AREAS AND PRIORITIES FOR STANDARDIZATION

Subject	Priority	Comparable international standards	Remarks
HYDROLOGICAL STATIONS - Equipment	I	WMO-Recommendations	Standardization should aim at unification of equipment in order to facilitate operation, use of spare parts, comparability of results. Compulsory for all governmental agencies and new stations.
- Network	II	WMO-Recommendations	Standardization should aim at optimization of network by integration of governmental and non-governmental stations on the basis of the existing stations, including guidelines for the allocation of new stations of various ranges of observation. Compulsory for all governmental agencies. Basis for contracts with non-governmental institutions.
WELLS - Control of water quality and yield	III	WMO-Recommendations Deutscher Verein von Gas- und Wasserfachamaennern (DVGW) DVGW W 111 (Pumping tests) DVGW W 115 (Well drilling for water development)	Standardization should aim at preservation of public health as well as data collection to improve planning situation. It should comprise standardization of equipment, methods and frequency of sampling, range and methods of laboratory work. Standards should give different restrictions depending on the planned use of the well water for household, agriculture, or industry. As far as pumping tests are concerned, only equipment and documentation of methods and results should be standardized; testing and evaluation methods should be recommended, however variation should be allowed for whenever the natural or economical environment requires. Compulsory for governmental wells; for private wells only through contract or provision in the drilling permit (e.g. when water is distributed to other people than the owner's family or when data on aquifer cannot be obtained through neighbouring government wells).

systems depends on the overall structure of the public administration. While in a centralized system political decisions can be taken at a ministerial level, in a decentralized system they may be shared out among the State ministries and the lower-level departmental bodies which possess specific functions and competence. The project should be managed by a decentralized organization, in other words an individual authority should be set up for each large scale project or each large-scale management of natural resources which must be integrated into the political structure.

3. Specific project conditions

Regulation of the areas of competence for project implementation is extremely varied, depending on the nature of the project. In most cases, for example, competence for major hydroelectric projects is in the hands of electricity supply companies. In accordance with their functions and responsibility for guaranteeing energy supply, they are at one and the same time applicants of the projects, borrowers, and project management authority.

Generally speaking, political institutions are only involved in so far as they are required to provide their general declaration of intent and, in certain cases, State guarantees for investment credits. In addition, they are responsible for decisions relating to the granting of water rights to the energy supply company. However, in most cases they scarcely or inadequately carry out their responsibility to control the actual use and fulfilment of the conditions in respect of environmental protection. This is because energy companies are extremely powerful commercial concerns, possessing high capital and independent income, which produce and sell energy. These firms exercise care not to undertake uneconomic projects. In fact, it is often they who define government policy, invoking their responsibility to guarantee the supply of energy. For this reason they exert decisive influence over political decisions.

Water supply companies, supplying drinking water and water for industrial use to urban areas and major cities, are in a similar position to energy supply companies. They also possess a tariff structure which renders them economically independent. If this tariff structure and the actual income from the sale of drinking water are not guaranteed due to governmental

interventions referring to the price of water, such firms often lack adequate equipment and personnel and the water supply is not guaranteed. However, those water supply companies which operate satisfactorily exert considerable influence over political decisions and are relatively independent, just like energy supply companies. They are at one and the same time planner, borrower and project authority. Since it is necessary to ensure the supply of drinking water, politicians put up scant resistance in the face of the wishes of the companies. Otherwise, they would have to face the complaints of the population if the supply of water were insufficient.

Circumstances are different both in the case of major irrigation projects and in large-scale operations to train rivers for the improvement of navigation or for flood protection. These types of projects does not receive backing from powerful commercial enterprises. Generally speaking, it is national strategies and policies for development which provide the basis for the conception of such projects, i.e., this type of project exclusively depends on a political decision in respect of the development of certain regions of the country. The conception of the project is a part of the administrative decision-making processes. It is not, or only to a small extent, backed by private commercial interests.

For example, a decision to develop agriculture and increase agricultural production in order to achieve subsistence and augment export income is often motivated by the needs of the national economy and is politically sound. However, agricultural enterprises are hardly ever integrated into the decision-making and planning processes. This is the case for irrigation projects. In the agricultural sector, such projects are frequently linked to agricultural reforms, measures to resettle the population, etc. The political decisions taken to execute these measures are hard to implement and frequently jeopardize the success of the project. The opposition of those who are adversely affected is nearly inevitable and the administration is not in a position to guarantee that the project will be completed without interruption, which is necessary to ensure its economic success. Another factor is that the administration is not financially independent, as are energy or water supply companies, but dependent on State budgets. In almost all cases, once the project has been completed, this means that the authority lacks sufficient funds to fully execute all the tasks attributed to it. This is above all

apparent in the operation and maintenance of the project. It should be pointed out that long-term success is largely dependent upon maintenance.

A similar situation prevails in river training projects, although resistance on the part of those adversely affected is less intense, since flood protection measures involve an improvement in living conditions. The administration responsible for implementing the measures finds itself, however, in a similar position to those responsible for major irrigation and drainage projects. Conflicts over river training projects arise out of the fact that they either threaten, restrict or affect the rights of use of others. The success of such projects also decisively hinges on maintenance.

Multi-purpose projects involving components such as hydroelectricity, water supply, irrigation and perhaps also flood protection are particularly problematic. Conflicts of interests arise between the major commercial firms (energy and water supply companies) and the public administration, which is responsible for all the other components. In most cases the major commercial firms, which are in a far better financial position than the public administration, carry the day, and as a result dams initially conceived for irrigation purposes, and whose surplus water was to be used to produce hydroelectric energy, are in practice primarily used to produce energy, and only secondly to ensure the availability of irrigation water.

4. Principal restrictions

The main restrictions affecting efficient management of water resources in major river basins are as follows:

- Inadequate or inexistent legislation relating to water (Water right and Water Administration Law).
- Overlapping competences of the respective ministries, bodies and administrations on account of inadequate distribution of tasks and functions as well as insufficient distribution of political and technical responsibilities.
- A lack of development plans for the conservation and use of water resources at the national level and for each river basin as well as for surface and ground water.
- Administration rather than management of major projects.

- The lack of financial independence of the project management authorities within the State budget.
- Inexistent or inadequate participation on the part of the population affected in the design and supervision of the project.

5. Conclusions

From the above remarks on the restrictions and requirements of water law and administration, it is clearly necessary to establish the political and administrative conditions necessary for the water resources to be managed satisfactorily, and therefore to establish the authorities responsible for project management in the form of autonomous units possessing the necessary funds. It must be emphasized that after the implementation of the project the authority should possess sufficient income from the supply of water, for example from irrigation and drainage projects, or from navigation taxes in the case of river training and navigation projects, to ensure their financial independence. Only then is it possible to guarantee success over the long term. In the case of multi-purpose projects, the project management authority must precisely establish the order of priority of the different components and operate them accordingly.

Chapter II

CONCEPTUAL ANALYSIS OF THE MANAGEMENT OF WATER RESOURCES

1. Management objectives and tasks in respect of the overall strategy for water resources utilization

Overall delopment strategies are formulated in national development plans. Requirements for the exploitation of water resources spring from the objectives set by these plans, and are in turn subject to laws, norms and decrees. The objectives for the management of water resources are the same or virtually the same as those set by the national development plans, in so far as they concern the use of water resources. The objectives may be:

- an increase in agricultural production by means of irrigation,
- the provision of hydroelectric energy,
- flood protection.

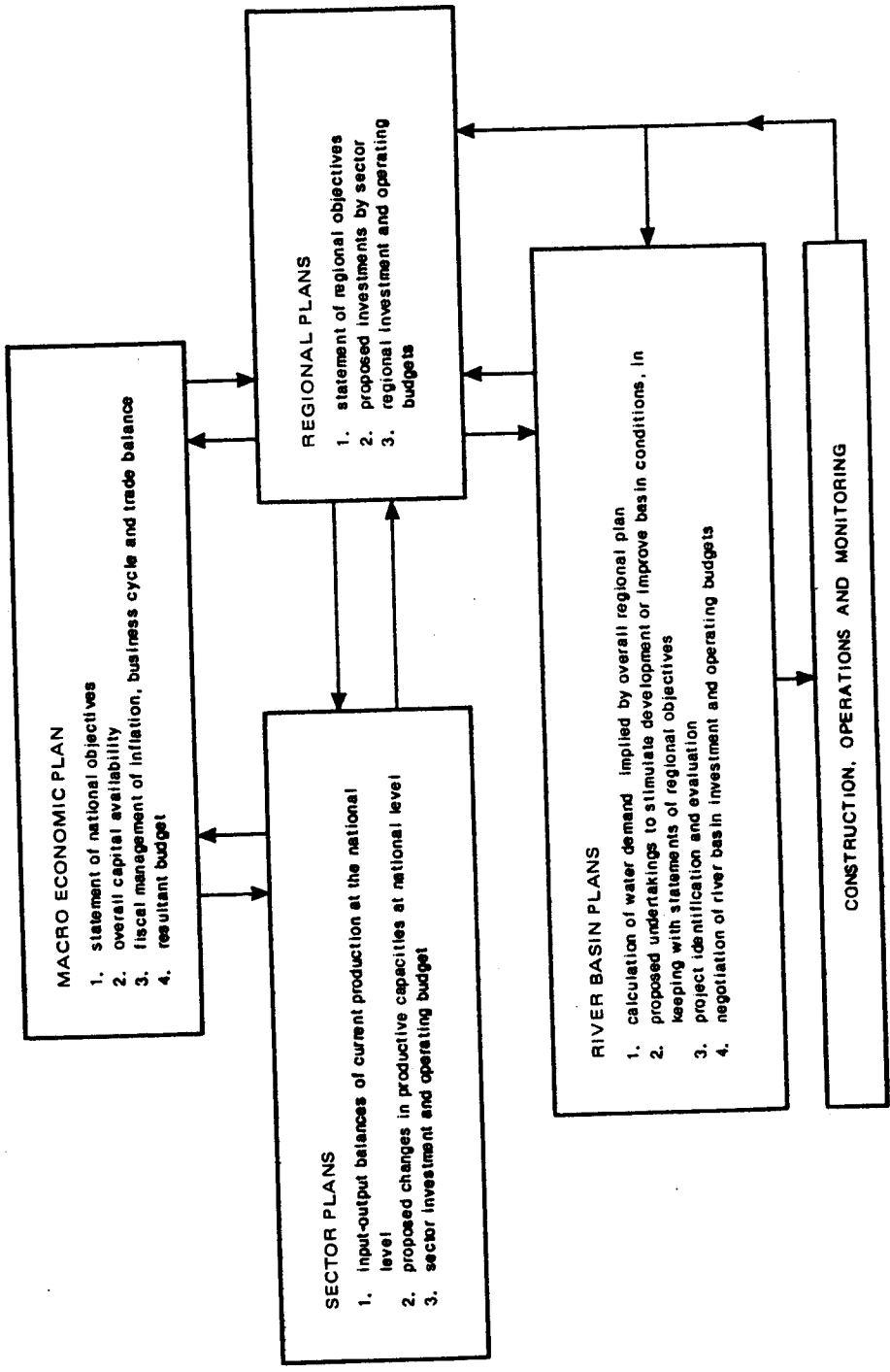
However, exploitation of water resources does not only depend on national objectives, but also on regional ones, i.e., the development possibilities of the different regions of the country as planned and formulated in the national development plans. The strategies and objectives of development at the national and regional levels differ from one state to the next. Consequently, it is not possible to make any definitive declaration in this respect. The only factor which remains unchanged in every case is the dependence of the exploitation of water resources on the development strategy.

The different levels of planning and their interconnections are illustrated in figure 2. Global development at the national level is contained in a macroeconomic plan, while the development of the different regions is determined in the so-called regional plans.

In order to exploit water as a resource and to make use of it with regard to development strategies as well as for all the other sectors of development

Figure 2

DIFFERENT PLANNING LEVELS AND THEIR RELATIONSHIPS



Source: OECD, "Management of Water Projects, Decision-Making and Investment Appraisal", Paris, 1985.

it is necessary to lay down sectoral plans. These hinge both on the macroeconomic plan and on the regional plans which also influence the determination of objectives and strategies. The development of river basin plans, in accordance with these requirements and objectives, is decisive for the development of water resources. The development possibilities of the different river basins will in turn influence the regional plans.

The following objectives may be defined for an orderly management of water resources:

- Improving living conditions
- Water supply
- Protection against floods
- Waste water disposal.

