PROPOSED MANAGEMENT STRUCTURES

Prepared by

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ABSTRACT

Proposed Management Structures for the Senegal

River Development Program

by

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The management structure of the Organization for the Development of Senegal River (OMVS) is the focus of this study. The development program of the OMVS is reviewed in addition to some background information. The field of organization design is presented as the process by which a structure of tasks and authority is created. The two major organization design theories (i.e. the universal and the contingency) are examined. The division of labor, departmentalization, span of control, and delegation of authority are reviewed as key design decisions. Furthermore, a survey of the organizational structure of four water management institutions in the U.S. are reviewed in addition to the institutional aspects of the development of international river basins. Finally, three alternatives are developed for the organizational structure of the Senegal River development project.

CHAPTER I

INTRODUCTION

The population and economic growth of the past few decades have resulted in increased demands for water throughout the world. Consequently, water related projects of all sizes have been and are being developed, especially in developing countries. The establishment of international financing organizations, such as the International Monetary Fund and the International Bank for Rural Development (World Bank), and national organizations, such as the U. S. Agency for International Development, has made much needed financial support available to many "third world" nations for water development projects. These project developments have brought about the need for management institutions during both the development and the implementation phases. The introduction of new irrigation technologies have altered traditional institutions. As projects become more sophisticated, the need for efficient and effective management organizations becomes more vital. For example, a capital intensive irrigation project requires a more complex institutional framework than a labor intensive project.

Administrative and managerial skills are very limited in most developing countries. Kiggundee et al. (1983) state that over 70 percent of the world's population live in developing nations where administrative problems threaten the survival of many projects. Many of these nations have embarked upon ambitious water development

projects. An example of this kind of development is the Senegal River program in West Africa in which three of the co-basin states are involved in a major water development project.

The planning and construction phases of most water projects in developing countries are conducted by large international companies which are based in the developed nations. After the completion of the construction phase, the foreign firms leave and the host country is faced with two potential problems in operating the project successfully:

1. The technology required to operate the project might not be appropriate for the conditions of the country (that is, the mere transfer of sophisticated technology is not the solution to the problems of most developing nations).

2. The country may be lacking the managerial skills and institutional frameworks for the effective operation of the project.

The purpose of this study is to address the second issue, that is organizational framework design. Various forms of organizational design are discussed and their application to water resources projects is demonstrated for both developed and developign countries. For the latter category, the Senegal River Development Project in West Africa is used as a case study.

CHAPTER II

ORGANIZATION DESIGN: AN OVERVIEW

Organization design is the process by which managers create a structure of tasks and authority (Gibson et al. 1982). In this process, the relative benefits of alternative structures for tasks and authorities are assessed. To design an organization structure it is necessary to formulate subunits according to some rational criteria and then to intergrate (relate) these units through some means of coordination to create a coherent organization.

Design Decisions

The following issues are addressed as the basis for the structure of any organization.

Division of labor

The task of a unit of an organization is divided into successively smaller and more specialized jobs. These jobs are then assigned to individuals. For example, rather than having two electricians also do mechanical repairs, the total task is divided between an electrician and a mechanic. A key decision in oganization design is the extent to which jobs are specialized. The supporters of dividing a task into many small jobs indicate the following advantages:

1. Training is greatly simplified, thus resulting in lower training costs.

2. Employees become proficient in their tasks, thus resulting in a high quality of output.

Obviously, there is a limit to specialization in an organization. Sufficient amounts of work must exist in a specialized job to keep the employee occupied.

Departmentalization

Common and closely related tasks are grouped together to form a unit of an organization. A major task in the process of departmentalization in defining a common basis for combining tasks into a unit. There are several bases for departmentalization, including the following (Gibson et al. 1982):

Functional departmentalization. Jobs are grouped on the basis of their functions. An example of this type of departmentalization is the Oldsmobile Division of General Motors. Its functions (departments) are engineering, production, manufacturing, reliability, distribution, finance, and personnel (see Figure 1). Functional departmentalization is the most widely used system. It is logical to group specialists of a field in one department. This basis for grouping attempts, to maximize the efficiency of an organization. In addition, people of similar professional background are more comfortable working with each other. For example, a computer scientist can more easily communicate with other computer scientisits. On the other hand, there are disadvantages to functional departmentalization. For example, sometimes it is possible

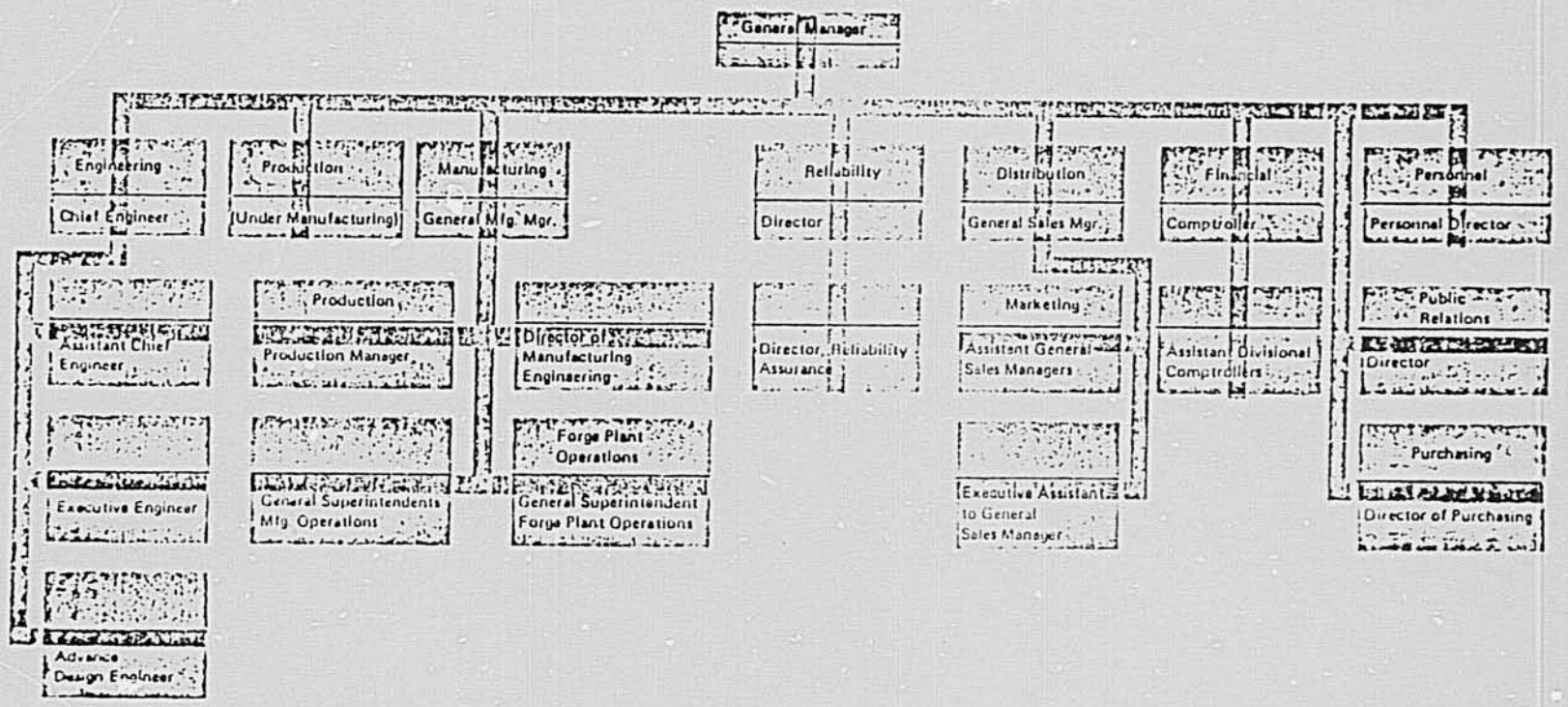


Figure 1. General Motors Corporation (Oldsmobile Division, Car and Truck Group).

the goals of the department interfere with the goals of the organization.

Territorial departmentalization. Departments are created on the basis of their geographical locations. This is widely used in large organizations where centralized coordination is difficult. The U. S. Bureau of Reclamation uses this system of departmentalization (Figure 2). One of the advantages of this system is the ability to concentrate on the requirements of each territory and to be able to evaluate the performance of the services rendered in each region.

Product departmentalization. In large and diversified organizations, products can be the basis for departmentalization. This allows for increased decentralization and close coordination between different units of a department. Managers can be asked to set goals for the performance of their departments. Actual performance is compared to the projected performance at the end of the period. Kimberly-Clark Corporation uses product departmentalization (Figure 3).

Customer departmentalization. Under this type of organization basic units are formulated with respect to the basis of the type of customers (users) it serves. For example, some universities have different staff for day and night students.

Mixed departmentalization. Some organizations have combined two or more of the above mentioned bases for departmentalization to suit their organizations.

Span of control

This term concerns the number of individuals (jobs) in a unit of an organization (Figure 4). In other words, what is the optimum

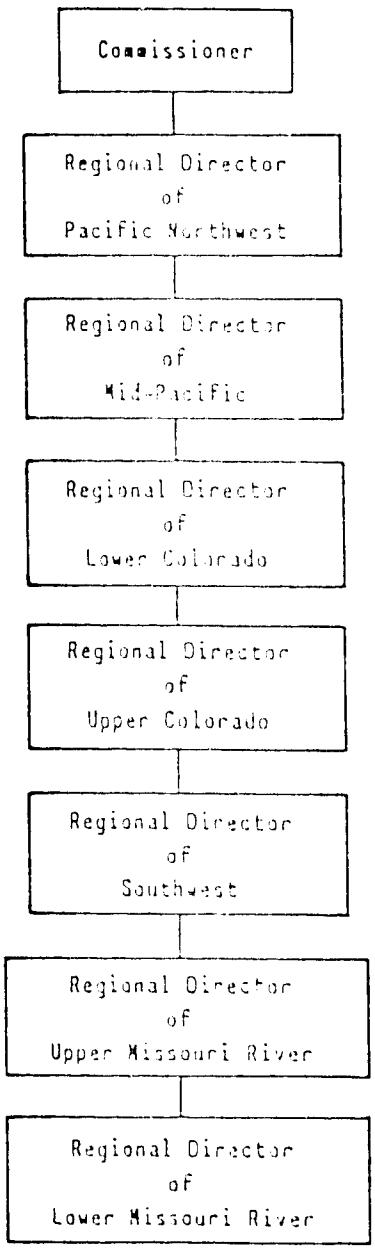


Figure 2. A simplified organization chart of the Bureau of Reclamation.