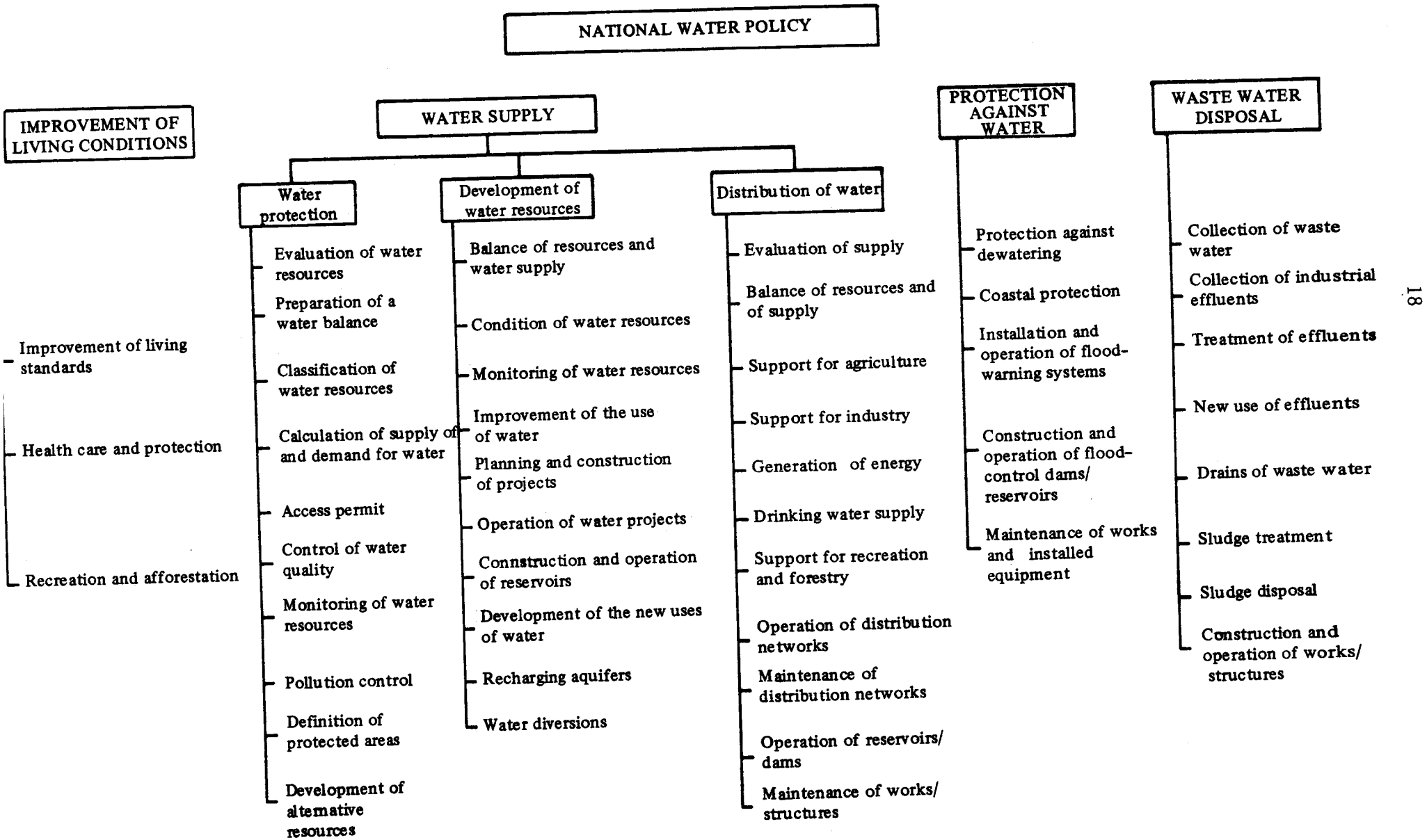
Figure 3 shows the links between the above-mentioned objectives and the tasks required in the management of river basins to achieve them.

The most important tasks may be set out as follows:

- Installation and operation of a hydrometeorological network
- Installation and operation of a network of streamgauges
- Collection and evaluation of measurement data in accordance with general norms as well as with the specific requirements of the project
- Establishment of water balances
- Identification of the demand for water for the different types of use depending on the strategy and objective of development
- Drawing up calculations for the satisfaction of demand
- Determination of priorities for use
- Elaboration of conditions for the use of the resources
- Monitoring the conditions
- Examination of the ecological compatibility of the resource development projects
- Project planning for the development of water resources
- Approval of the bases of the planning
- Supervision over the implementation of the projects
- Maintenance of the projects, components of the projects and the technical installations.

These tasks must be carried out in part by ministries and in part by the administration directly responsible. Planning, supervisory activities and the operation as well as the maintenance of the different projects are however the

Figure 3


NATIONAL WATER POLICY
IMPROVEMENT OF LIVING CONDITIONS
Improvement of living standards
Health care and protection
Recreation and afforestation
WATER SUPPLY
Water protection
Evaluation of water resources
Preparation of a water balance
Classification of water resources
Calculation of supply of and demand for water
Access permit
Control of water quality
Monitoring of water resources
Pollution control
Definition of protected areas
Development of alternative resources
Development of water resources
Balance of resources and water supply
Condition of water resources
Monitoring of water resources
Improvement of the use of water
Planning and construction of projects
Operation of water projects
Connstruction and operation of reservoirs
Development of the new uses of water
Recharging aquifers
Water diversions
Distribution of water
Evaluation of supply
Balance of resources and of supply
Support for agriculture
Support for industry
Generation of energy
Drinking water supply
Support for recreation and forestry
Operation of distribution networks
Maintenance of distribution networks
Operation of reservoirs/ dams
Maintenance of works/ structures
PROTECTION AGAINST WATER
Protection against dewatering
Coastal protection
Installation and operation of flood-warning systems
Construction and operation of flood-control dams/ reservoirs
Maintenance of works and installed equipment
WASTE WATER DISPOSAL
Collection of waste water
Collection of industrial effluents
Treatment of effluents
New use of effluents
Drains of waste water
Sludge treatment
Sludge disposal
Construction and operation of works/ structures

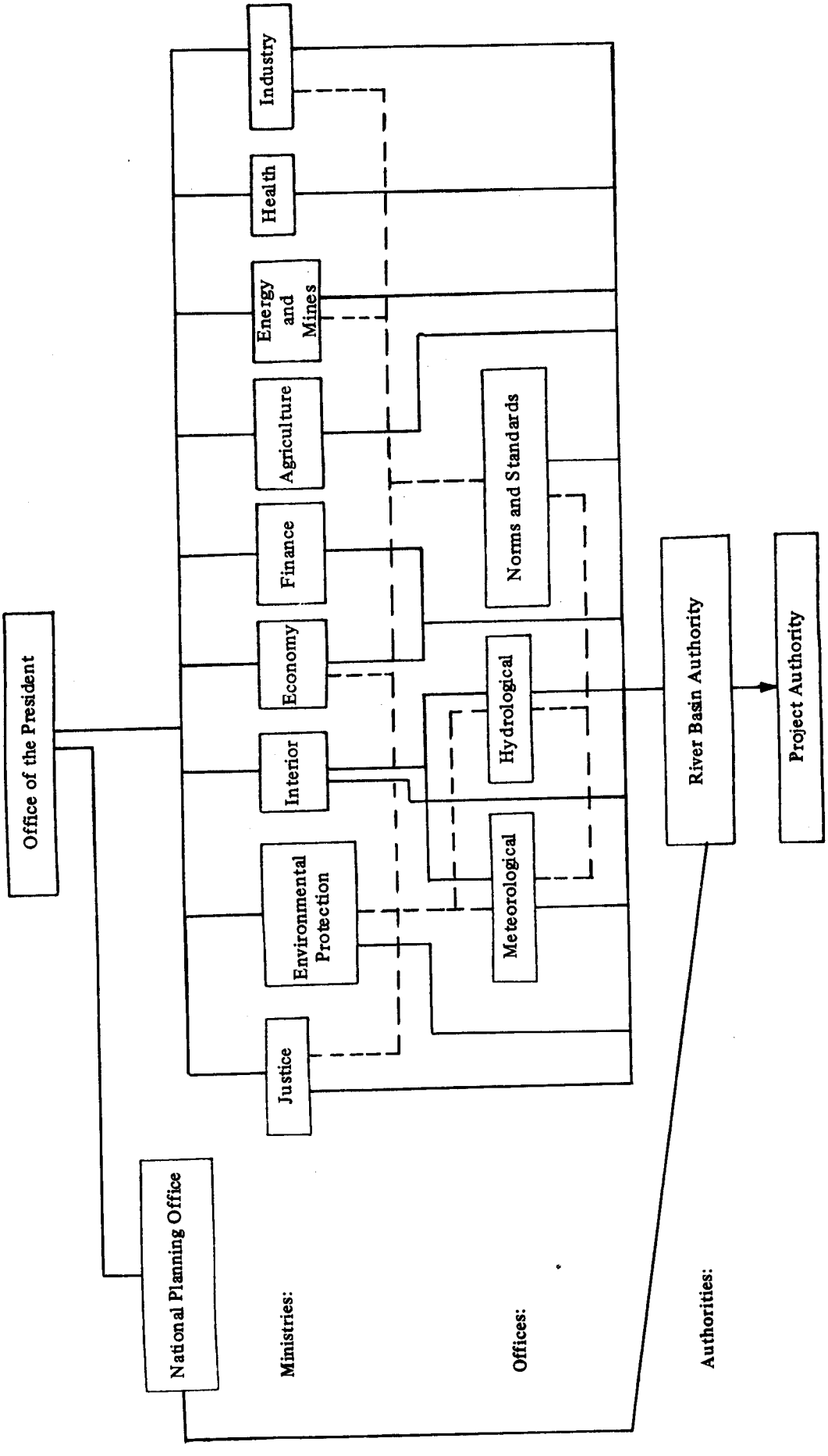
duty of the Project Management Authority (PMA), which is not necessarily part of the central administration. It should be an independent authority which manages the project on economic lines in accordance with the management of an industrial firm.

2. Interconnections between the different institutions and authorities involved

The general governmental and administrative structure is made up of innumerable institutions, ministries and national offices which participate in the decision-making processes related to the country's development and, in this particular case, to the development of water resources (see figure 4). Strategies are developed at the governmental level, while projects are executed at a regional level under the control of the ministries. At the regional level, there is a wide variety of areas of competence. Depending on the structure of the State and of the administration, the most important ministries are represented by offices or regional branches, or have alternatively established authorities charged with and responsible for the management of a river basin, and it is possible that regional areas of competence may go beyond regional administrative boundaries; only in a minority of cases do these boundaries coincide with natural river basins. For this reason, the River Basin Authority (RBA) is or may be responsible for managing a basin situated in several departments or federal States, supervising and co-ordinating all activities related to the use and protection of the water resources, etc.

Generally speaking, such authorities are not autonomous institutions with exclusive responsibility, but are rather subject to political and administrative measures as well as being dependent on ministries which may exert influence over their decisions. Consequently, it is necessary for measures related to the development of water resources to be agreed with the ministries. While all ministries possess the same rights within the government, they are nevertheless of varying importance. The influence of the Ministries of Industry, Energy, Finance, for example, is certainly greater than that of the Ministry of the Environment or that of Health, which explains why projects and other developments have not always met the objectives mentioned under item 1 of this chapter. On the contrary, there has frequently

Figure 4


Office of the President
National Planning Office
Ministries:
Justice
Environmental Protection
Interior
Economy
Finance
Agriculture
Energy and Mines
Health
Industry
Offices:
Meteorological
Hydrological
Norms and Standards
Authorities:
River Basin Authority
Project Authority

been a failure to take into account objections relating to the environment or to harmful social and economic consequences.

In addition to conflicts of interests within the government, third party interests are also affected by certain development projects; for example, the interests of the donor countries. It follows therefrom that the decisions taken by a River Basin Authority or by institutions responsible for the development of the region always lead to really satisfactory development. For this reason, and in order to avoid overlapping responsibilities and competences as well as the negative development resulting therefrom, it is suggested that an institution be established with exclusive responsibility for the control of all activities related to the development of water resources. This institution should constitute the sole organ of control and supervision over the locally responsible administration. Table 4 sets out the functions of such an institution. It could be established as an autonomous ministry or as part of another ministry, for example, a Ministry of the Environment. In order to ensure co-ordination between the remaining ministries and authorities responsible for water and for development policy it is necessary to set up a National Water Committee to assist this institution and to co-ordinate the different government institutions charged with the development of water resources. In addition, the Committee could act as an arbitrator in the case of disputes between the institution and private users. It follows that the members of the Committee must be high-ranking members of the government, capable of taking decisions on behalf of their institution and their ministry. All the members of the National Water Committee must be permanent. The Committee could have the following structure:

- Secretary (Minister or Vice-Minister for Water)
- Members:
  . Department for Water Resources Development
  . Ministry of Planning
  . Ministry of Finance
  . Ministry of the Economy
  . Ministry of Agriculture
  . Ministry of Industry
  . Ministry of Energy and Mines
  . Regional authorities for the development of water resources
  . River Basin Management Authorities, etc.

Table 4

MAIN FUNCTIONS OF A CENTRALIZED WATER ADMINISTRATION

- Formulation of the national water policy
- Preparation of water-related legislation including proposals for standardization
- Issue of guidelines to regional and local administration
- Evaluation of water resources at the national level
- Execution of hydrometeorological survey including data analysis and data processing
- Processing and publication of data concerning water resources
- Assessment of water demand at the national level
- Co-ordination with other sectors at the national level
- Allocation of financial resources
- Appointment and replacement of heads of units of the regional level
- Approval of organizational changes of the regional level
- Supervision of the local/regional level including right to overrule in important cases
- Co-ordination between units of the local/regional level in case of boundary-crossing tasks
- Co-ordination and decision concerning transmission of water resources between areas of regional responsibility
- Filing of individual water rights
- Training of staff at all levels
- Research
- Settling of legal disputes between citizens and the local/regional level
- Approval of all water resources projects and activities

The activities of the National Water Committee should be supported by personnel from the Ministry of Water. Its functions are set out in table 5.

Competence at the regional level should be attributed to the River Basin Management Authorities. They may be managed as associations, as is the case, for example, in the Federal Republic of Germany.

A Water Associations Act must lay down the legal bases and functions of the association. Its main tasks are as follows:

- to provide, modify and maintain in proper conditions the water courses and their banks, and to control the flow conditions;
- to provide, modify, maintain, operate and utilize navigation facilities, impounding reservoirs, locks, levee sluices, and the like, as well as hydroelectric power plants and water collecting basins;
- to irrigate and drain plots of land and protect them against flooding;
- to discharge, utilize, treat and neutralize innoxious waste water;
- to supply drinking water and water for industrial use;
- to improve and maintain soil under cultivation;
- to manage and control ground water;
- to reclaim flooded and water-logged land.

The members of the River Basin Association are landowners, industrial firms, mines and all those who:

- benefit from the accomplishment of the tasks assigned to the Association;
- caused damage which made the establishment of the Association necessary;
- were required to pay contributions to cover the costs of water management, of engineering, soil improvement, waste water treatment, reservoir operations, etc.

From the organizational angle, River Basin Associations are self-governing bodies. The organs which make up the associations are the board of directors and the assembly, which is composed of all associates. The board of directors is elected by the members for a term of office laid down in the articles of the association. These articles specify the number of boardmembers. The statutes of the association as well as the election of the board of directors must receive confirmation from the relevant ministry. The assembly carries out the following tasks: examination and supervision of the activities and decisions of the board of directors and the budget, as well as

Table 5

THE FUNCTIONS OF THE WATER COMMITTEE

- To approve guidelines concerning the general water policy prior to release by the Ministry of Water
- To approve draft decisions concerning general priority for certain sectoral or regional water demands
- To take decisions when agreement cannot be reached on the allocation of water supply to water-consuming projects
- To discuss all principal issues concerning water resources, development, and use and to advise the Minister of Water on these issues
- To appoint one or more commissions to decide legal disputes between the water administration and private parties.

discharging the board of directors from its responsibilities at the end of each financial year. In addition, it may provide the management with assistance in all major areas. The management deals with the association's relationship with the outside. The association is financed from the subscriptions paid by members and the sums paid for the volume of water sold. An income statement must be drawn up each year, showing expenditure and income. Such expenditure as is not covered by the members subscriptions or income from the sale of water may be financed by credit.

The River Basin Association is always under the control of the public sector, represented, for example, by the Ministry of Water. It must request authorization for all water projects from the competent administration, although it is nevertheless responsible for carrying out the project itself.

The River Basin Association or Authority is not simply an institution for planning, co-ordinating and controlling all measures linked to the development of water resources in the river basin, but also constructs and operates the physical infrastructure, such as reservoirs, treatment plants, dykes, locks, etc. The operation of these structures may be the responsibility of the project authorities. These Project Management Authorities (PMA) in their capacity as commercial enterprises may be members of the River Basin Association or Authority. The River Basin Association or Authority supervises the correct execution of the PMA's tasks and the use of the water as prescribed as well as the observation of the operating rules.

3. Stages of project development

If it has been decided to carry out a project to develop water resources, for example a dam to generate hydroelectric energy or to supply irrigation in combination with the development of a rural area and the construction of the necessary infrastructure to distribute water, the River Basin Association or Authority is responsible for examining the project in the light of the legal regulations and of the development plan for the river basin. At the same time for requesting approval for the implementation of the measures from the Ministry of Water or respective department of the Ministry for Environmental protection. It may set up a project management authority responsible for the planning, construction and operation of the project. This body may either be a

department or a private member of the co-operative or of the River Basin Association or Authority.

A time sequence of the activities is given in figure 5.

Clearly a period of between five and ten years may be necessary for the implementation of a multi-purpose project from its initial design to completion, and in extreme cases even 20 years may be necessary. Since such projects imply decisive intervention, it is necessary to carry out research from the very beginning of the project in order to minimize possible damage. Only carefully considered planning gives a clear picture of the costs and subsequent expenditure which will be necessary to eliminate any damage caused to the environment. On the basis of this planning it will be necessary to carry out a cost-benefit analysis, to provide a basis for financing the project.

From the outset of the project it is necessary to identify those who will or may be affected thereby, and to involve them in the processes and decisions linked to the project. If the institution responsible for planning and implementation is a River Basin Authority, it is easier to obtain the participation of the affected population than under other forms of administrative structure, since at least part of the population concerned belongs to the association. Figure 5 shows the different stages of planning in relation to the early participation of the affected population.1/

4. Impact of the project on the environment and environmental protection measures

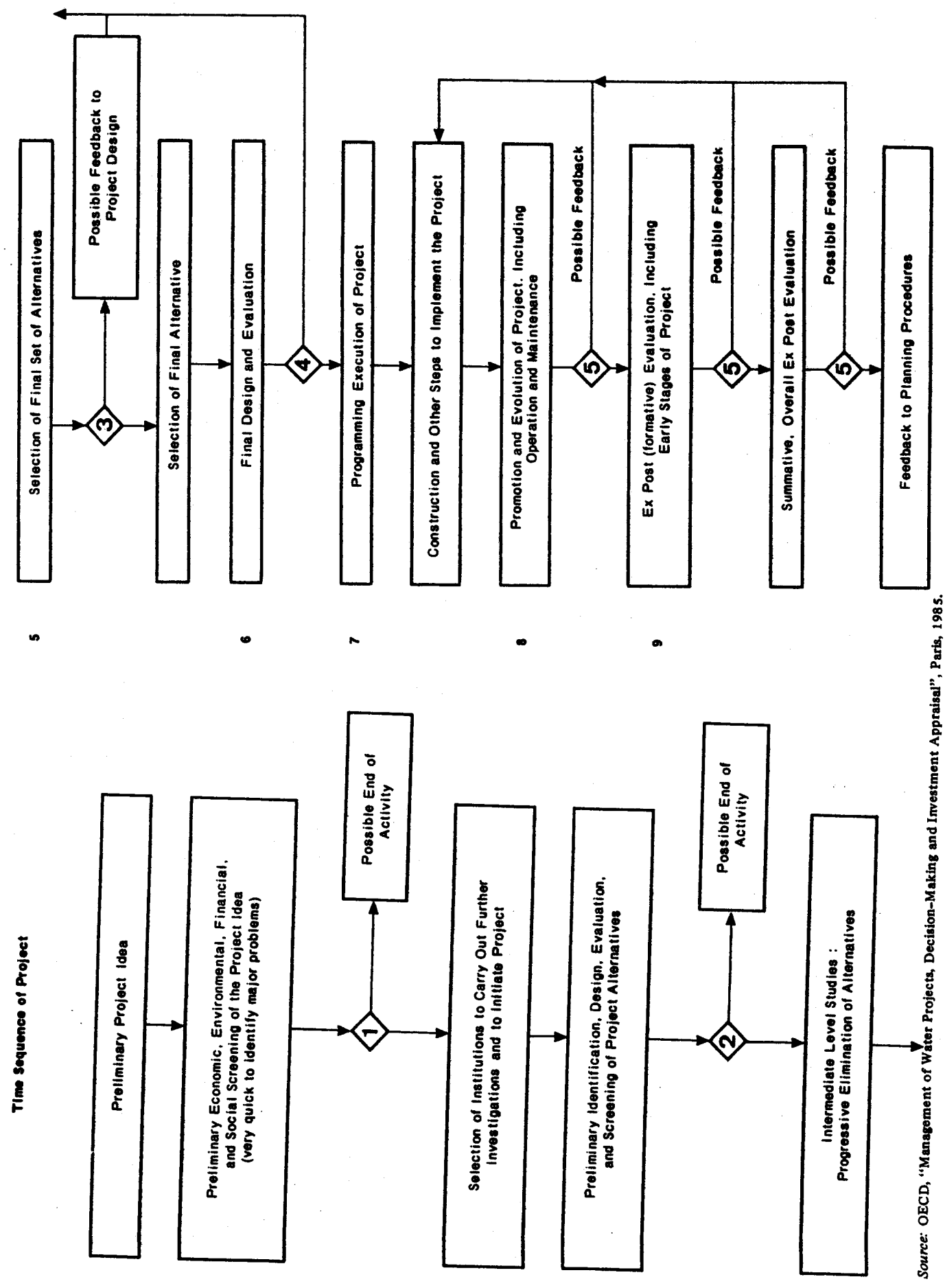
Any project to develop water resources constitutes an intervention in the environment. The term "environment" may be interpreted as follows:

a) The natural environment:
   - The physical and geographical system
   - The biological system.

b) Sector of utilization: this section covers the different forms of economic utilization of natural resources, such as:
   - Development of water sources/water supply
   - Energy
   - Agriculture and forestry
   - Fisheries

Figure 5

A MASTER TIME SEQUENCE OF WATER PLANNING ACTIVITIES



Source: OECD, "Management of Water Projects, Decision-Making and Investment Appraisal", Paris, 1985.

- Communications including navigation
- Other branches of the economy, such as:
- Tourism
- Industry, etc.

c) The human environment: the term "human environment" in its broadest sense covers society together with the whole of its social and cultural aspects, influences on human life and the standard of living.2/

The various activities and measures taken in connection with the different projects have varying impacts on the environment. These are so complex and so manifold as to make it impossible for them to be specified in this document.3/

Projects to develop water resources frequently cause economic and social problems. These are almost always due to inadequate management of the water resources as a result of an inadequate structure.

Problems in the management of water resources directly lead to environmental problems.4/ It is apparent from the causes of environmental damage that environmental protection is an essential and fundamental task for water management. Only sound administration of resources together with a competent river basin association or authority resting on sound legal and financial foundations can make an essential contribution to environmental protection. It is essential to carry out ecological compatibility studies for each project, in order to identify the effects of the measures and minimize the impact of the project. Additional components and measures to the project will make it possible to avoid, or at least to minimize environmental damage. Again, this issue is so complex that it is impossible to enter into greater detail here. Decisions relating to environmental protection measures must be taken in accordance with the individual characteristics of each project. It is impossible to make generalizations.

Chapter III

THE STRUCTURE OF A PROJECT MANAGEMENT AUTHORITY

1. The objectives and tasks of management

The objectives of managing water resources may include:

- optimization of the use of the water resources for agricultural or industrial ends or to meet the needs of the population
- minimization of interventions in the river basin area and of resulting environmental damage.5/

In the case of major water projects, such as for example hydroelectric projects involving major dams, irrigation projects, multi-purpose projects, "water management" is similar to river basin management or watershed management on account of the measures taken in the area of the basin and their inherent impact.

Consequently, the Water Management Authority (WMA) has two important functions:

a) Watershed Management (WM):

Co-ordination of all the measures taken to develop the water resources of a river basin (utilization of the surface and groundwater), taking into account environmental conditions.

b) Project Management (PM):

Specific project responsibilities:

- planning and construction
- operation and maintenance
- profitability with optimization of the benefits
- improvement of regional social conditions.