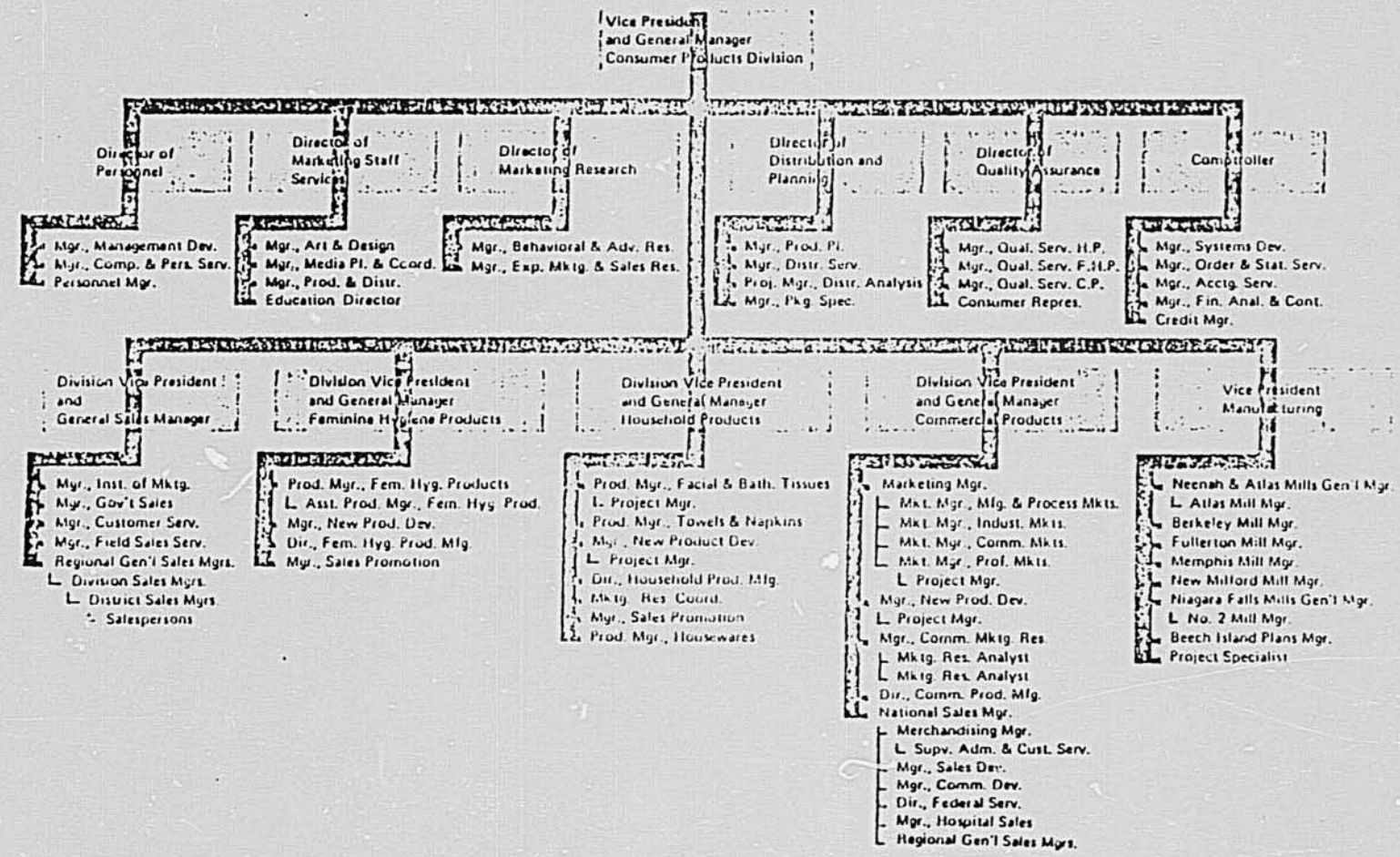


Figure 3. Kimberly-Clark Corporation (Consumer Products Division) (after Gibson et al. 1982).

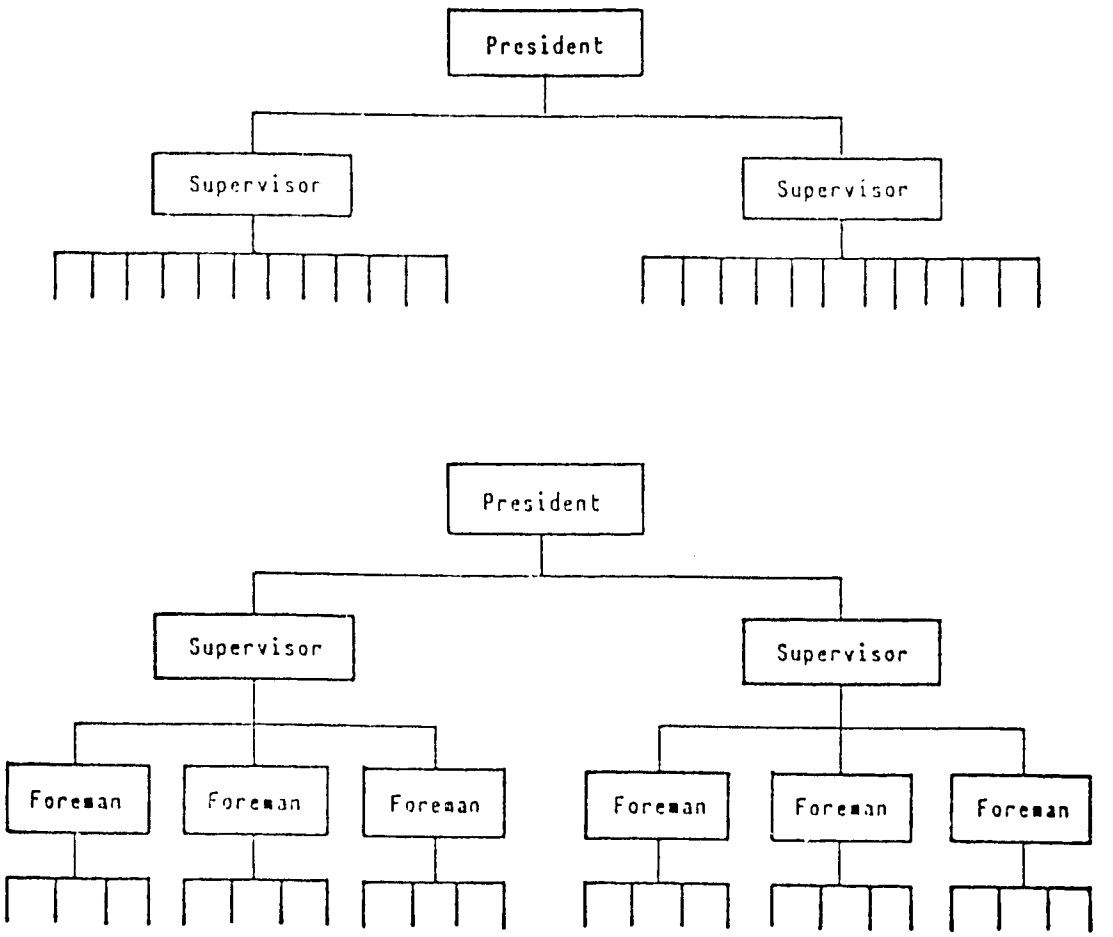


Figure 4. Wide and narrow spans of control (after Gibson et al. 1982).

number of employees to report to one supervisor? Is a narrow span of control more effective or a wide one? An answer to this question involves the number of interpersonal activities which the manager of the department must handle. Organ and Hammer (1982) state that the number of subordinates responsible to any one supervisor should be limited to a range of about three to eight. Ouchi and Dowling (1974) have shown that in addition to the number of employees in a department, it is necessary to consider the number of people who have access to the manager from outside of the department. Gibson et al. (1982) suggest that the number of potential relationships between a manager and subordinates increases geometrically as the number of subordinates increase arithmatically. They propose that the number of potential relationships, R, can be calculated by the following formula:

$$R = N \left(\frac{2^N}{2} + N - 1\right)$$

where N is the number of subordinates.

In summary, three factors are important in determining an optimum span of control for a particular unit, namely:

1. Required Contact. The required contact is dependent upon the nature of the activities of the unit. For example, in a research and development department frequent personal contact between the supervisor and the subordinates is required for timely completion of projects. Whereas, in a mass production industry contact can be infrequent.

2. Level of subordinate education and training. The span of control can vary as we move vertically within an organization. For example, in higher levels of an organization narrow span of control is desirable. Whereas, in lower levels, the span of control can increase due to the low levels of employee education and training. Gibson et al. (1982) state that "It is generally accepted that a manager at the lower organizational level can oversee more subordinates because work at the lower level is more specialized and less complicated than at higher levels of management."

3. Manager's ability to communicate. A supervisor who can effectively communicate with his subordinates can manage more people than one who cannot communicate well.

Delegation of authority

Delegation of authority is the main issue of decentralization, and relates to the question: At what level of organization (hierarchy) can decisions be made without approval from higher management? This question is not related to the geographic dispersion of an organization, but rather it deals with the delegated authority of different levels of managerial hierarchy. In a decentralized organization, different levels of management are required to make decisions that encompass many subjects. This situation will, ideally, develop professional managers who are generalists. In this way, they are trained for position of increased authority and responsibility. In such an organization, managers are compared on the basis of their performance rather than personalities because it is necessary for them to compete with each other on the basis of performance. Another advantage of decentralization is that the

autonomy given to managers satisfies their desire to participate in the decision-making process, thus providing a climate for innovative management. Furthermore, decentralization requires well-trained managers who do not resist the delegation of authority to their subordinates.

Structural Characteristics

The following three characteristics usually are used to describe the nature of an organization:

Formalization

A formalized organization has written regulations, policies, and procedures regarding the tasks to be performed and each employee has a clearly defined assignment. Such organizations usually have high degrees of specialization. However, the manner in which the employees view the written procedures of their organization is important. An organization might appear to be formalized, but unless the policies and regulations are enforced, they will not be effective.

Centralization

This characteristic describes the location of decison-making authority within the hierarchy of an organization. Not all decisions have the same importance in an organization. Therefore, it is important that decisions are made at a location appropriate to their nature.

Complexity

A complex organization with a large number of distinct job

descriptions and departments has more managerial problems than a simple organization. There are two types of organizational complexity.

1. Horizontal complexity refers to the number of unis of the same level.

2. Vertical complexity is related to the number of levels of an organization.

The degree of complexity of an organization is increased by decreasing the span of control. Moreover, highly specialized organizations are normally complex.

In general, management must choose between two basic organizational types - functional or product designs (refer to the section on departmentalization). Each has its own advantages and disadvantages. Functional organizations tend to be more efficient and usually have better production performance criteria than organizations based on product designs. However, product oganizations tend to maximize adaptiveness and development criteria. The following section presents a compromise between functional and product organizations.

Matrix Organization Design

A recent development in the field of organization theory is the concept of matrix organization design. This is an attempt to combine the advantages of functional and product-oriented organizations. Several large companies have adopted matrix organizations. Examples include Caterpillar Tractor, ITT, and Texas Instruments. In a matrix organization, an employee is a member of both a functional unit and a

product (or project) team. For example, a computer programmer who is an employee of the computer services department may be assigned to work on one or more projects or products. As a result, he will answer to two managers, one in the functional unit (for example, computer services) and another in the product team (for example, According to Knight (1976) "The matrix (organization) is essentially a coordinative device added to an executive hierarchy which remains the true basis of managerial authority." For example, interdepartmental project teams can be formed with a project manager coordinating the efforts of the team members working in parallel or interdepartmental hierarchies to achieve a common goal. The team members come from different functional departments, resulting in parallel lines of communication Figure 5 illusrates the basic makeup of a matrix organization. Galbraith (1971) points out that the task force (project team) should be composed of people who have enough authority to commit their units to action, but are not so high in the structure that they do not have immediate technical knowledge regarding the problem.

In a matrix organization, the functional units act as a "fall-back" for the project teams, providing a home for team members when they are not working full-time on a project. In addition, the home units provide an opportunity for the team members to associate with their colleagues and to receive professional reinforcements.

Knight (1976) cites the following advantages of the matrix organizational setup:

1. Efficient use of resources. The highly specialized employes can work on interdepartmental project teams and share their expertise

Projects, Products	Functions			
	Manufacturing	Marketing	Engineering	Finance
Project or Product A				
Project or Product B				
Project or Product C				
Project or Product D				
Project or Product E				

Figure 5. The basic makeup of a matrix organization (after Gibson et al. 1982).

with them, thus avoiding duplication of specialty units. For example, one computer services unit can serve the entire organization rather than having a computer services section in each project unit.

2. Flexibility under conditions of changes and uncertainty. Communication takes place both vertically and horizontally between different functional departments and project units. This allows for rapid response to changes in environmental and market conditions.

3. Technical excellence. Experts of different fields interact with each other resulting in improved communication skills. Such an environment encourages interdisciplinary approaches to problems rather than a one-discipline approach.

4. Freeing top management for long-range planning. Due to the decentralized nature of a matrix organization, top management is not involved in the day-to-day operation of the organization. Ongoing

decision making authority is delegated to lower managers, freeing top management for long-range planning.

5. Improving motivation and committment. The members of the project teams work together on a common task in which they are all knowledgeable and interested. This allows for a highly participative decision making process, resulting in increased motivation and commitment among the team members.

6. Providing opportunities for personal development. As team members interact with each other, representing different points of view, their knowledge of the organization and other fields increases. This type of interaction provides considerable opportunity for the development of their skills and knowledge.

Sufficient empirical data does not exist to support the above-mentioned claims. With regards to the adoption of matrix organization theory in developing countries Moris (1984 states that it "usually involves creating extra staff positions at middle levels. However, the strongly hierarchical developing country systems generally do not permit consultation contributions from intermediate level specialists." Therefore, in most cases, it has proven problem water.

CHAPTER III

MACRO-ORGANIZATION DESIGN

Macro-organization design refers to the process by which the overall characteristics of an organization structure are selected. In this chapter, we will review several existing macro-organization design theories.

There are two major schools of thought in the field of macro-organization theory. The first school stresses that there is a "best way" to design the structure of an organization. These are called universal theories and include classical organization theory, bureaucratic theory, and system 4 theory. The second, and most recent, school of thought is called contingency design theory and states that the optimal structure can vary depending upon such factors as technology and environmental conditions. Figure 6 illustrates the basic characteristics of the universal and the contingency design theories.

Universal Design Theories

Classical Organization Theory

Managerial deficiencies and problems were recognized as early as the 1920's. Early writers in the field of organization theory strived to define certain principles that would assist managers in the performance of their duties. Among the pioneers of this field

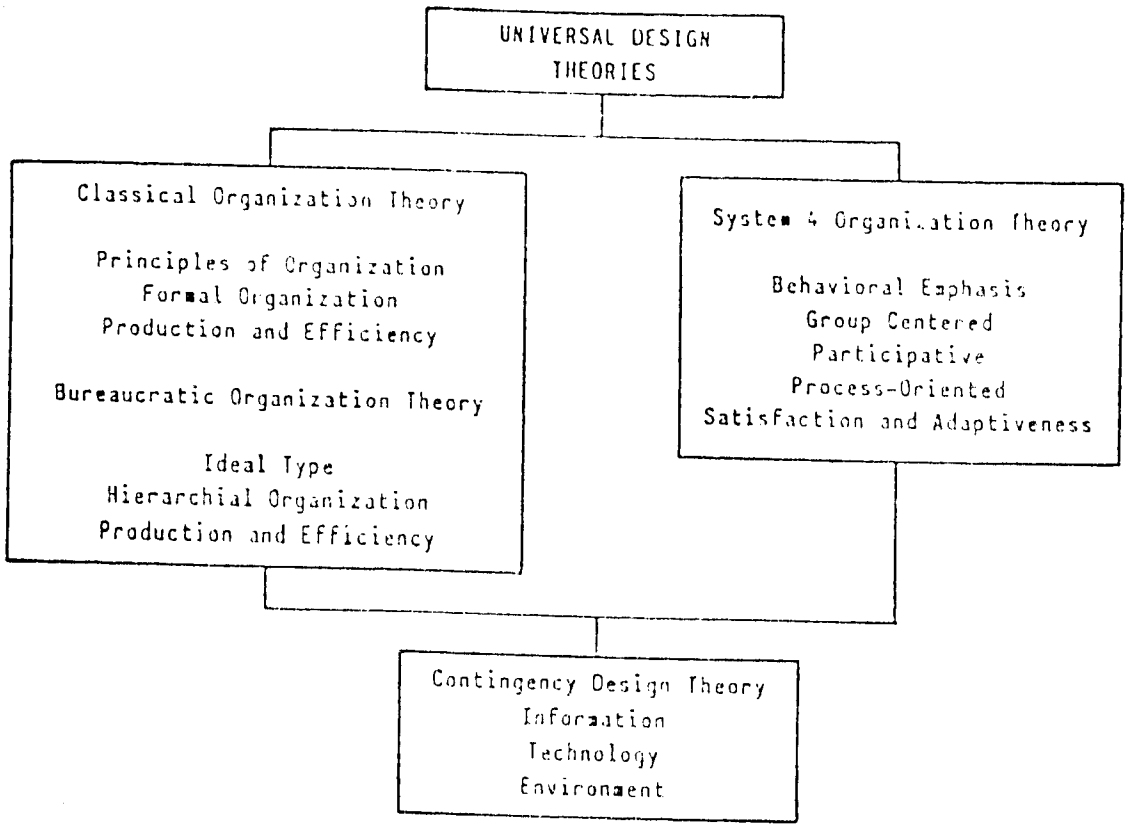


Figure 6. The development of macro-organization design theories (after Gibson et al. 1982).

was a Frenchman named Henri Fayol. Fayol (1929) suggested the following set of five principles which he felt would be helpful forthe management of a large coal mining company in France.

The principle of division of work. Fayol stated that specialization must be the basis for the division of work: "(specialization) has been recognized as the best means of making use of individuals and groups of people." He also recognized that there is an optimal level of specialization: "division of work has its limits which experience and a sense of proportion teach us may not be exceeded."

The principle of unity of direction. This principle states that all related activities must be coordinated by one manager and be organized under one department.

The principle of centralization. For every situation, there is an optimal balance between centralization and decentralization. The degree of centralization is dependent upon the capabilities of managers. It does not imply that all decisions must be made by one person at the top of each department.

The principle of authority and responsibility. Authority of a manager must be compatible with his responsibilities. For example, if a manager is given the responsibility for coordinating a department, he must also be delegated, according to Fayol, "the right to give orders and the power to exact obedience."

The scalar chain principle. As a result of the four preceding principles, an organization is set up with a graded chain of superiors from the "ultimate authority to the lowest ranks." This scalar chain is the proper route for all vertical communication. A communication from the lowest level must pass through every superior in the chain of command. Conversely, a top-to-bottom communication is done by passing through each superior from the top to the bottom. Fayol's ideas on management are representative of most writers in the field of classical design theory. The important contribution of these early writers has been their rational approach to organization design.

Bureaucratic Organization Theory

The word bureaucracy has different meanings for different people. Most people think of bureaucracy as the negative results of

large organizations, such as "red tape". In the context of organization theory, bureaucracy is referred to as the sociological concept of rationalization of collective activities (Gibson et al. 1982). It describes a form of organization that assures the predictability of the behavior of employees. Max Weber (1947) states that a bureaucratic structure is "superior to any other form in precision, in stability, in the stringency of its discipline, and in its reliability. It thus makes possible a high degree of calculability of results for the heads of the organization and for those acting in relation to it." Weber proposed the following design considerations for an effective bureaucratic organization:

Division of labor. Division of labor must be on the basis of specialization. When tasks are divided into highly specialized jobs, employees become proficient in their jobs and perform well.

Consistency. Each task is performed according to a set of rules and procedures to assure uniformity and consistency of performance. This minimizes uncertainty in task performance due to individual differences.

Chain of command. Every member of the organization is accountable to a supervisor. The authority of these superiors is delegated to them by the top of the hierarchy, consequently, creating a chain of command.

Formalism. Members of the organization conduct business in an impersonal and formalistic manner. They maintain a social distance from their subordinates and clients in order to assure impartiality and to avoid any kind of favortism resulting from personal friendships.

Unbiased hiring. Employment is based on technical qualifications and dismissal from the organization must be well justified. In addition, promotions are on the basis of job performance and years of experience. Employment in the organization is seen as a life-long career by the employees. This situation results in a high degree of loyalty and a strong sense of identification with the organization.

The above-mentioned principles refer to an "ideal" bureaucratic organization. Very few organizations exhibit all of these characteristics. Most government organizations (including water resources institutions) are essentially the bureaucratic type and tyically exhibit some of these characteristics.

System 4 Organization Theory

This is the most recent development in the field of universal design theory and constitutes a humanistic approach to organization design. The System 4 organization concept is best explained by Likert (1961). He noticed that the majority of successful managers were using a concept that he called "the principles of supportive relationships". Likert states:

> The principle of supportive relationships points to a dimension essential for the success of every organization, namely, that the mission of the organization be seen by its members as genuinely important. To be highly motivated, each member of the organization must feel that the organization's objectives are of significance and that his own particular task contributes in an indispensible manner to the organization's achievement of its objectives. He should see his role as difficult, important, and meaningful. This is necessary if the individual is to achieve and maintain a sense of personal worth and importance. (Likert 1961).

Likert also noticed that the majority of ineffective organizations had the following characteristics in common:

1. Breaking the total operation into simple component parts or tasks.

2. Developing the best way to carry out each of the component parts.

3. Hiring people with appropriate aptitudes and skills to perform each of these tasks.

4. Training these people to do their respective tasks in the specified best way.

5. Providing supervision to see that they perform their designated tasks, using the specific procedure and at an acceptable rate as determined by such procedures as timing the job.