2. Responsibility in respect of general issues

The political and administrative institutions should endow Water Management Authority with full responsibility in regard to its decisions and the execution of the measures, in accordance with the objectives and tasks.

a) The Watershed Management Authority (WMA)

The WMA must assume full responsibility for its work and activity and observe both laws and regulations and specific technical norms. While it must not be influenced by day-to-day political considerations, on the other hand it must assume responsibility before the competent political institutions.

The WMA will have to carry out the following functions:

- Undertake the integral planning of the water development project
- Planning the utilization of the water resources, soils, etc. (long-term programme and establishment of priorities for projects)
- Establishment of norms
- Co-ordination and approval of individual projects
- Evaluation and supervision of individual projects.

b) The Project Management Authority (PMA)

The PMA will take responsibility for the following activities:

- Planning the specific project
- Implementation of the project
- Operation of the project
- Maintenance of the infrastructure works
- Financial and credit questions
- Collection of taxes on the use of water (e.g., for the sale of water to irrigators, producers of hydroelectric energy, etc.).

Under normal circumstances, i.e., when a large number of relatively small agricultural enterprises is supplied by large reservoir, the PMA is only responsible for supplying the water and distributing it to a tertiary canal, in other words, the PMA is responsible for the maintenance of the dam and of the principal canals (primary and secondary). From the tertiary canals onwards, the agricultural enterprises must assume responsibility for maintenance. In the case of irrigation and drainage projects where there are special circumstances, the PMA may also be responsible for marketing products and for the extension service.

The PMA must collect taxes on the use of water at the point of delivery, depending on the quantity and distance over which it has been transported to the agricultural firms. Consequently, the PMA should be run on the lines of an industrial enterprise to generate benefits in the political, economic, entrepreneurial terms. It goes without saying that the management of industrial firms or of those producing energy requires a rigorous organization, a feature which has so far rarely been the case of the agricultural sector.

In the case of hydroelectricity and water supply projects the tasks of the PMA are in general carried out by the supply companies, most of which are in a relatively sound financial position in comparison with other firms. Such is not the case of the management authority of major irrigation projects whose structure and functions are described below; it has been shown that such authorities are the weakest institutions, since most of them do not possess sufficient funds of their own for the operation and maintenance of the project, but are dependent on funds from the national budget.

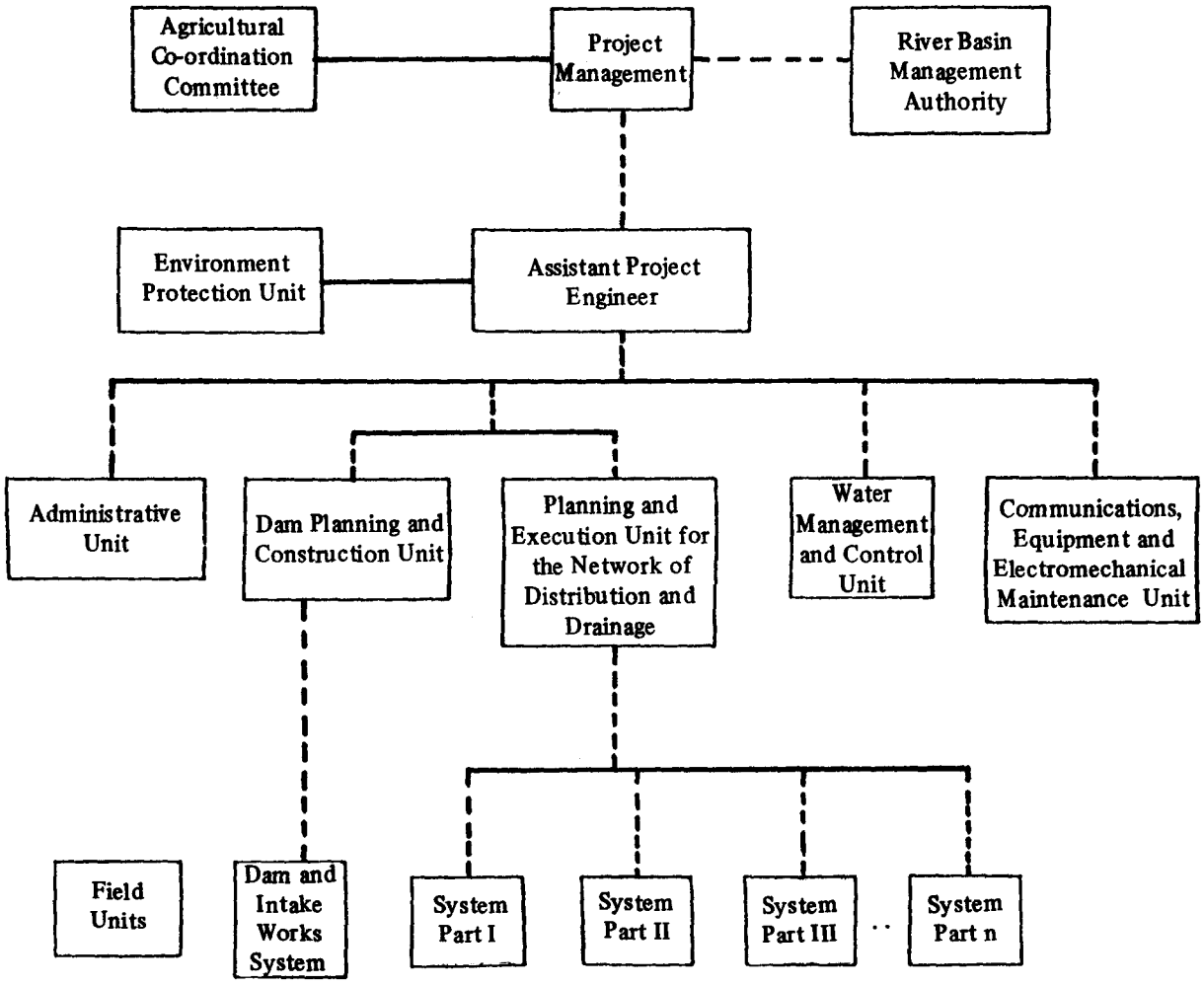
3. Staff requirements

Staff requirements essentially depend on the tasks and structure of the Project Management Authority. In the case of irrigation and drainage projects, the authority could be organized along the lines shown in figure 6. No provision is made here for the organization of authorities responsible for the management of other types of project, such as hydroelectric projects.

The staff requirement in each particular unit depends on the respective stage reached by the project. At the outset of a project less skilled personnel are required than during the operating stage. The number of units also increases during the execution of the project. During the planning and implementation stages the technical planning department must employ skilled personnel, as it is one of the most important of the authority's departments. Once the construction work has been completed and the project has begun to operate, only a small part of the personnel of this department will continue to work in the Engineering Services Unit, whose tasks mainly consist of planning, putting out tenders for, and supervising maintenance work on canals and roads as well as improvements and the reconstruction made necessary by the operation of the project.

Figure 6

ORGANIZATION CHART FOR AN IRRIGATION PROJECT AUTHORITY



The personnel, who will subsequently be responsible for the operation and maintenance of the structures, should already be employed during the construction of the major hydraulic works, such as canals, reservoirs, dikes, etc. Through its collaboration in the construction they will acquire a technical understanding of the operation of the works together with a grasp of the maintenance requirements.

4. The budgetary and financial position

The Project Management Authority must possess the necessary budget to carry out the tasks involved in the different stages of the project for which it is responsible, i.e., the study and design stages, as well as execution and operation. This will prevent difficulties arising over personnel, and will ensure that the necessary funds are available to run the offices, vehicles, and to pay for material, etc.

As a considerable proportion of the studies and design receive international funding, the budgets and funds are ensured through the budget of the respective ministries or through external funding. The authority receives support in carrying out the study from consultants, and it is possible to keep the number of staff posts to a minimum. The same is true of the funds necessary for the execution stage, although the number of personnel will vary in accordance with the state of progress of the construction works and the requirements of the authority.

During the operating stage the necessary funds must be guaranteed by the State budget. If the authority receives income from the project (taxes paid by farmers for water rights, payment of services, etc.), it will be possible to reduce the public funds by a similar amount.

One problem which arises in almost all major irrigation projects is the lack of budgetary funds during the operation, as the authority receives no income of its own as it supplies water free of charge to irrigators. It must be clearly established that:

- the authority and operation of the system will be financed from the sale of water, or
- the necessary funds from the national budget will be made available to the authority through a subsidy to the price of water.

5. Physical characteristics and requirements

a) Operation

In order to carry out the tasks satisfactorily, by which we mean not merely to administer, but to manage the project on the lines of an industrial enterprise, among other things, the following physical equipment is required, for example:

i) Sufficient office space for the personnel:
   15 to 20 m2 per person (employee)
   3 m2 per labourer
ii) Warehouse: 300 - 500 m2
iii) Office furniture and equipment:
   - furniture (cupboards, desks, chairs)
   - typewriters
   - copiers
   - heliograph
   - pocket calculators
   - personal computers
   - topographic instruments
iv) Office materials
v) Vehicles
   - four-wheel drive vehicles
   - pick-ups
   - motorcycles

all of which must correspond to the functions of the personnel and their tasks as well as to the different stages of the project.

More vehicles will be required during the implementation of the project than during its operation.

b) Maintenance

Different types of equipment and machinery will be required for the maintenance of the project depending on the work to be carried out, for example:

i) Sufficient office space for the personnel:
   10 m2 per foreman and employee
   2 m2 per worker for communal rooms, etc.
ii) 200 - 500 m2 workshop depending on the type and size of the project

iii) The workshop must be fitted out and provided with the necessary machinery and equipment for the repair of the hydraulic steel structures:

- vehicles
- machines
- generators
- turbines
- earthmoving equipment and tractors
- machinery for cleaning the canals.

6. Location of the Project Management Authority

The Project Management Authority must be located in the project area. Its actual location depends on the type of project.

i) In the case of hydroelectric projects it should be located in the area of the dam or hydropower plant.

ii) In the case of irrigation projects the Authority should be located in the project area.

The location of the Authority should be such as to ensure the following:

- it should be accessible throughout the whole of the year
- it should have easy access to the regional road network
- it should be able to communicate easily and rapidly with the whole of the project zone
- it should be located at the main point of trans-shipment with a view to commercialization.

Consequently, an outlying small town with good road communications could be chosen as the headquarters of the Authority. If, however, a central place in the project area meets the above criteria, priority should be given to this.

Chapter IV

THE MANAGEMENT ACTIVITIES OF A PROJECT AUTHORITY

1. Introduction

The Project Management Authority (PMA) has responsibility for the whole of the planning, execution and operation of a project; it is consequently necessary that it be created at the outset of the project.

Since the Watershed Management Authority (WMA), as the supreme authority is responsible for co-ordinating the utilization of all the water resources, at the beginning of the project, i.e., during the initial examination and design, these tasks may be carried out by one of its departments. The period over which the department can perform the functions of a Project Management Authority or the decision to establish an autonomous authority will depend upon the type and scale of the project. For example, in the case of a hydroelectric project, the energy supply company will assume the functions of a PMA; in the case of irrigation projects it is not necessary to set up a specific authority, although this would be desirable and advantageous in the case of very large projects.

The tasks which correspond to the different stages of the project are irrespective of the institutional issues; nevertheless, it is essential to set up a project authority or a department of the Water Management Authority (WMA) to perform the required functions.

2. Studies and design stage

a) Preparation of a preliminary project;
b) Co-ordination of the preliminary project with the competent authority with regard to:

- use of water (availability of and demand for water)
- water rights
- soil conservation
- construction of dams or reservoirs (land use planning)
- intake of river water
- intake of groundwater
- introduction of drainage water.

c) Discussion of the project with the local population and others affected;
d) Preparation of a profitability study;
e) Review of the project design.