6. Where feasible, using incentives in the form of individual or group piece rates.

The above six statements are the characteristics of a classical organization. According to Likert (1961), an organization can be characterized by eight dimensions, each of which forms a continuum with classical design theory at one extreme and system 4 organization theory at the other end (see Table 1). Likert refers to the classical organizations as system 1. System 1 organizations, he claims, are inclined toward status quoism and conservation. Gibson et al. (1982) state the following with regards to system 4 organization theory:

> The system 4 organization is more adaptable because its structural design encourages greater utilization of the human potential. Managers are encouraged to adopt practices which tap the full range of human motivations; decision making, control, and goal-setting processes are decentralized and

Table 1. Characteristics of classical and System 4 organization design theories (after Gibson et al. 1982).

Classical Design Organization	*System 4 Organization*
1. *Leadership process* includes no perceived confidence and trust. Subordinates do not feel free to discuss job problems with their superiors, who in turn do not solicit their ideas and opinions.	1. *Leadership process* includes perceived confidence and trust between superiors and subordinates in all matters. Subordinates feel free to discuss job problems with their superiors, who in turn solicit their ideas and opinions.
2. *Motivational process* taps only physical, security, and economic motives through the use of fear and sanctions. Unfavorable attitudes toward the organization prevail among employees.	2. *Motivational process* taps a full range of motives through participatory methods. Attitudes are favorable toward the organization and its goals.
3. *Communication process* is such that information flows downward and tends to be distorted, inaccurate, and viewed with suspicion by subordinates.	3. *Communication process* is such that information flows freely throughout the organization—upward, downward, and laterally. The information is accurate and undistorted.
4. *Interaction process* is closed and restricted; subordinates have little effect on departmental goals, methods, and activities.	4. *Interaction process* is open and extensive; both superiors and subordinates are able to affect departmental goals, methods, and activities.
5. *Decision process* occurs only at the top of the organization; it is relatively centralized.	5. *Decision process* occurs at all levels through group process; it is relatively decentralized.
6. *Goal-setting process* is located at the top of the organization, discourages group participation.	6. *Goal-setting process* encourages group participation in setting high, realistic objectives.
7. *Control process* is centralized and emphasizes fixing of blame for mistakes.	7. *Control process* is dispersed throughout the organization and emphasizes self-control and problem solving.
8. *Performance goals* are low and passively sought by managers who make no commitment to developing the human resources of the organization.	8. *Performance goals* are high and actively sought by superiors, who recognize the necessity for making a full commitment to developing, through training, the human resources of the organization.

shared at all levels of the organization. Communications flow thorughout the organization, not simply down the chain of command as is the case in bureaucracies.

According to Likert (1967), a system 4 organization must implement the following principles in its organization design:

1. The principle of supportive relationships.
2. Group decision making and group methods of supervision.
3. High performance goals.

The structure of a system 4 organization (Figure 7) consists of working groups which are linked together by managers. Each unit of the organization, represented as a triangle in Figure 7, is headed by a manager who is also a member of the higher unit (dots represent managers). This dual capacity allows the manager to act as "linking pins", connecting each unit with its immediate supervior's unit and coordinating their efforts with other group managers. This overlapping unit structure, in combination with the manager's use of participative decision making, according to Likert (1967), "represents an optimum integration of the needs and desires of the members of the organization, the shareholders, customers, suppliers, and others who have an interest in the enterprise or are served by it."

System 4 organization design theory is viewed by its advocates, as universally applicable. In other words, it is thought to be the "one best way" to design an organization.

Contingency Design Theory

An evolution of classical design theories is termed contingency theory, which attempts to design an organization on the basis of its

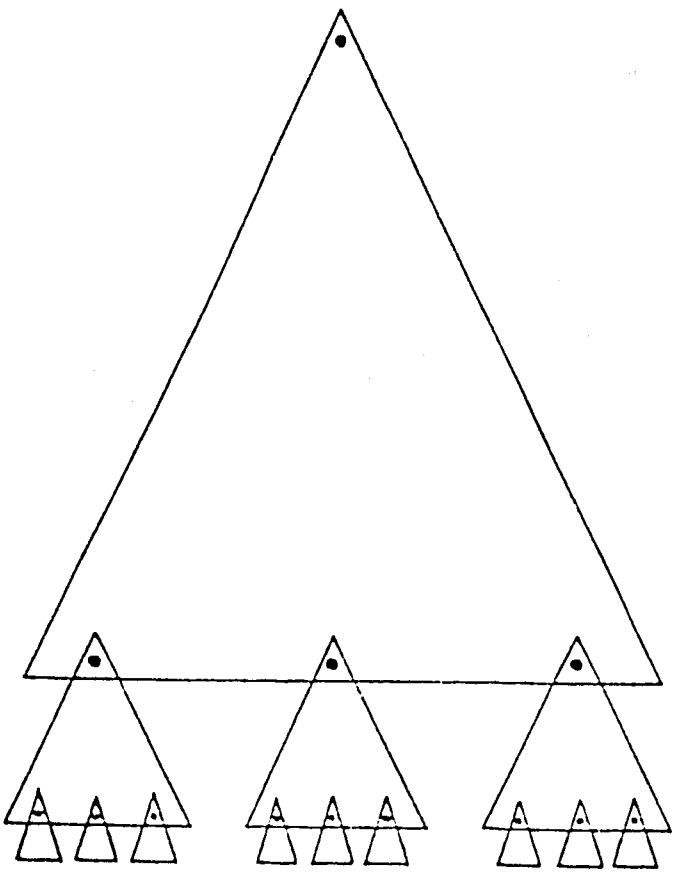


Figure 7. The system 4 organization (after Gibson et al. 1982).

requirements. The flexibility that exists in contingency theory frees the designer from having to choose from universal design theories. It merely attempts to answer the following questions: "under what circumstances and in what situation is either classical theory or system 4 theory the more effective?" (Gibson et al. 1982). For a particular situation contingency design theory attempts to combine the best of the three universal theories (classical, bureaucratic, and system 4).

Researchers have tried to identify the factors that determine the appropriate organizational design for a particular situation. There are two major schools of thought with regards to this subject. One group of researchers suggest that the choice of technology determines the best organizational structure. However, the second group identify environmental factors as the determinant. In the following sections these two factors are briefly discussed.

The structural consequences of technological choice

Rousseau (1979) defines technology, in the context of organization theory, as "the application of knowledge to perform work." Technology is the process by which inputs are transferred into desired outputs.

Most oganizations strive to increase their degree of mechanization and automation. In water resources projects, the use of computers and remote sensing equipment are becoming prevalent. Likewise, in the production of physical products, mass production techniques and process production techniques are replacing manual operations.

Mass production technology often results in routinizing jobs. What was before a craft job is now broken into several components, each constituting a step in the mass production process. Hage and Aiken (1969) found that routine technology leads to formalization, and the centralization of design making process. Figure 8 illustrates the role of technology in organization design process.

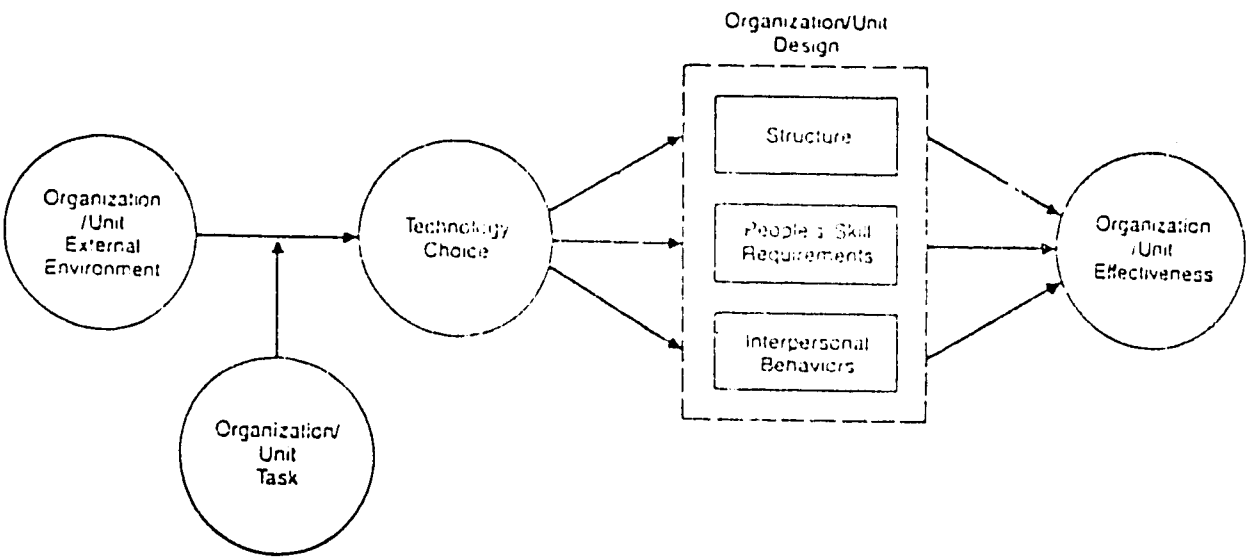


Figure 8. Sequential relationship between external environment, organization or unit technology, design and effectiveness, and contingency input of organization or unit task (after Miles 1980).

Environment and the choice of organization design

Miles (1980) refers to environment as:

> "the forces and institutions outside of the firm with which its members must deal to achieve the organization's purposes. These include competitors' actions, customers requirements, financial constraints, scientific and technological knowledge, and so on."

Pfeffer (1978) states that environmental conditions manifest themselves as interdependence between the organization and other entities. He further states that organizational structures are designed to cope with external interdependence, including competition interdependence. Further, such structures must be able to deal with the uncertainty and changing patterns of tastes, norms, and values confronted by the organization. Interdependence with external organizations affects the influence of internal subunits, which is also likely to be reflected in the resultant organizational structures. For example, in a study of 16 health and welfare organizations, Aiken and Hage (1968) found that due to resource limitations, these organizations undertook joint programs which increased interdependence between them. This action resulted in increased structural complexity, increased members of professional staff, and less formalization.

An Environmental-Contingent Model of Organization Design

Gibson et al. (1982) outlines an organization design model that is based on environmental factors affecting an organization. This environmental-contingent model is claimed to be applicable to any

institutional setting. For a general organizational design model, we must take a systems approach. In other words, an organization is viewed as an element of a set of interdependent components that make up the system.

An organization interacts, in a total environment, with four subenvironmental entities, namely, input, technology, knowledge, and output. Figure 9 illustrates this concept. An effective organization accommodates the requirements of these subenvironments. Each is discussed briefly in the following paragraphs.

The output subenvironment

The output subenvironment is the most important element in the total system of an organization. The choice of desired output dictates the type of technology, knowledge, and input required. For example, the choice of crop (output) for an agricultural industry determines the type of input (seed and fertilizer), technology (harvesting machinary), and knowledge (availability of information) required.