Once the study and design stage has been agreed upon and approved, it is possible to begin the stage of feasibility studies. The PMA does not itself carry out the prefeasibility and feasibility studies, but merely establishes the guidelines; it entrusts the task to independent consultant engineers and supervises and accepts the studies. The following activities in particular constitute important functions of the authority:

a) Negotiations with the bank or the credit granting institutions.
b) Requesting funding from the Ministry of Planning (for submission to the World Bank, IDB or other financial institutions).
c) Definition of the terms of reference.
d) Informing the local population.
e) Tenders for the design work.
f) Evaluation of bids and subsequent recommendation.
g) Agreement with the credit granting institution.
h) Awarding the design work to consultant firms.
i) Support for the consultants in carrying out their task through providing counterpart services.
j) Definition of criteria for environmental protection and restrictions on planning.
k) Involvement of the local population and other parties affected in the planning.
l) Supervision of consultant services.
m) Evaluation of alternatives considering environmental aspects.
n) Acceptance of the feasibility study.
o) Presentation and discussion of the study with the financial institution.

p) Informing the local population and other parties affected as to the results of the study.

q) Request for funding for the planning activities at the tender stage.

r) Execution of planning activities at the tender stage:
- Preparation of the terms of reference.
- Call for tenders.
- Analysis of the bids and award of contract.
- Presentation to the financial institution.
- Support for the consultants in the execution and provision of counterpart services.
- Supervision over the planning activities.
- Approval of the planning and documents at the tender stage.
- Presentation of the tender documents to the financial institution, their discussion and possible alterations.

s) Informing the local population and others as to the formal plan.

t) Disbursement of the funds for the studies.

3. Implementation stage

a) Presentation of the studies together with the application to the Ministry of Planning to obtain international or bilateral credit.

b) If necessary, implementation of agrarian reform (in case of irrigation projects in existing agricultural areas, compensation for areas required for canals, roads and reservoir).

c) Hiring personnel for:
- canals;
- alignment of transmission lines;
- roads (site roads), etc.

d) Negotiations with the financial institution.

e) Call for tenders and award of contract for the construction works, per lot of construction work if appropriate:
- reservoir;
- irrigation infrastructure works;
- drainage network;
- hydroelectric power station;
- transmission lines including transformer sub-stations.

f) If necessary, dissemination of information relating to resettlement measures and their execution.

g) Definition of regulations to minimize damage to the environment as a consequence of the execution.

h) Supervision of the construction works.

i) Review of the consultant's reports, of the plans, etc., together with the approval of alterations.

j) Acceptance of the structures (supervision of the test operation, etc.).

k) Bringing the system into operation.

l) Completion of financial operations:
   - settlement with the executing organisms;
   - settlement with the consultant;
   - settlement with the financial institution;
   - settlement with the competent Ministries (Ministry of Finance, Ministry of Agriculture, Ministry of Energy, etc.).

m) Successive hiring of personnel in accordance with the state of progress of the works, and their training in the operation of the infrastructure.

4. Project operation

Activities during the operational stage depend on the responsibilities of the project management authority during its operation and the resulting tasks. In particular, these activities are as follows:

a) River basin management activities

The availability of water is subject to certain variations on account of hydrological fluctuations. The use of water in the project as well as its distribution over time must not only correspond to the specific requirements of the project, but be planned and adjusted in accordance with the restrictions on which the approval for the operation is based and take into account other users.

It is necessary to co-ordinate and agree upon operating plans for the use of the water with the Watershed Management Authority for wet, average and dry years, as well as combinations thereof and for series of different years. It is necessary to adjust the plans drawn up during the design stage, since 10 years or more may separate the design stage from the beginning of operations. Analysis of the series of data for the most recent years (hydrometeorological

data) may reveal changes which could affect the strategy for using the water in the project. Watershed management must also take into account aspects linked to soil conservation and environmental protection of the physical-geographical and biological system.

Reafforestation programmes in the upper river basin to avoid erosion thereupon and sedimentation in the reservoir or project area are not the direct responsibility of the PMA. However, such a measure may be put forward as a requirement to the WMA.

A similar situation prevails in respect of deforestation and changes in the use of land in the upper basin, over which the project authority has virtually no influence.

b) Water management including reservoir operation

In this area the PMA must regulate the allocation of water in accordance with its specific use. In an irrigation project, for example, the amount of water drawn from a reservoir is calculated in accordance with the amount of water required by the plans, in other words:

- type of crop;
- growth;
- surface under cultivation;
- season (evapotranspiration), etc.

It is in accordance with the above that the water must be distributed in the fields. In order to do so it is necessary to draw up and agree upon crop plans and rotation plans with the farmers for the irrigation of the different perimeters.

The allocation of water in accordance with demand is a major task of the project authority, which contributes to the conservation of water. This highlights the difference between rational management of water by a project authority and ordinary administration, which generally involves releasing the water after a given date in unchanging quantities from the reservoir into the distribution network, without taking into account the preparation of the fields by the farmers, or the type of crops.

In multi-purpose water projects annual reservoirs must not solely be operated so as to maximize energy generation, but also in accordance with the volume of water necessary for the irrigated area. The volume of water available to generate energy during the different seasons of the year can be calculated on the basis of the above allocations and the amount of water left

in the river. Other norms may be adopted for projects involving inter-year storage dams.

The project authority must endeavour to ensure that the utilization of water takes conservation into account. In order to do so, in irrigation projects it is necessary to provide appropriate advice to farmers on calculating the demand for water depending on the crops and the seasonal distribution of the water. Field officers or extension officers must be trained to carry out this task. In order to optimize the use of the available water the project authority may prescribe crop rotation and the cultivation of particular crops on a certain percentage of the land.

c) Management of physical structures

The physical infrastructure must be operated by trained personnel from the project authority. The intake orifices in the dams must be opened and the distribution gates operated in accordance with the operational plan for the use of water and bearing in mind the plant's water requirements. It is necessary to adjust both of these permanently depending on the level of demand. In order to do so it is necessary to maintain close links with the farmers and also close co-ordination and communication among the personnel operating the different sectors of the system. The personnel will have to permanently control and adjust the allocation of water and must always be at the disposal of the farmers.

It is not sufficient to possess a theoretical operating plan; it must also be adjustable in the field in accordance with the personnel available. Consequently a relatively large number of personnel is required in this sector (see chapter V).

Management of the physical structures must also cover the adaption of the physical infrastructure (canals, outlet structures, regulating structures, etc.) to the operating conditions and alterations to the overall scheme over the course of its years of operation. In addition, it is necessary to design replacement structures and supervise the execution thereof. An engineering services unit is necessary to carry out these planning and supervisory tasks within the project authority.

d) Repair and maintenance

If a system is to function satisfactorily, a reliable maintenance department is necessary for the physical infrastructure. This means that the project authority must be able to count on adequately trained personnel to

maintain the different components of the work. In this respect, it is necessary to lay down certain service intervals for the different components and to specify the maintenance tasks themselves.

Those components of the work which require maintenance are as follows:

- all the mechanical gates;
- concrete structures;
- irrigation and drainage canals (removal of sediments and weeds);
- highway network and accommodation roads;
- measuring installations (water levels, streamlines, etc.).

The necessary personnel must be hired and trained during the implementation stage.

A workshop in which repairs can be carried on the following components is necessary:

- electromechanical components, such as gates, valves, etc.
- vehicles and machinery
- concrete and masonry, etc.

The necessary craftsmen must be at the disposal of the Project Management Authority.

e) Environmental protection

The Project Management Authority must also carry out tasks in connection with environmental protection. It must endeavour to ensure that the harmful impact of the project upon the environment is minimized. This involves the following tasks in particular

i) soil conservation by providing advice to farmers on:
   - conservation methods on cultivated land;
   - protection against erosion, e.g., wind fences, wind breaks;
   - drainage;
   - volume of irrigation water (risk of salinization);
   - methods of carry out leaching;
   - land levelling.

ii) water conservation:
   - economic use of water and demand-oriented irrigation;
   - water quality, for example
     . the ground water quality may be affected by excessive inputs of fertilizers, incorrect use of herbicides and pesticides, direct

infiltration from fields or from drainage canals, infiltration of polluted industrial waters;

. the surface water quality may be affected by the introduction of drainage water or of polluted water from enterprises agroindustrial, industrial and manufacturing);

- flood protection: reservoir operation must be such as to protect the land against flooding;
- it is must be compulsory for a certain volume of water to be released from the reservoir into the river to protect the aquatic and terrestrial fauna and flora.

iii) health of the population: minimization of the risks of diseases caused by aquatic pathogens and water-related vectors, such as, for example:

- schistosomiasis (spread by snails);
- malaria (spread by insects);
- typhus (spread by polluted water).

iv) sector of utilization: optimization of the use of resources to ensure the well-being of the local population.

v) human sector: improvement of social conditions through the development of the regional economy and the increase of other social consequences and improvements, such as:

- health;
- income;
- employment;
- education;
- fishery, etc.

f) Financial management

Financial management is one of the key tasks for the Project Management Authority.

The project can only be successful if there is a sound financial base for its long-term operation. In order to ensure this, the following are necessary:

i) the establishment of operating, maintenance and repair budgets;

ii) breakdown of costs into expenditure on personnel, material, service and operating expenditure as well as reinvestments;

iii) itemization of income:

- the price of water for users must be set as well as the price per kWh in the case of hydroelectric projects;
- co-ordination must be ensured and agreements reached with those who bear responsibility at the political level;
- the demand for subsidies must be worked out;
- applications must be made for public funds to meet the demands for subsidies;
- accounts must be settled and accounting records kept.

Chapter V

RESOURCES REQUIRED FOR PROJECT OPERATION AND MAINTENANCE

1. Organization and tasks

An example of the personnel structure for the operation of the project and maintenance of its physical infrastructure is given in the organization chart which appears in figure 7.

The project manager will be assisted in his tasks by an assistant project engineer. They will both be responsible for the operation of the project, as well as for its technical, financial and personnel development.

The Project Management Authority will be divided into different departments in accordance with the activities and tasks which need to be carried out within the project, bearing in mind its size and the different components of the infrastructure. Field units will be set up to ensure the operation of the project as well as maintenance work. Each of these units covers an area of approximately 4 500-6 000 hectares, which is in turn subdivided into zones of some 1 500 hectares each.

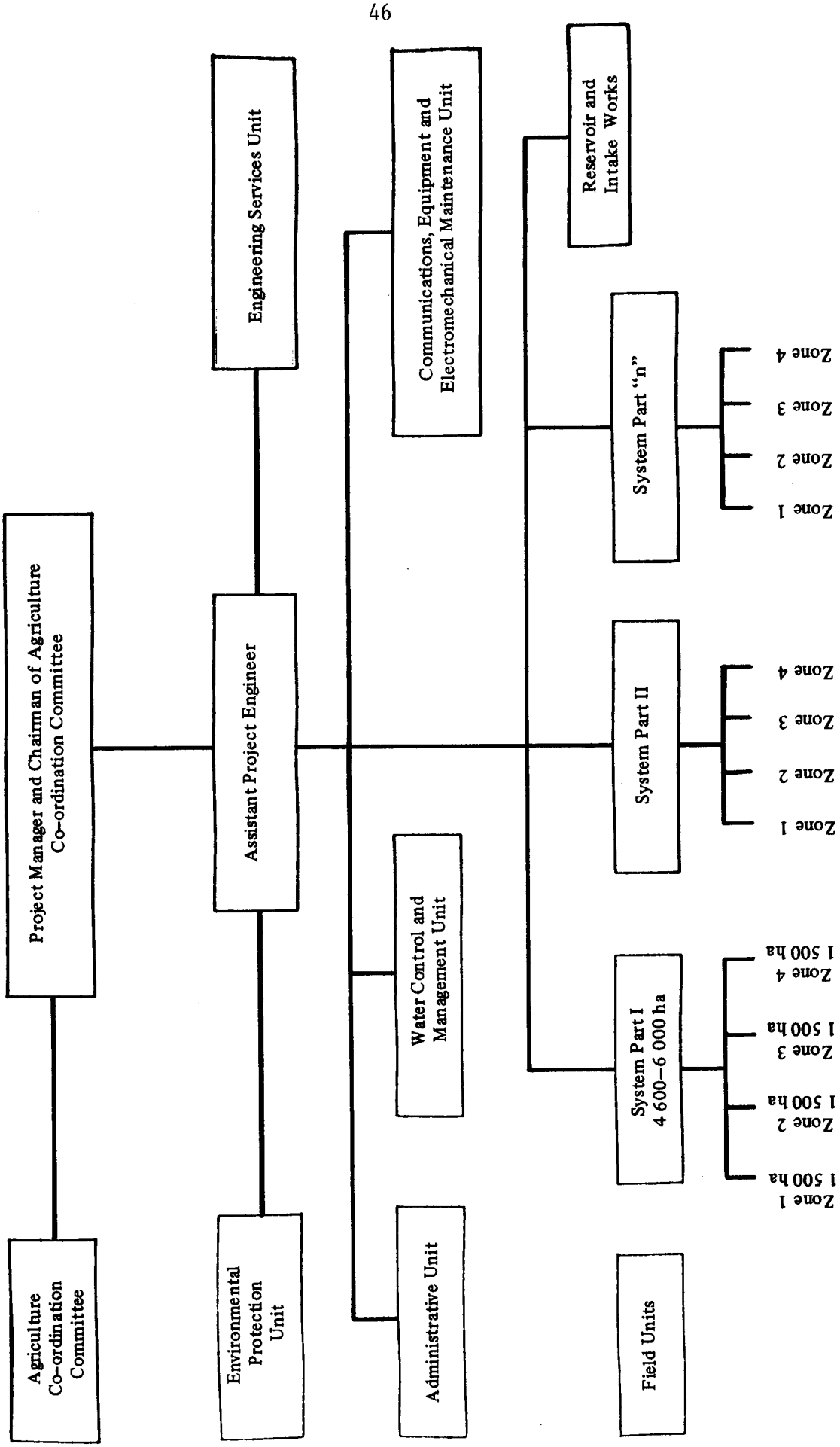
The departments or units are responsible for carrying out the following activities:

a) Agricultural Co-ordination Committee

The Agricultural Co-ordination Committee is made up of representatives of:

- the Ministry of Agriculture
- the Extension Service
- the Agrarian Bank
- the irrigation associations
- the agricultural co-operatives
- local agricultural institutions

Figure 7


Project Manager and Chairman of Agriculture Co-ordination Committee
Agriculture Co-ordination Committee
Assistant Project Engineer
Engineering Services Unit
Environmental Protection Unit
Communications, Equipment and Electromechanical Maintenance Unit
Water Control and Management Unit
Administrative Unit
Reservoir and Intake Works
System Part "n"
Zone 4
Zone 3
Zone 2
Zone 1
System Part II
Zone 4
Zone 3
Zone 2
Zone 1
System Part I 4 600–6 000 ha
Zone 4 1 500 ha
Zone 3 1 500 ha
Zone 2 1 500 ha
Zone 1 1 500 ha
Field Units

- the private local market
- the project manager from the Project Management Authority who is also the chairman of the Committee.