The input subenvironment

Raw materials, people, and problems can be input to an organization system. A refinery takes raw materials to process; a hospital processes people, and government agencies process problems. When inputs are fairly stable, the organization tends to be bureaucratic in design. For example, a wastewater treatment plant with a stable and predictable input often operates as a bureaucratic organization. Whereas, a hospital with diverse and uncertain input subenvironment must be more flexible in its organization design.

The technology subenvironment

The choice of technology is dependent on both the available input and the desired output. When input is stable and output is homogeneous, mass-production technology is often used. However, when both the input and the output are variable, job-order production technology is utilized. The former is routine technology whereas, the latter constitutes non-routine technology. Most water resources organizations use routine technology in their operations. The relative stability of the input, output, and technology subenvironments in water industry favors a classical organization design.

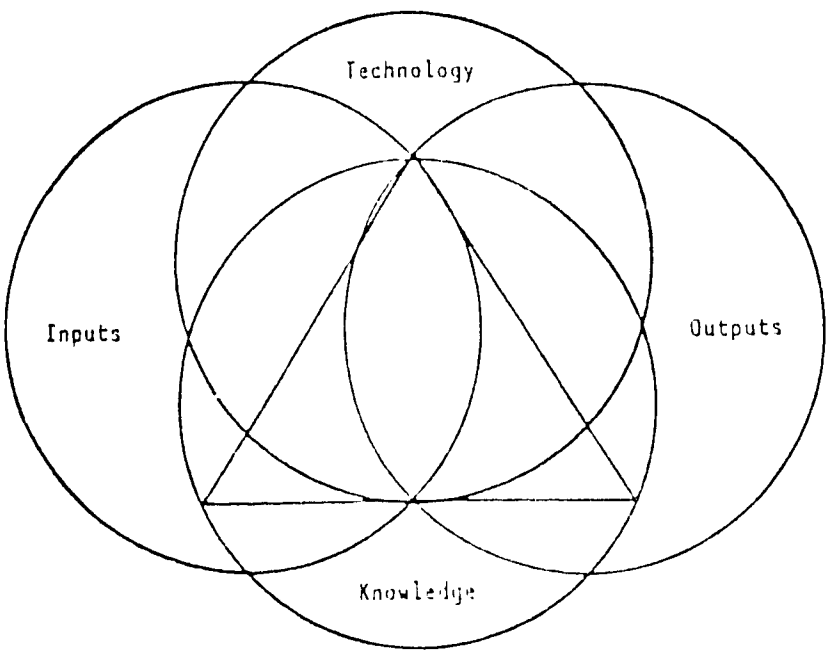


Figure 9. The four subenvironments of an organization (after Gibson et al. 1982).

Whereas, in organizations where non-routine technology is used and subenvironments are not stable, a matrix organization design is more appropriate. An example of the latter case is space related industries.

The knowledge subenvironment

Knowledge subenvironment refers to the predictability and stability of the preceding subenvironments. For example, in a surface water scheme, knowledge about future stream flow (input) may be unstable (stochastic) whereas knowledge about output and technology subenvironments is often predictable and unchanging.

A specific organization design results from key managerial decisions (division of labor, departmentalization, span of control, and delegation of authority) about the overall structure of tasks and authority.

Alternative designs range along a continuum with functional orgnaization at one extreme and product organization at the other. Matrix organization offers a balance between the two types of organization design. The following is a summary of major issues in organization theory as stated by Gibson et al. (1982):

1. The task and authority relationships among jobs and groups of jobs must be defined and structured according to rational bases. Historically, practitioners and theorists have recommended two specific, yet contradictory, theories for designing organization structures.

2. One theory, termed classical design, is based upon the assumption that the more effective organization structure is characterized by highly specialized jobs, homogeneous departments, narrow spans of control, and relatively centralized authority. The bases for these assumptions are to be found in the historical circumstances within which this theory developed. It was a time of fairly rapid industrialization which encouraged public and private organizations to emphasize the production and efficiency criteria of effectiveness. To achieve these ends, classical design theory proposes a single one best way to structure an organization.

3. In recent years, beginning with the human relations era of the 1930s and sustained by the growing interest of behaviorial scientists in the study of management and organization, an alternative to classical design theory has been developed. This theory, termed system 4 design proposes that the more effective organization has relatively despecialized jobs, heterogeneous departments, wide spans of control, and decentralized authority. Such organization structures, it is argued, achieve not only high levels of production and efficiency, but also satisfaction, adaptiveness, and development.

4. The design of effective organizational structure cannot be guided by a single "one best way" theory. Rather, the manager must adopt the point of view that either the bureaucratic or system 4 design is more

effective for the total oganization or for subunits within the organization.

5. The manager must identify and describe the relevant subenvironments of the organization in terms of outputs, inputs, technology, and knowledge. These subenvironments determine the relationships within units, among units, and between units and their subenvironments.

6. The manager must evaluate each subenvironment in terms of its rate of change, relative certainty, and time span of feedback. These conditions are the key variables for determining the formal structure of tasks and authority.

7. Each subunit structure is designed along the bureaucratic system 4 continuum in a consistent manner with the state of environmental conditions. Specifically, slower rates of change, greater certainty, and shorter time spans of feedback are compatible with the bureaucratic design; the converse is true for the system 4 design.

8. Concurrently with the design of subunit structures is the design of integrative techniques. The appropriate techniques, whether rules, plans, or mutual adjustment, depend upon the degree of subunit differentiation. The greater the differentiation the greater the need for mutual adjustment techniques. At the other extreme, the greater the need for rules and plans.

CHAPTER IV

WATER RESOURCES ORGANIZATIONS IN THE U.S.

This chapter constitutes a brief review of the organizational aspects of water management institutions in the U.S. The review is based on a description of four important water institutions which are listed as follows:

1. The Tennessee Valley Authority which was created by the Federal Government for a large multi-purpose project, including navigation.

2. The Upper Colorado River Basin Commission which also falls under the jurisdiction of the Federal Government and is a multi-purpose project which includes a large hydroelectric capacity.

3. The California Department of Water Resources which operates an extensive state water resources development program.

4. The Coachella Valley Water District of Southern California typifies a local water management organization.

Tennessee Valley Authority (TVA)

TVA was established in May 1933 by an Act of the Congress of the United States to be an independent corporate agency of the federal government. The basic objectives of the TVA are:

> To regulate the flow of the Tennessee River system to create a deep water navigation channel in the Tennessee River and to regulate flood waters in the Tennessee and lower Mississippi Valleys; to produce power; to provide for reforestation and for the agricultural and industrial development of the Valley; to provide for the national defense; to operate experimental chemical plants for the

> development of new fertilizer materials and for manufacture of munitions in times of national emergency. TVA also is charged with caring for conservation and development of natural resources in the Tennessee River basin (TVA 1983).

The drainage basin of the Tennessee River and its tributaries covers an area of 40,910 square miles. Approximately 4.7 million people live in the drainage basin of the Tennessee River and about 6.9 million people are served by TVA power. In addition, TVA employs about 37,000 persons.

TVA is headed by a three-member Board of Directors appointed by the President and confirmed by the Senate. The President designates a chairman from among the three directors who are appointed for terms of nine years each, with one of the terms expiring every three years. The day-to-day affairs of the agency are administered by a General Manager, who is responsible to the Board of Directors. Operations are conducted by six major offices under the General Manager: Power, Engineering Design and Construction, Natural Resources, Agricultural and Chemical Development, Economic and Community Development, and Management Services. Figure 10 shows the organization chart of the TVA.

TVA operates 39 dams on the Tennessee River system. 30 of these are on the tributaries and act as water storage dams. The remaining 9 dams are on the mainstream of the Tennessee River and basically serve as navigation control dams. Figure 11 is a map of Tennessee Valley region and its river system.

The nine main Tennessee River dams have navigation locks. Commerical navigation on the Tennessee River extends from its mouth at the Ohio River to Knoxville, Tennessee, a distance of 650 miles,

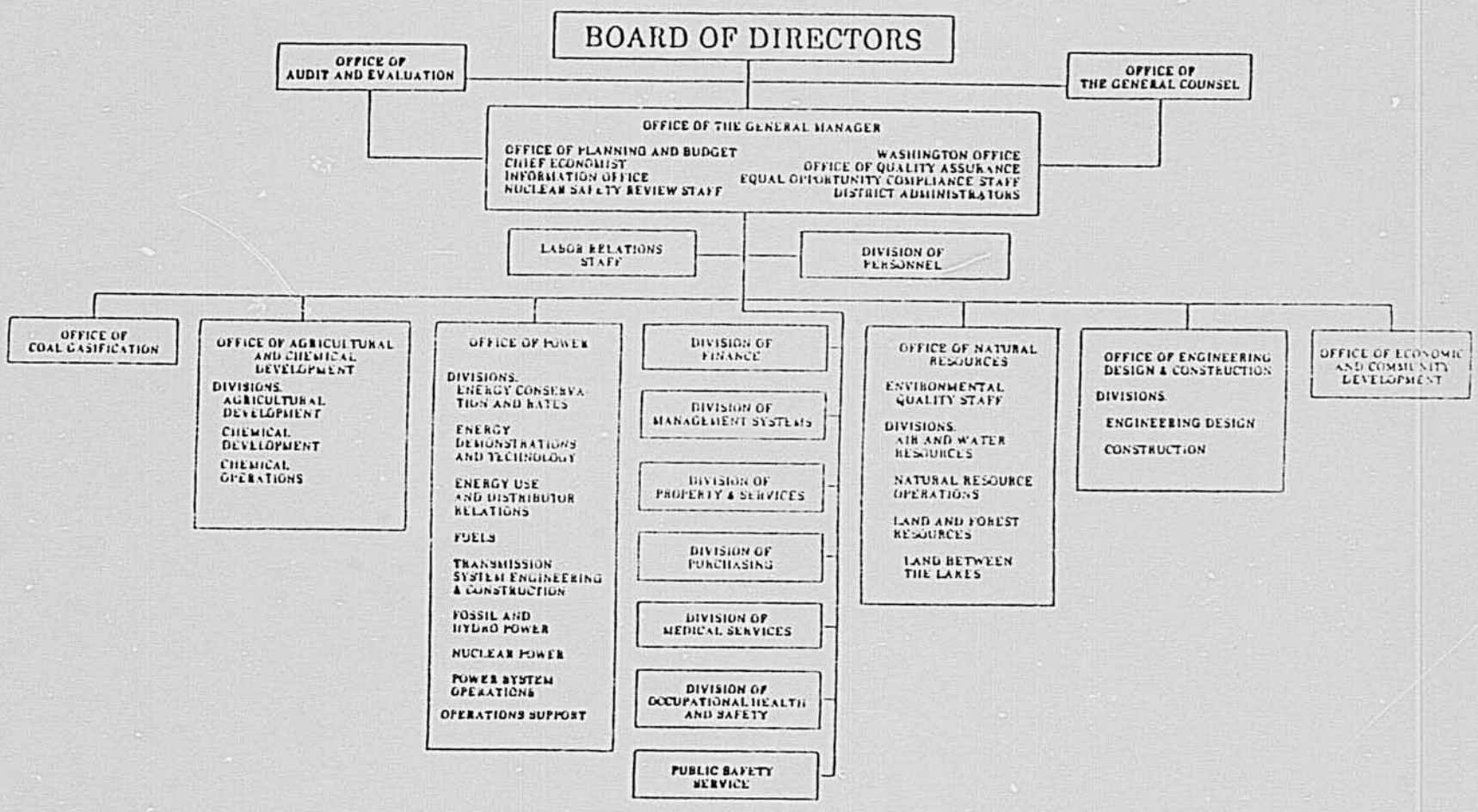


Figure 10. Organization chart of Tennessee Valley Authority.

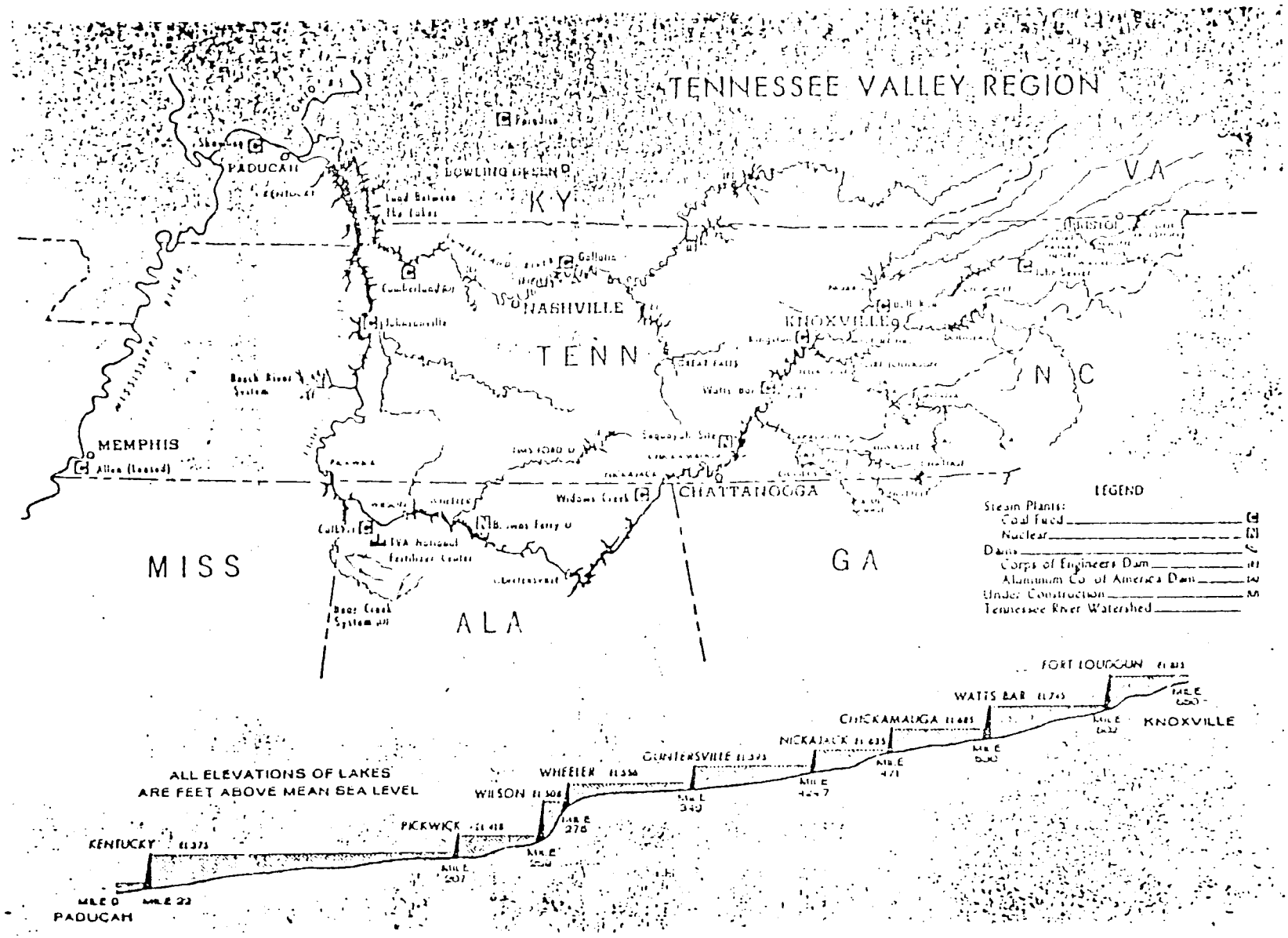


Figure 11. Map and profile of Tennessee River Basin.

plus 150 miles of tributary channels. Navigable channels are maintained at a depth of 11 feet. The main products shipped on the river are coal and coke, grain, petroleum and chemical products. Figures 12, 13, and 14 show some features of navigation on Tennessee River. The navigation system of the TVA is operated by the Army Corps of Engineers.

One of the main features of the TVA is its power generating capacity. The power system includes 30 hydroelectric plants, 12 coal-fired steam plants, two nuclear plants, one hydroelectric pumped-storage plant, and four combustion-turbine plants in service. It includes approximately 16,400 miles of transmission lines, most of them operating at 161,000 and 500,000 volts, and 361 substations. In 1982 the total generating capacity was about 32 million kilowatts.

Upper Colorado River Basin Commission (UCRB)

The Colorado River Basin is located in the Western United States. Through extensive water resources development, it provides electricity, water supply, and flood damage mitigation for a large portion of the Western U.S. Colorado River Basin is developed and managed by the U.S. Bureau of Reclamation. The USBR is headed by the Commissioner of Reclamation who is appointed by the Secretary of Interior. There are two Regions in the Colorado River Basin, the Upper Basin and the Lower Basin. The Commissioner of Reclamation appoints the Regional Directors. Figure 15 shows the organizational structure of the Upper Colorado Region.