Prior to each season the Committee has the task of establishing the agricultural programme and the type of crops in accordance with prevailing conditions and government policy, as the water delivery schedule is based on an agreed cropping pattern for the irrigated area. The pattern does not only depend on the availability of irrigation water, but mainly on the marketing possibilities and/or government policies, the farmers' traditional cropping habits, the regional habitual diets, soil type and classification, topography, transportation facilities, introduction of new varieties or different crops, availability of seeds and other relevant factors. Since these factors may vary from year to year, cropping pattern is subject to a large number of modifications and alterations.

b) Project manager

The project manager is responsible for all water management and maintenance of the project. He is also responsible for finance, personnel, equipment, operation, maintenance, contacts with both the users of irrigation water or their associations and supporting services as well as with all other authorities and establishments involved in irrigation and drainage.

He is also responsible for submitting reports to the WMA on relevant issues and to the financing institution on the budget requirements for each financial year. He will also inform the WMA on any critical or emergency situation which may arise in his area, and give his opinion and advice to cope with the situation. The project manager also acts as a chief supervisor on the efficient and economic operation of all physical infrastructure and water management.

The project manager's main office consists of five additional units answering to the assistant project engineer and responsible to him. They are:

- Administrative unit
- Water management and control unit
- Communications and electro-mechanical unit
- Engineering services unit
- Environmental protection unit.

c) Assistant project engineer, engineering services unit and environmental protection unit

Assistant project engineer: responsible for assisting the project manager and acting in his place when he is away from the project; he is directly in charge of the engineering services and environmental protection units. These units assume the following tasks:

i) Engineering services unit

- Plan and programme all the operational and maintenance activities for the whole system.
- General supervision on the implementation of the programmes and activities mentioned above.
- Draw up a schedule and programme major rehabilitation or construction work in collaboration with the watermasters.
- Supervise all major repair and rehabilitation works.
- Keep records of and check operational, maintenance and rehabilitation works in accordance with the requirements and information obtained from the field staff.
- Carry out an annual evaluation of the system in respect of operational and maintenance works and prepare the corresponding reports.

ii) Environmental protection unit

- Plan for environmental protection measures in the project area.
- Execute programmes to measure the water quality (ground water and surface water), water tables and sedimentation.
- Environmental protection measures in the upper river basins, supply of data to the WMA and support for planning.
- Health of the population: planning measures against diseases spread by polluted water or by insects; training of the extension service staff in methods of minimizing damage to the environment.

The following units should also be under the responsibility of the assistant engineer:

iii) Administrative unit

This unit carries out the following tasks:

- Administer all legal, financial and budgetary affairs.
- Deal with aspects of the payroll and personnel matters.
- Procure land, equipment and materials.

- Advise other administrative matters.

iv) Water management and control unit

This unit:

- Plan and monitor cropping pattern and water delivery schedules for each season in agreement with the Agricultural Co-ordination Committee and the farmers.
- Prepare tables, diagrams and other items required for analysing the supply of water.
- Co-ordinate the cropping schedule together with the Extension Service.
- Plan the discharge, regulation and allocation of water into the main and secondary canals.
- In the case of multi-purpose projects, co-ordinate the discharge of water from the reservoir.
- Collect progress reports on all irrigation and agricultural activities.
- Plan changes in the water delivery schedule on account of rainfall or deviations from the cropping schedule and issue instructions in discharge adjustments on canal intake and lateral headgates.
- Prepare reports based on agricultural statistics from the areas under cultivation.
- Keep records of all water demands and releases from the headworks to the tertiary turnouts.
- Collect and keep records of agrometeorological data.
- Prepare educational and training programmes for the heads of areas served by an intake, operators of tertiary canals and farmers.
- Advise and assist the zonal watermen and their personnel in all matters relating to the on-farm operation and maintenance.
- In co-operation with the engineering services unit prepare reports on all irrigation and agricultural activities, water demands and discharges as well as hydrological and other records.

v) Communications and electro-mechanical unit

- Operate and maintain all telephone and radio-communications equipment in order to ensure permanent communications between the office and the field staff.

- Assist the personnel of the water masters and zonal watermen in maintaining all the mechanical and electrical equipment used in the project.
- Provide all welding services required in the field.
- Maintain and operate all the vehicles and mechanical equipment belonging to the project.
- Maintain all the floating equipment required in the reservoir.
- Operate a workshop for minor repairs of vehicles and the above equipment.

vi) Field units

For the organization of the operating and maintenance work, the irrigated area must be subdivided into sections of from 4 500 to 6 000 hectares. Each section must be served by a field unit which must in turn be subdivided into zones with a surface of approximately 1 500 hectares. (The criteria adopted for this subdivision may be the length of canals, the number of structures and intake works which may be operated, etc.) A distinction is made between the operation and maintenance of the main canal and its works, on the one hand, and the operation and maintenance of the secondary and tertiary canals and their works on the other (these will be carried out by zonal personnel).

- Reservoir unit

  In general this unit does not deal either with the distribution of water, the maintenance of the canal network or cultivation, but is responsible for the operation and maintenance of the reservoir and the head works, appurtenant structures, buildings and neighbouring sites.

- Field units No. 1 - n

  The operation and maintenance personnel of the subprojects is responsible for the following tasks: i) operate all gates and valves and maintain all the components of the system to ensure the scheduled flows of water; ii) collect all necessary data to establish cropping patterns, water delivery schedules, as well as for following up and monitoring these schedules; iii) establish contact with the operators of the tertiary canals, heads of irrigated areas and farmers and train and assist them in irrigation practices, and iv) in general, keep the Watershed Management Authority (WMA) informed as to events taking place

in the field while also acting as an organ for putting measures into effect.

2. Staff requirements and structure

The minimum staff and its structure are indicated below. This structure closely corresponds to the operational and maintenance organization established by the WMA. Nevertheless, it must be borne in mind that such a personnel structure is valid for major projects with irrigated areas of more than 10 000 hectares.

Position/Unit	Total number of personnel	Professional personnel	Non-professional personnel
- Project manager	1	1	
- Assistant project engineer	1	1	
- Engineering services unit:			
. Office engineer	1	1	
. Secretary/typist	1		1
. Technical engineers	2	2	
. Draughtsmen	2		2
. Surveyor	1	1	
. Survey workers	5		5
- Environmental protection unit:			
. Environmental engineer	1	1	
. Typist/secretary	1		1
. Medico-technical assistant	1		1
. Technician	1		1
. Laboratory personnel	1		1
- Administrative unit:			
. Administrator	1	1	
. Administrative assistant	1		1
. Accountant	1		1
. Chief storeman	1		1
. Storekeepers and workers	2		2
. Typist/secretary	1		1
. Auxiliary office personnel	1		1
- Water management and control unit:			
. Irrigation engineer	1	1	
. Asst. Irrigation engineer	1		1
. Hydraulic eng.	1	1	
. Hydrographer	1		1
. Agronomist	1	1	

. Agricultural technicians	2		2
. Typist/secretary	1		1
. Draughtsman	1		1

Position/Unit	Total number of personnel	Professional personnel	Non-professional personnel
- Communications and electro-mechanical equipment unit:			
. Mechanical engineer	1	1	
. Administrative assistant	1		1
. Switchboard and radio operators	3		3
. Telephone and radio technicians	4		4
. Electricians	2		2
. Welders/ Fieldcraftsmen	2		2
. Workshop foreman	1		1
. Workshop mechanics and workers	3		3
. Equipment operators	7		7
. Drivers	3		3
. Typist/secretary	1		1
- Reservoir and headworks			
. Chief supervisor	1	1	
. Maintenance engineer	1	1	
. Hydrographer	1		1
. Gate tenders	2		2
. Skilled workers	8		8
. Foremen	1		1
. Labourers	27		27
. Caretakers for guest house and other buildings	3		3
. Boatman	1		1
. Security officer	1		1
. Guards	14		14
- Distribution network, per 4 500-6 000 hectares (section No. 1 - n):			
. Watermaster	1		1
. Maintenance foreman	1		1
. Hydrographer	1		1
. Gate and check tenders	3		3
. Canal maintenance workers	11		11
. Drivers	1		1

. Office assistant	1	1
. Guards	3	3
. Caretakers	2	2

- (Zones No. 1 - 4):

. Zoneman	1	1
. Assistant watermen	2	2
. Gate and check tenders	2	2
. Skilled workers	1	1
. Hydrographer/Office assistant	1	1
. Canal maintenance worker	1	1

Each "section" possesses a pool of maintenance and operational workers, hydrographers and gate tenders to operate and maintain the main canals, one gate tender for every five-seven gates and one canal worker for every 2.5-3.5 kilometres of canal.

Each zoneman is assisted by two assistant zonemen who are mainly responsible for on-farm operation and maintenance, together with gate tenders and maintenance workers who operate and maintain the lateral canals in their respective zones. Each gate tender should be responsible for between eight and twelve gates, farm turnouts and other regulatory structures, while the length of canal per worker should vary between 3.5 and 5 kilometres depending on the size, stability, lining of the canal, etc.

3. Staff training

The training required by the personnel depends on the different positions they occupy in the departments, units, sections, etc. Professional personnel must possess at least 10 years experience of irrigation and drainage together with special knowledge at a management level in the areas of operation/maintenance and water management. If the project management authority is to be organized, administered and run on the lines of an industrial firm both the manager and assistant project engineer as well as the administrator must in addition have received training in business economy.

Within the field units in the sector dealing with the distribution of irrigation water the educational requirements of the personnel will be as follows:

i) Each section will be headed by a watermaster who should have at least 10 years of experience in the operation and maintenance of irrigation projects. He should preferably be a graduate engineer, with additional management training. He should be responsible for 3-4 zones.

ii) Each zone should be headed by a zoneman who is responsible to his specific watermaster. The zoneman should have at least five years experience in the operation and maintenance of irrigation projects and be a graduate of an agricultural engineering school.

4. Logistical facilities

A building of approximately 150 m2 is required for the main office, in accordance with the need for approximately 20 m2 for each employee and worker. In addition, approximately 250-300 m2 are required for the workshop and a similar area for the materials warehouse.

In addition, smaller offices of approximately 30-50 m2 are required in the various zones of the project. Buildings needed for the repair and maintenance services, of approximately 100 m2 each are particularly important.

Permanent telephone or radio communications must be ensured between the offices. The equipment required will depend on the number of zone offices.

All offices and workshops must be provided with the necessary furniture and fittings.