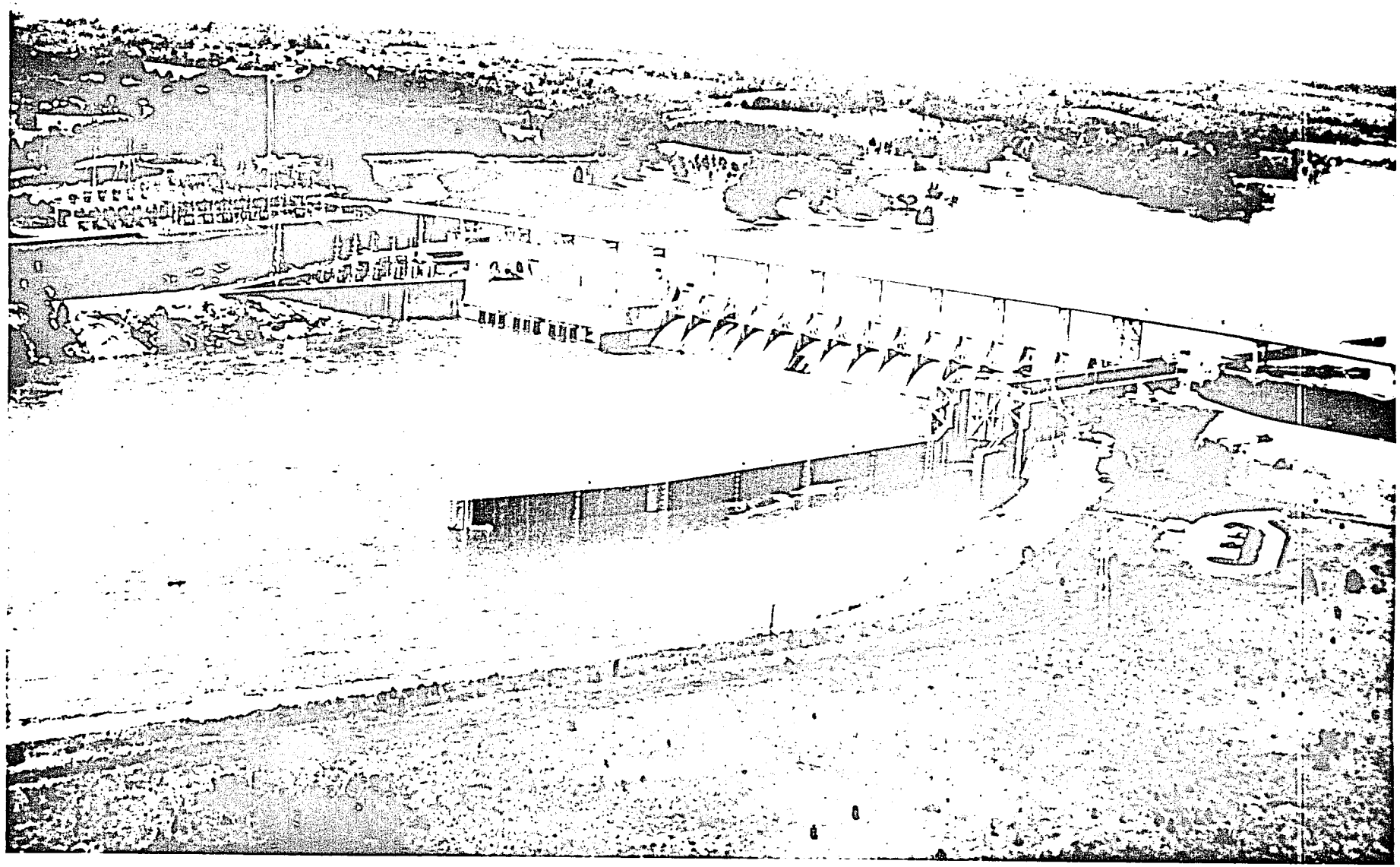


Figure 12. Fort Loudon Dam in Tennessee River Basin

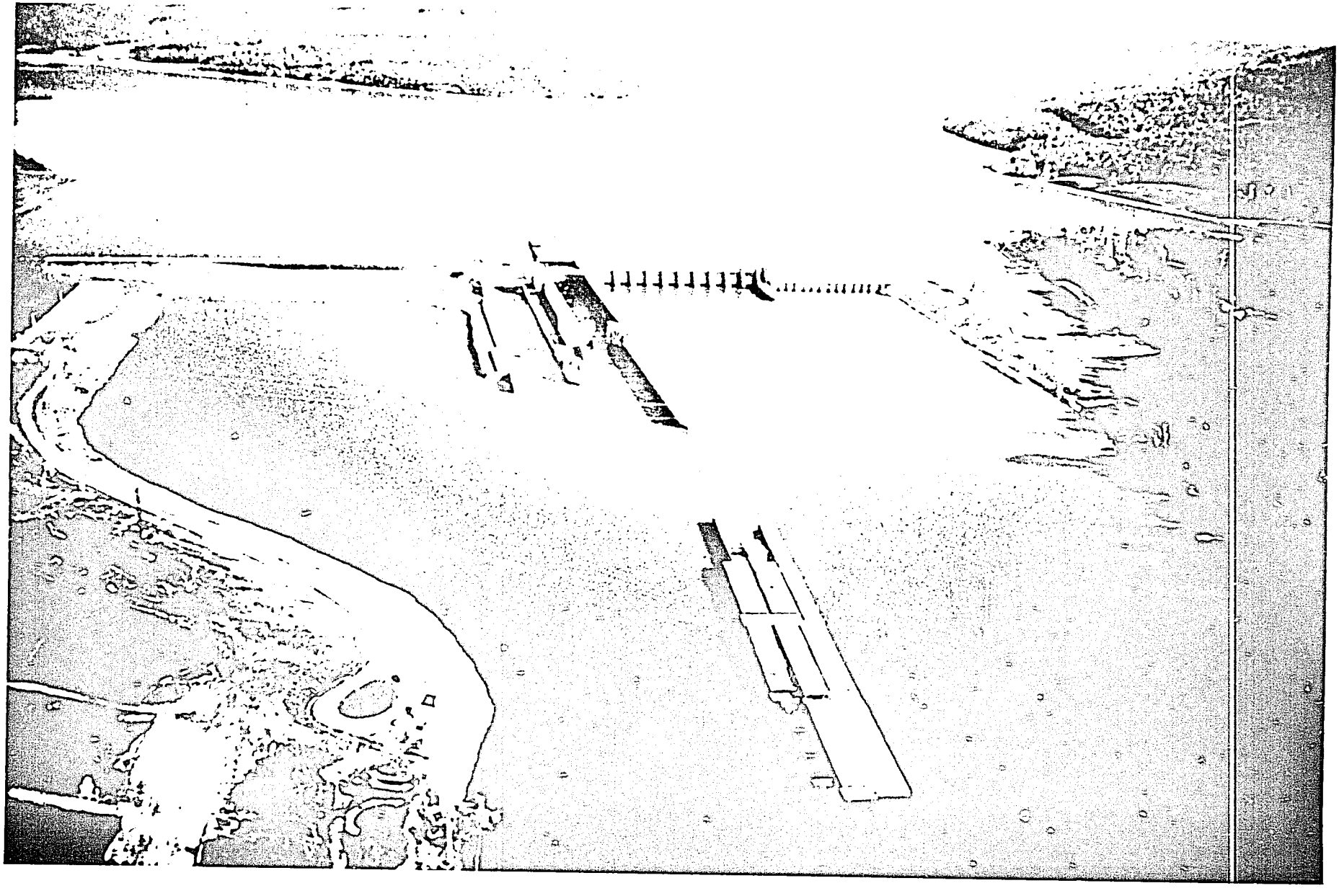


Figure 13. Barges in Tennessee River.

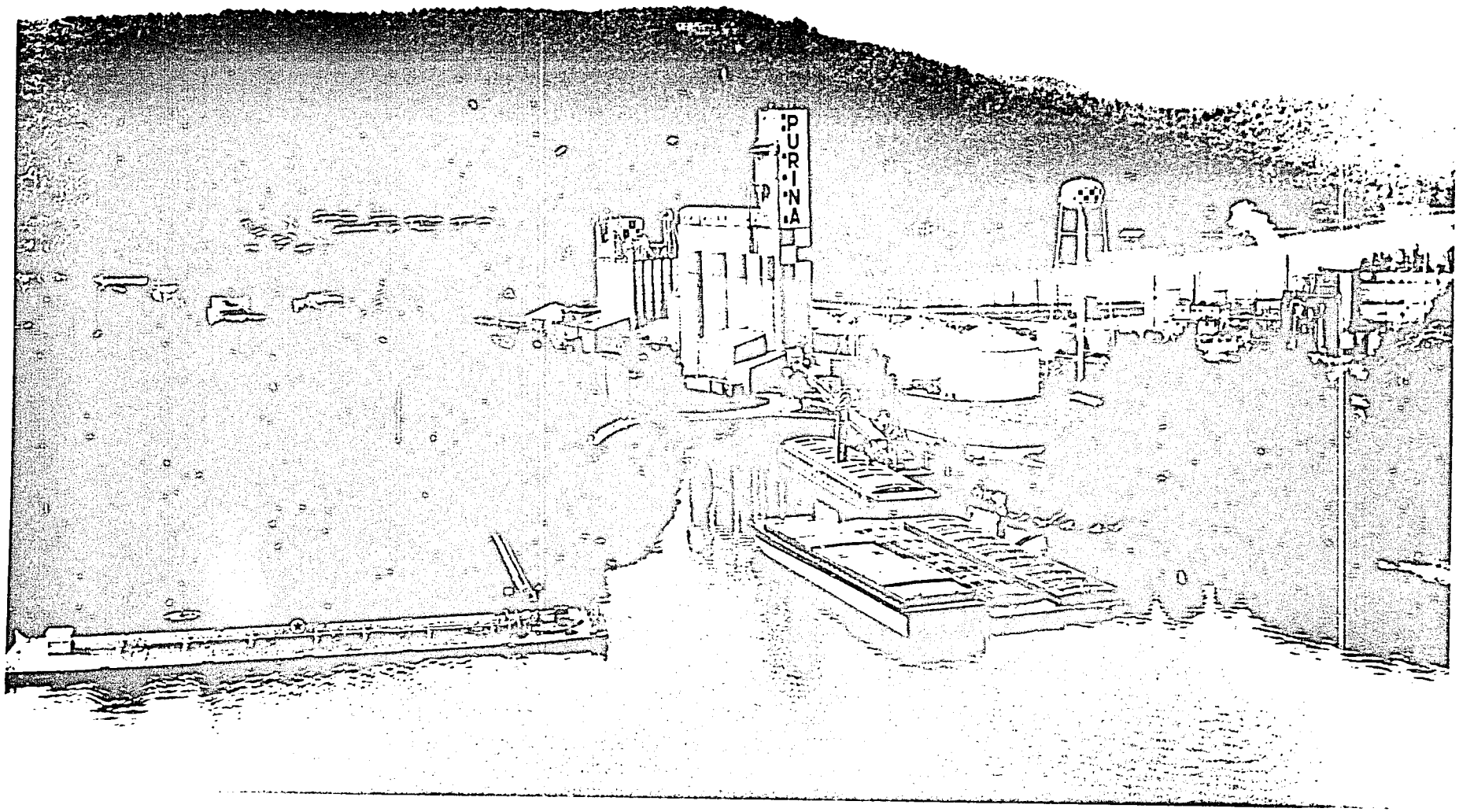


Figure 14. A barge being loaded in Tennesee River.

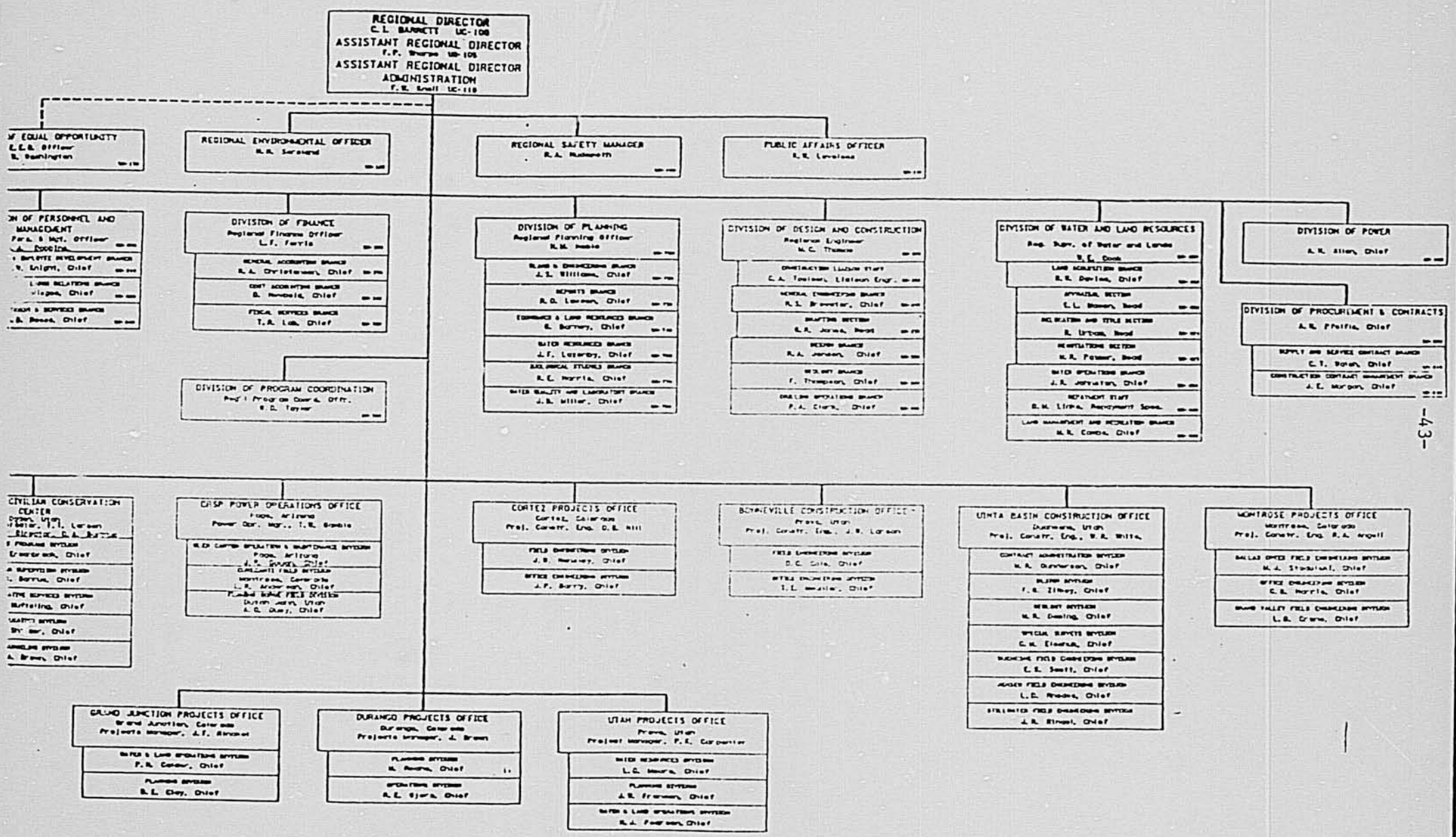


Figure 15. Organization chart of Upper Colorado Region.