5. Equipment

The following vehicles will be required for the execution of the works:

Position	Type of vehicle
Project Manager	Land Rover
Assistant project engineer	Pick-up
Irrigation engineer	Pick-up, which may also be used by the assistant irrigation engineer, hydraulic engineer, hydrographers and agronomists, at the discretion of the irrigation engineer
Mechanical engineer	Pick-up

Maintenance unit	1-3 pick-ups
Office engineer	Pick-up which may also be used by the technicians and surveyors of the engineering services unit
Watermaster	Pick-up
Headworks Superintendent	Pick-up, which may also be used by the superintendent maintenance engineer to transport the necessary tools and materials to the damsite or the diversion weir site.

It is planned that all other personnel of the reservoir and headwork unit will use bicycles to reach places located around the reservoir.

Section maintenance Foreman	Pick-up to transport the canal maintenance workers, tools and materials to and from job sites. Should no vehicle be available, the job workers will have to use bicycles to reach their job sites.
Zonemen	Motorcycle
Assistant zoneman	Motorcycle

It is planned that the gate and check tenders will in general reach the different gates and checks under their charge by bicycle.

Chapter VI

OPERATING RULES FOR THE PHYSICAL INFRASTRUCTURE

1. General system operation

Like any enterprise, a system under operation requires constant decisions and solutions during the ongoing process of the work.

The actual purpose of water resource utilization projects is to provide the users at any given time with the volume of water necessary for economic ends. In hydroelectric projects for example, this means that the supply of water must follow the demand for energy, i.e., provide the volume of water required to operate the turbines in accordance with the fluctuating demand for energy, or, in irrigation projects, guarantee the supply of the volume of irrigation water at specific delivery points on the distribution system, in accordance with the demand for water in the fields. In order to do so, it is necessary to draw up an appropriate schedule and plan for the use of the resource.

While in the case of an integrated project it is necessary to draw up detailed plans of operation, they must be managed in a flexible manner in order to be able, for example, to take into account changes necessary to meet demand arising from crop rotation in the case of agricultural projects, etc.

The operating plan must illustrate the interrelation between all factors and clarify the interrelationship between the decisions taken. Such interrelationships must be clarified in the form of operating rules and flow charts, in other words the operating rules must be drawn up in such a way that if it is decided to adopt a measure all the other measures necessary at other points of the system will be apparent.

To achieve this, the personnel, who will operate a project should be engaged in good time, i.e., at the planning and construction stages. The

personnel will thus be able to become familiar with the project and have sufficient time to draw up detailed operating plans and rules. The operating criteria adopted by the design engineer are also of considerable importance, since each design is based on considerations and examinations of the use and operation of the specific works or components of the project. The design engineer's considerations also constitute the basis for the efficient and safe use of the works. Consequently the operational staff should familiarize itself with design criteria and the resulting specific instructions for the use of each component, as early as possible, and communicate this information to each of the operators.

The operating plan and operating criteria --which are set out in the Definite Plan Report-- together with the design engineer's operating criteria must constitute guidelines for drawing up operating rules and instructions. These should be reviewed whenever the development and operating conditions so require.

The overall operating plan must take into account water rights (existing and future), water laws, contracts, conditions, agreements with other authorities or agencies regarding, for example, flood control or water use, conservation of fish life, flora and fauna, etc.

2. Demand oriented water management and conservation

It is often necessary to construct a reservoir as part of major projects designed to make optimum use of water resources and to protect and conserve water. The Project Management Authority must develop reservoir operation plans and submit them for the approval of the higher authority (River Basin Authority or Association). These reservoir operation plans should be drawn up so as to meet the requirements of the project and take into account the rights of others as well as the provisions of the authority supervising the project. This means that the reservoir must be operated in such a manner that the release of water from the reservoir is determined by the demand, while at the same time ensuring that a minimum amount of water remains in the river.

In the case of hydroelectric projects, the release of water from the reservoir must follow the demand for energy. This means that in times of higher demand for hydroelectric energy the supply of water driving the turbines must be greater, while in times of low demand the supply of water is

lower. This leads to fluctuations in the flow of rivers downstream from the reservoir, which in turn have an unfavourable impact on other sectors, for example on navigation, and which may require the construction of compensation reservoirs to stabilize the flow.

In irrigation and drainage projects the release of water is aligned on the effective demand in the irrigated area, in other words the release of water must correspond to the crop's demand for water, which varies during the growing cycle. In addition it is necessary to ensure that a certain minimum amount of water remains in the river to avoid its drying up.

Furthermore, the reservoir operation plan must take into account the fluctuating water levels in the reservoir. Depending on the size of the reservoir (annual or inter-year reservoir) the volume of water actually stored in the reservoir is to be considered as the volume of water available. In the case of irrigation and drainage projects, this may imply that the project authority may decree restrictions on cultivation. This is the case when on account of the reserves stored in the reservoir at the beginning of the irrigation season it is apparent that the volume of water available and the expected inflow are insufficient to cultivate the whole area and to cover the demand of the crops planned. In such cases it is possible to decree a reduction in the irrigated areas or a change in the crops. Such reductions or changes lead to limitations in the supply of irrigation water, about which farmers must be informed. Nevertheless, in wet years when there is surplus water it is possible that the supply of water to users may be greater than had been planned. In such cases it may be possible to grow other crops which consume more water, or to cultivate additional land. Restrictions such as those mentioned above are mainly expected in the case of annual reservoirs, since the volume of water stored is decisively affected by the inflow during the rainy season and the irrigation campaign. Inter-year reservoirs on the other hand have a compensatory function and are capable of compensating for at least one dry year without restrictions being necessary.

Nevertheless, the reservoir operation plans must not only regulate the release of water in accordance with demand and taking into account the volume of water stored and expected inflow, but they must also embody the operating rules in respect of flood protection. These rules must also be drawn up in accordance with the needs of the population dwelling downstream from the reservoir and with the flood control storage capacity, in order to avoid

catastrophic flooding. To maintain flood control capacity it is necessary to make provision for flood spillway measures or for appropriate operation of the reservoir. Extreme water releases must be guided by the maximum permissible discharge in the downstream channel.

These examples illustrate that in order to meet these requirements the reservoir operation plan must be meticulously prepared.

In addition to the operating rules for the reservoir, the project authority must initiate, plan for and take measures to protect the water resources, such as for example:

i) Conservation of the quality of water: depending on the purpose of a reservoir, it is necessary to identify areas for the protection of the water, indicating for which purposes the reservoir may or may not be used. A reservoir which is used to supply drinking water must not be used at the same time as a drinking point for animals, and consequently it must be prohibited to lead animals to the banks of the reservoir in order to avoid the introduction of fecal matter and phosphates. As far as the use of reservoirs for recreative purposes or water sports is concerned, this must not be allowed in reservoirs intended to supply drinking water but may be allowed on those which supply irrigation water or water for the generation of hydroelectric energy. In these two cases it is merely necessary to issue instructions regarding the conduct of tourists or those who practice water sports, and it may be necessary to impose restrictions at certain water levels (low water or flood water).

ii) Fishing: the use of the reservoir for fishing must also be regulated by the management authority. In certain circumstances it may be necessary to issue fishing licences. The project authority must ensure that fishing does not interfere with the operation of the reservoir or prevent it from fulfilling its purpose.

iii) Supervision of water flowing into the reservoir: the project authority must supervise by means of measurement not only the quantity of water flowing in, but also the concentration of suspended load. This may lead to the silting of the reservoir. If necessary the supervisory authority must be required to take appropriate measures in the catchment area to reduce the introduction of sediments (reafforestation, etc.).

3. Elements of system operation

a) Hydraulic and physical structures

The design engineer must provide the project management authority with structural descriptions and drawings, in accordance with which they have been designed, as well as guidelines for the operation of all the regulating structures and works. In addition to the structural descriptions, the engineer will provide drawings showing the completed structures. A set of the necessary documentation, including maps, measurement data, etc., will be compiled and provided to the project authority.

In accordance with the design criteria laid down by the engineer and the execution of the infrastructure the project authority will have to draw up operating plans for the control of the system, in other words of the hydraulic structures, regulating gates and physical infrastructure. These documents will provide a basis for training the operators in charge with the control of different works. They must be provided with charts or tables to enable them to operate the gates in such a manner that the supply of water is ensured in line with the operating engineer's instructions and in accordance with the demand calculations. For this purpose measuring equipment will also be installed and operated in order to provide records of the actual supply of water.

The operating engineer must also explain the functioning of each structure to the operators, so that they are able to identify and inform upon any damage. This requires that the physical infrastructure of the project and the operation of all structures be regularly checked and inspected. It is necessary to draw up reports about these inspections in accordance with an established pattern.

The analysis of these reports constitutes the basis for carrying out any repair and maintenance work in addition to routine maintenance work.

b) Distribution regulations

The distribution of water, for example through the distribution network of an irrigated area, must be determined by operating instructions. Depending on the demand for water and the hydraulic capacity of the distribution network (canals, regulating works, outlet works, etc.) it is necessary to draw up a control programme each week on the basis of which the personnel operating the project is able to regulate it on a day-to-day basis. This operating plan must allow rapid reaction in the face of changes in the demand for water in the

irrigated areas. It is not possible to draw up an operating plan for the distribution network valid for the whole year on the basis of a crop calendar. The distribution of water must rather aim at constantly modifying conditions, both in order to save water and to keep operating costs at a minimum. For this purpose it is necessary to establish, in accordance with the respective users and prior to each irrigation period, the area and type of crop (also depending on the amount of water available), to determine the demand for water and the date on which the irrigation period will begin. No water must be supplied to the distribution network if it is not used on the irrigated areas.

Since the demand for water does not only depend on the state of growth of the crops but also on the climatic conditions, it is necessary to carry out fine adjustment on a daily basis. This is why the operations engineer must review the effective demand and the supply of water in view of the climatological data and information on crop growth provided by the operating personnel. Such fine adjustments are restricted however, by the hydraulic possibilities of the distribution network.

It is important that the distribution regulations also take into account maximum and minimum amounts for the supply of each agricultural unit. These extreme figures must be defined in the supply agreement with each particular agricultural unit, and in addition it must be made clear that the supply of water will be ensured only when the area is actually under cultivation, which means that fallow land is not supplied.

The above limitations of the canal network mean that the times for the supply of water within the system of rotation are compulsory. The rotation cycle may make it necessary to introduce changes when different farmers have begun plowing. At the beginning of each irrigation cycle it is necessary to define the rotation cycle in conjunction with the farmers in order to avoid subsequent conflicts and arguments.

c) Crash programmes for emergencies

To offset any irregularities or interruptions in the operation of the hydraulic infrastructure, as well as unexpected damage which may occur to the physical infrastructure, such as for example, to the dams, canals, etc., it is necessary to lay down regulatory measures and draw up instructions. It is vital that emergency programmes for the control and regulation as well as the

rapid elimination of damage in the case of unforeseen circumstances be available.

Crash programmes for emergencies must contain guidelines to facilitate the taking of decisions concerning gradual measures. The example given here concerns the flood spillway of a reservoir, whose gates jam when a flood wave raises the level of the reservoir due to extreme rainfall in the river basin. The criteria for taking emergency measures must make it possible to calculate, depending on the expected flood wave, of flood water, the level of water in the reservoir, the available flood control storage, etc., whether there is any risk of overtopping of the dam. If this is the case, it is necessary to examine whether it is possible to evacuate sufficient flood water by opening those spillway gates which work. If not, it is necessary to examine whether the risk may be overcome by further opening of the bottom outlet. If neither of these are possible, instructions must provide for the forced opening or elimination of the jammed spillway gates (for example, by the use of explosives). The procedure to be followed in such circumstances must be laid down in such detail that when the measures are taken they are absolutely certain to succeed.

In line with this example it is necessary to provide for emergency measures to meet other malfunctions or possible interruptions affecting the control systems of a hydroelectric power station, in the water intakes, in the regulating works of a distribution system or in the hydraulic operation of a canal (e.g., a landslip affecting the banks of a canal). The necessary funds to carry out these measures must be readily available. All emergency measures must aim to minimize any damage which may affect either the users of a project or the physical infrastructure and environment.

d) Environmental restrictions

Plans for the operation of a project, embodied in operating rules, operating plans, procedural instructions, etc., must take into account the marginal environmental conditions, in other words they must cause no damage to the environment (comp. chap. 2.4). Instructions for reservoir operation, for its use for touristic purposes etc., must be carefully drawn up in order to avoid causing excessive damage to the flora and fauna in the area of the reservoir, in the lower river basin, as well as any harmful impact on the quality of water and the navigability of a river, threat of flooding to the population downstream, etc. It is consequently necessary to require that

operating plans and instructions relating to the relevant environmental aspects be agreed upon and approved by the competent supervisory authorities. It is not possible to draw up universal plans or instructions for all types and components of a project. Impact on the environment is in fact highly dependent on the particular circumstances in the project area, in other words, environmental restrictions must be defined on an individual basis for the operation of each project. In order to do so, it is necessary to carry out ecological compatibility research the results of which should be taken into account in the operating rules.

Chapter VII

MAINTENANCE RULES FOR THE PHYSICAL INFRASTRUCTURE

1. General rules

As a project progresses from the construction phase to the operational phase, a maintenance programme must be drawn up covering the whole of the project infrastructure, i.e., all the works, regulating installations and machines, etc. It must include all works which are under either the responsibility of the Project Authority or of the users of the water.

The outline maintenance programme must indicate the schedule of maintenance work necessary for each structure and technical installation, i.e., it must define the maintenance intervals for all technical works and installations.

Supervision over the operation of the infrastructure is the responsibility of the operating personnel, who may carry out the daily inspection as part of their everyday work. As explained in chapter VI notification of any defects must be placed on record and given to the maintenance section. The need for any repair work outside ordinary maintenance work will be decided on the basis of these reports.

The maintenance personnel must receive training from the operational authorities in all aspects of maintenance work. In addition, special units must be set up to carry out routine maintenance work and special repairs.

The maintenance section must also ensure that the users, who are responsible for the conservation of the infrastructure, actually carry out the work required.

The maintenance personnel must draw up maintenance reports on the work carried out. These reports must separately state the date, time, structure,

type of work carried out, for each routine work or repair, together with any special remarks. Not only do these reports provide proof to the builder or insurance company as to the execution of the maintenance work and of the proper working order of the installations prior to the appearance of a defect, whenever guarantee rights are involved, but they also indicate the vulnerability of the structure or technical installation, which may indicate a need for a change in design in order to bring down operating costs. It is consequently necessary that representatives of the Planning Department of the project authority take part in inspections of maintenance work at least once a year.

The maintenance programme must be revised from time to time on the basis of the analysis made of the maintenance work. This review must take into account the vulnerability of the different components of the work, actual maintenance expenditure, etc. If necessary the maintenance periods should be shortened or lengthened.

2. Hydraulic structures

a) Intake structures, weirs, sand traps, measuring installations

Where hydraulic structures such as weirs, river intakes, sand traps, etc., are concerned the design engineer must provide the Project Authority with structural descriptions and drawings. These must illustrate which of the structures require special maintenance, as is the case, for example, of the head chamber of a river intake with a flushing gate for removing bed load, trash racks and the cleaning of trash racks, concrete works, stilling basins, etc.

Concrete structures must be examined at least twice a year as well as following major floods, and the appropriate measures must be taken to repair any damage. In order to carry out these inspections it might be necessary to install emergency gates and to lower the water level in order to expose the work so as to facilitate a detailed overall inspection. The downstream face of the spillway, energy dissipators in stilling basins as well as the adjacent sections of rivers (risk of scouring), have proved to be particularly vulnerable. Any damage caused must be immediately eliminated in order to keep the work in operation. Maintenance work on major hydraulic structures is not merely limited to the structure itself, but also concerns the junctions with

the bank. Care must be taken whenever necessary to ensure the elimination of damage to the banks which may cause seepage under the structure and in the abutments. Should this type of damage occur frequently it will be necessary to alter the design or to remodel the work.

It is necessary to lay down compulsory norms for repair work on concrete structures, masonry or rockfill, so as to ensure that the repair is correctly carried out.

The design engineers and/or those who produce the measuring equipment installed on the project (equipment for measuring volumes of water, pressures, etc.) must also provide norms for the maintenance of the equipment and instructions allowing to check its operation. The personnel responsible for the maintenance must be adequately trained.

b) Hydraulic steel structures

The suppliers of the hydraulic steel structures must provide instructions for their operation and maintenance. These maintenance instructions must contain both the description of the different components of the structure and drawings to allow the respective personnel to dismantle and reassemble the structures as necessary for maintenance purposes.

Furthermore, it is necessary to define:

- maintenance periods, as regards lubrication, oil changes, etc.
- instructions for painting
- instructions for the choice of paint (quality)
- thickness of the coats of paint
- gasket changes
- bearing inspection
- indications concerning wearing parts and service intervals for the wearing parts, etc.

Maintenance and repair work on hydraulic steel structures and technical and mechanical installations must only be carried out by trained personnel. The maintenance department must assure itself that such personnel possesses the required specialized training.

c) Canals and distribution devices

The operation of the primary, secondary and tertiary canals as well as of the drainage canals must be checked at regular intervals, provided they form part of the distribution network of the project and their maintenance is not the responsibility of the farmers.

The maintenance of the irrigation and drainage canals mainly involves cleaning, in other words the elimination of weeds, and examination of the state of the canal slopes. Any slope failures, which frequently occur in earth canals, must be repaired. If necessary the inclination of the slopes must be altered. In the case of lined canals the lining must be examined. Damaged lining must be repaired once the cause of the damage has been analysed.

The canals must be inspected at least twice a year. In order to carry out the inspection, it is necessary to empty the section of canal concerned so as to carry out a detailed inventory of the state of the canals and to perform the maintenance works.

A check must be made of the efficiency of the diversion structures in the canal network in distributing the water throughout the smaller canals. To do so, it is necessary to measure the volume of water and, if necessary modify the structures to restrict the volume of water distributed.

The outlet works in the distribution system (field outlets, service outlets, emergency outlets, etc.), must be maintained so as to be always in correct working order and, in the case of hydraulic steel structures, they must be maintained in accordance with the criteria set out in section b) of this chapter.

As far as tubes are concerned, it is necessary to draw up the necessary norms taking into account the manufacturer's instructions.

d) Dams and embankments

The maintenance of dams and embankments mainly concerns conservation and protective measures, such as for example cutting the grass on those parts of the banks which are not under water, and repairing banks damaged by water and waves. Points of potential collapse must be eliminated from banks, and they must be reinforced and measures taken to ensure greater stability, for example, by the use of rip rap, paving, etc.

Inspections must also bear on the hydraulic behaviour of dams and embankments. In other words it is necessary to examine the extent of permeability or percolation downstream from the dam as a result of seepage below the dam's abutments, which affect the stability of the dam. If necessary measures must be taken to ensure impermeability in accordance with local conditions. Control mechanisms for measuring settlements, pore pressure, the evacuation of water in drains etc., must be examined. The results of these

measurements must be analysed in order that the appropriate measures may be taken if critical values should be observed. The design engineer must indicate to the Project Authority the permissible limit values. Descriptions and drawings of the structures must be available so that counter measures may be planned and carried out in critical circumstances.

The operating personnel is responsible for supervising the work, and must inspect and check on a daily basis the operation of the hydraulic structures, particularly in reservoir projects. Maintenance work on the hydraulic steel structures in reservoir works, bottom outlets, flood spillways, water intakes, etc., must be carried out in accordance with the instructions and norms set out in section b) of this chapter.

3. Service roads

The Project Management Authority is also responsible for maintaining service roads so as to maintain free access to all structures and, in the case of an irrigation and drainage project, along the canals. Maintenance work mainly involves repairing the road surface which is frequently damaged by erosion during rainfall.

Overflows or leaks on the canal system, in culverts etc., may cause erosion to the surface roads which in extreme cases may interrupt traffic.

Chapter VIII

FINANCIAL MANAGEMENT AND BUDGETS

1. Financial management

It has been repeatedly emphasized throughout this document that projects to utilize water resources should be managed on the lines of industrial enterprises.

It is consequently essential that the project authorities, just like major industrial enterprises, publish an annual financial statement setting out the capital, expenditure and income. This is the only means by which it is possible to verify whether the Project Authority is an economically sound enterprise. The Project Authority must draw up a detailed analysis of costs so as to be able to charge prices which cover the costs of the services provided. This cost analysis will provide a basis for adjusting the tariffs and prices for the services rendered. It is only in this way that a Project Authority can be managed on the lines of an economically sound firm.

2. Annual costs of operation and maintenance

The Project Management Authority must draw up each year a programme for the necessary operation and maintenance activities for the project. On the basis of this programme estimate must be made of all costs, in such detail that the figures are verifiable. The costs must be broken down into the following principal groups:

- personnel expenditure
- operating expenditure in offices, workshops, etc.
- operating expenditure on equipment (vehicles, instruments, machines, etc.)

- communication systems
- regular operation activities
- regular maintenance activities
- budget for unforeseen expenditure and repair to wear and tear and damage.

3. Capital costs and depreciation

In addition to the current expenditure required for the operation and maintenance of a major project, the financial plan must also make provision for investment costs, capital costs and depreciation.

Any major project, be it an irrigation project, a hydroelectric power station, etc., represents an investment which is generally financed by long-term credit granted at favourable rates of interest by the development banks.

On undertaking the project the authority in question must also assume responsibility for the financial costs. In many cases a project is financed by funds from the State budget. This nevertheless involves decisive drawbacks and is not compatible with the autonomous management of the project along the lines of an industrial firm. Consequently, the Project Management Authority in its capacity as a commercial firm should itself assume responsibilities for the financing.

As has been mentioned above, all types of projects, be they irrigation projects, projects to generate hydroelectric energy, supply drinking water or multi-purpose projects involve heavy investment. Ownership of the land on which the operating buildings, transmission lines or distribution canals are to be built must be transferred by the government to the Project Management Authority, provided the land involved is publicly owned or it must alternatively be given free servitude. A Project Authority will certainly not be able to obtain credit without the State's guarantee, since it is generally unable to provide a security itself to banks.

From the outset of the project, i.e., from the phase of study and construction planning to its execution and operation it is necessary to calculate as a part of the annual budget the necessary costs and invesments for each of the phases, in addition to which a cost estimate must be drawn up at the beginning of each year.

The interest on the amortization of the credits and State guarantees, must be added to the actual costs.

Once the project has been completed and brought into operation provision must be made in the calculation for the depreciation of the structures, facilities and equipment.

The concrete structures, wiers, dams, dykes, canals, buildings, etc., are depreciated over a 50-year period and the hydraulic steel structures including the turbines, generators, etc., over 25 years. The depreciation period for the technical and mechanical installations in the workshops, office equipment, etc., should be no longer than 10 years. Vehicles, mobile cranes, etc., are depreciated over a 4 to 5 year period.

These depreciation periods make it possible to calculate the necessary reinvestment to maintain the project operational and which must be included in the budget.

4. Generating revenues

The above budgetary costs must be met from income. The only means of generating revenues in projects to utilize water resources are the following:

- the sale of water used by the farmer at a fixed price in agricultural projects;
- the sale of energy per kWh in hydroelectric projects;
- the sale of water consumed at a fixed price per cubic metre and measured by meters in drinking water supply projects;
- in the case of flood protection projects, navigation projects, etc., it is difficult to share out the costs among the users. In these cases the only means of generating revenues is by general State taxes transferred to the Project Authority. In navigation projects the shipping companies are frequently compelled to pay direct taxes for using the river, canal or lake. This income will then be transferred to the Project Authority. Protection against flooding however, constitutes an undertaking of public interest and can only be financed through taxes.

The rates, tariffs and prices per cubic metre of water supplied must cover the cost. It is essential that the projects be financially self-sufficient in that their income covers their financing. This, however, is in contradiction with

practice in many countries in which water is supplied free to users. In such cases it is virtually impossible to run the project on economic lines, unless the State guarantees to make up the shortfall in income by funds from its budget. Such a form of reimbursement is only possible to the extent that the State budget makes provision for such funds. Bearing in mind the delicate financial situation in these countries, there are virtually no funds left to finance the activities of the Project Authority. Consequently, as experience has revealed, in many cases a large number of project authorities are unable to fulfill and carry out the functions attributed to them. Financial problems almost always undermine the infrastructure of the project, which not only constitutes a serious loss for the entrepreneurial economy of the Project Authority, but also for the national economy. This further emphasizes the need to set tariffs for the supply of water at a level which covers costs, and for governments to grant the corresponding authorizations to the firms responsible for managing the project.

Notes

1/ OECD, "Management of water projects, decision-making and investment appraisal", Paris, 1985.

2/ For further details see Helmut Lauterjung, "Identification of the Environmental Realms Affected by the Projects and Classification of Impacts", 1986.

3/ For detailed information on these impacts see Helmut Lauterjung, "Identification of Main Actions and the Effects on the Environment", February 1986.

4/ Helmut Lauterjung, "Systematic Classification of Water Resources Problems in Terms of the Economic and Social Impacts", March 1986.

5/ Helmut Lauterjung, "Classification and Description of the Objectives of Water Resources Management", March 1986.