The Regional Director and the divisions that are not directly involved in field work are located in Salt Lake City. Whereas, the Project Offices, Operation Offices, and Construction Offices are located in their respective areas. Each Office or Division has its own manager who is directly responsible to the Office of the Regional Director. The Upper Colorado River Project is managed by an inter-state organization whose responsibility extends across the states of Nevada, Utah, Idaho, Arizona, Colorado, Wyoming, and New Mexico.

California Department of Water Resources

California Department of Water Resources (CDWR) is the state agency for the development of water resources in California. It operates and maintains a large network of reservoirs, pumping stations, and canals throughout the State. The California State Water Project (SWP) is composed of 10 principle reservoirs (mainly in the North). About 80 percent of the State's water supply is in Northern California, whereas 80 percent of the demand for water is in Southern California. The California aqueduct, a large canal, carries about 2.3 million acre-feet (2,8000,000,000 cu.m.) of water from the northern reservoirs to southern farmlands and urban areas each year. Prior to the construction of SWP, potential users of water were organized in 30 different water agencies or irrigation districts. Contracts were made with these agencies and the firm yield of the project was allocated among them. Under these contracts, the entire cost of SWP is expected to be repaid in a period of 50 years with interest. Figure 16 shows the organization chart of the COWR.

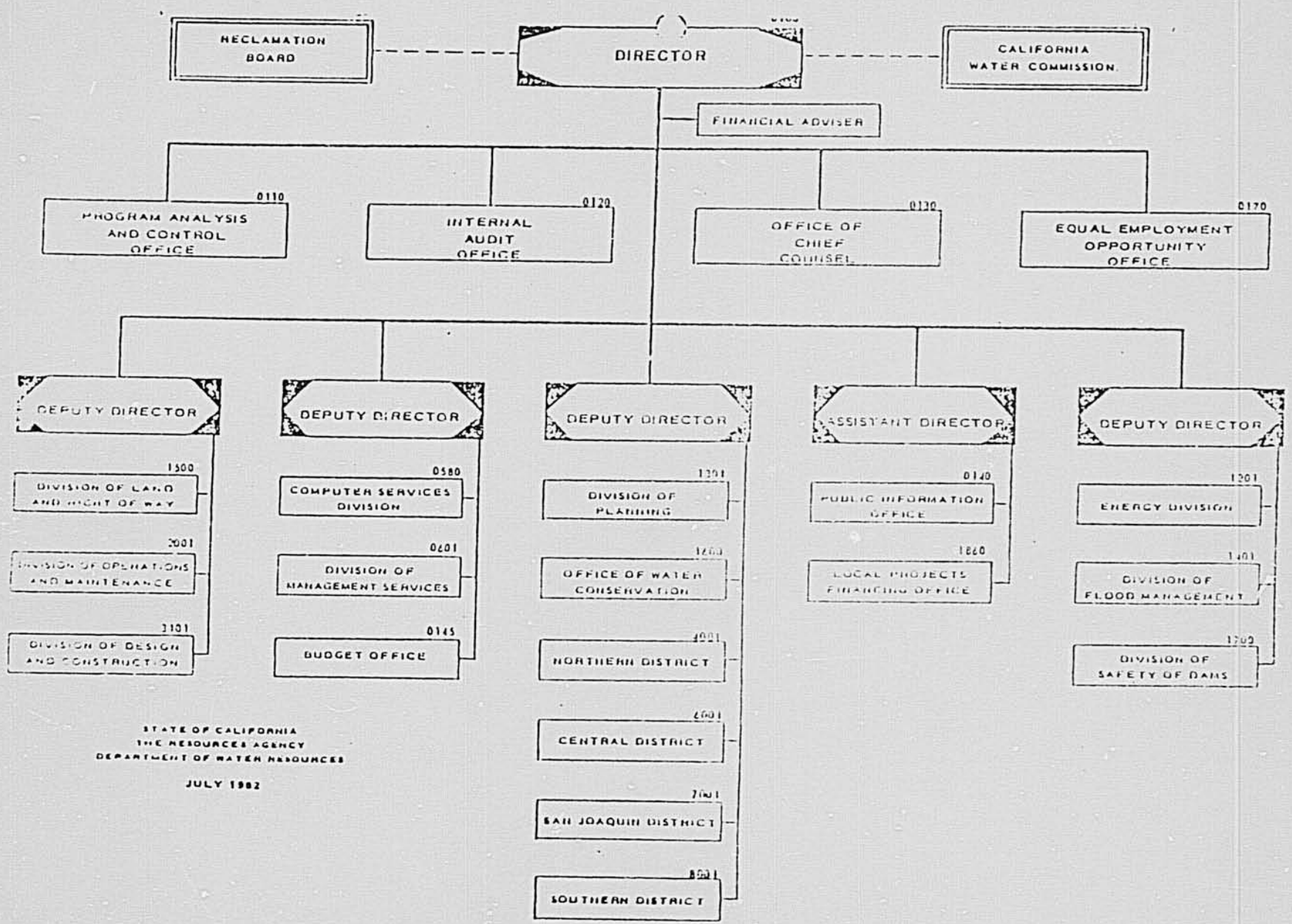


Figure 16. Organization chart of California Department of Water Resources.

The Director of the CDWR is appointed by the Governor of the State of California. The work of the CDWR is distributed among four Deputy Directors and one Assistant Director who manage several Divisions and Offices. For water management purposes, the State of California is divided into four Districts. Each district manages the day-to-day operation and maintenance of the facilities within its area in addition to some planning work. Figure 17 shows the District boundaries of the CDWR and Figure 18 shows the organization chart of one of the Districts.

Coachella Valley Water District (CVWD)

Coachella Valley is located in Southern California. This fertile valley receives its water from the Colorado River by the way of the Imperial Dam, the All American Canal, and the Coachella Canal. The CVWD receives about one half million acre feet of water each year and is involved in the following fields of service: importation and distribution of domestic water, wastewater collection and reclamation, regional stormwater protection, importation and distribution of irrigation water, irrigation drainage systems, and water conservation. Nearly 64,000 acres of land lie within the boundaries of the District. Except for the main supply canal, most of the CVWD's distribution system is comprised of underground pipelines.

The CVWD is a public agency of the State of California. The District is governed by a five-member Board of Directors elected by the citizens of the District in five divisions (areas). They serve four year terms, three elected at one election and two years later

Figure 17. District boundaries of the California Department of Water Resources.

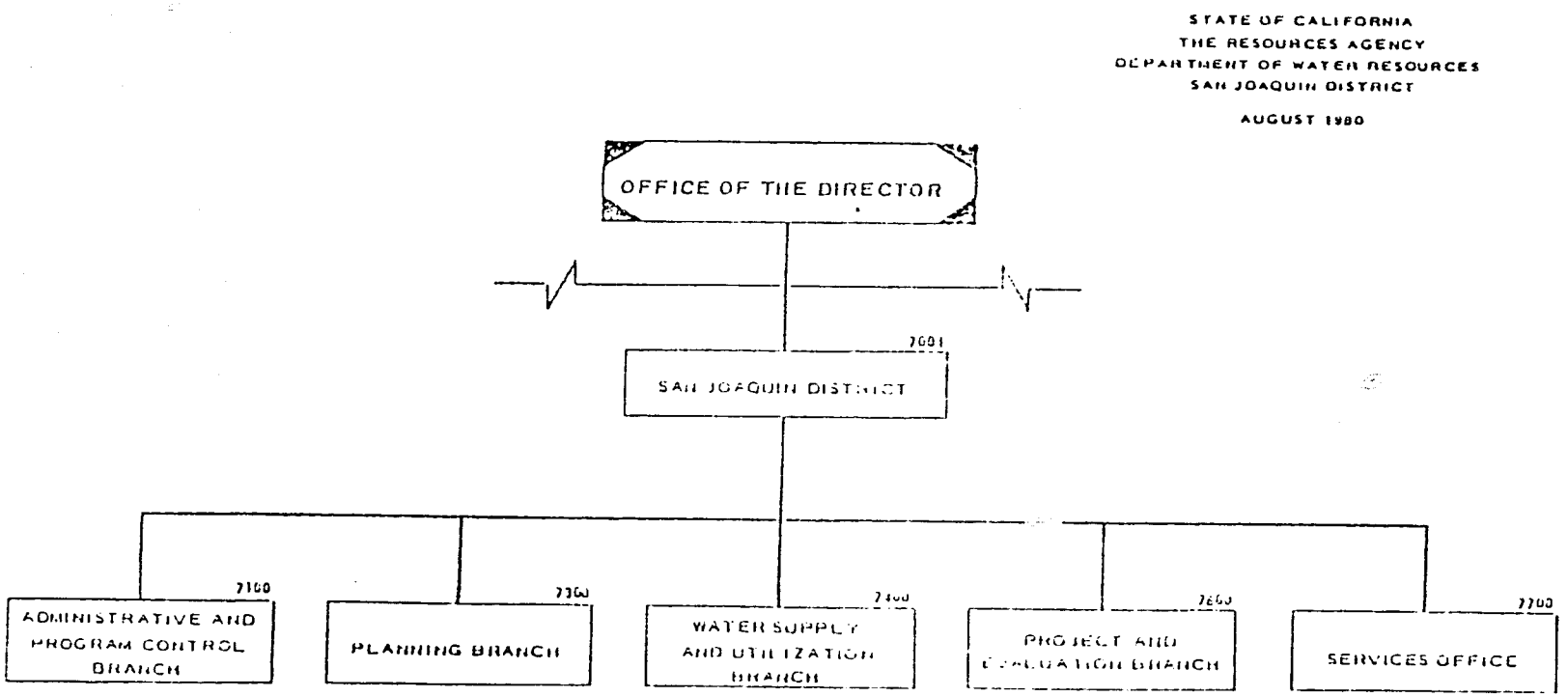


Figure 18. Organization chart of the San Joaquin District of the CDWR.

two others are elected to provide a staggering of the terms of office. The Board's chief executive officers are General Manager, Secretary, and Auditor. The General Manager appoints all other personnel and is responsible for their performance. The work of the District is divided along functional lines (refer to Chapter II for an explanation of functional departmentalization) and each of the major units is headed by a department head responsible for its performance. The main departments of the District are: Engineering, Operations and Maintenance, Finance and Accounting, Secretary, Legal Department, Administrative Services, and Resources Director. Figure 19 shows the organization chart of the CVWD.

Because of the significant difference in the sizes of these four organizations (37,000 persons employed by TVA as compared to 300 employed by CVWD), it would be difficult and unrealistic to compare them. However, one can make certain general and descriptive remarks about these organizations. To accomplish this, the following organizational characteristics will be addressed for each organization:

1. Specialization

   The degree of specialization will be measured by the number of specialties (fields) represented in the macro-organization structure.

2. Departmentalization

   The common basis for grouping of tasks (departmentalization) will be indicated.

3. Span of control

   This is mesured by the maximum number of subordinates responsbile to one manager.

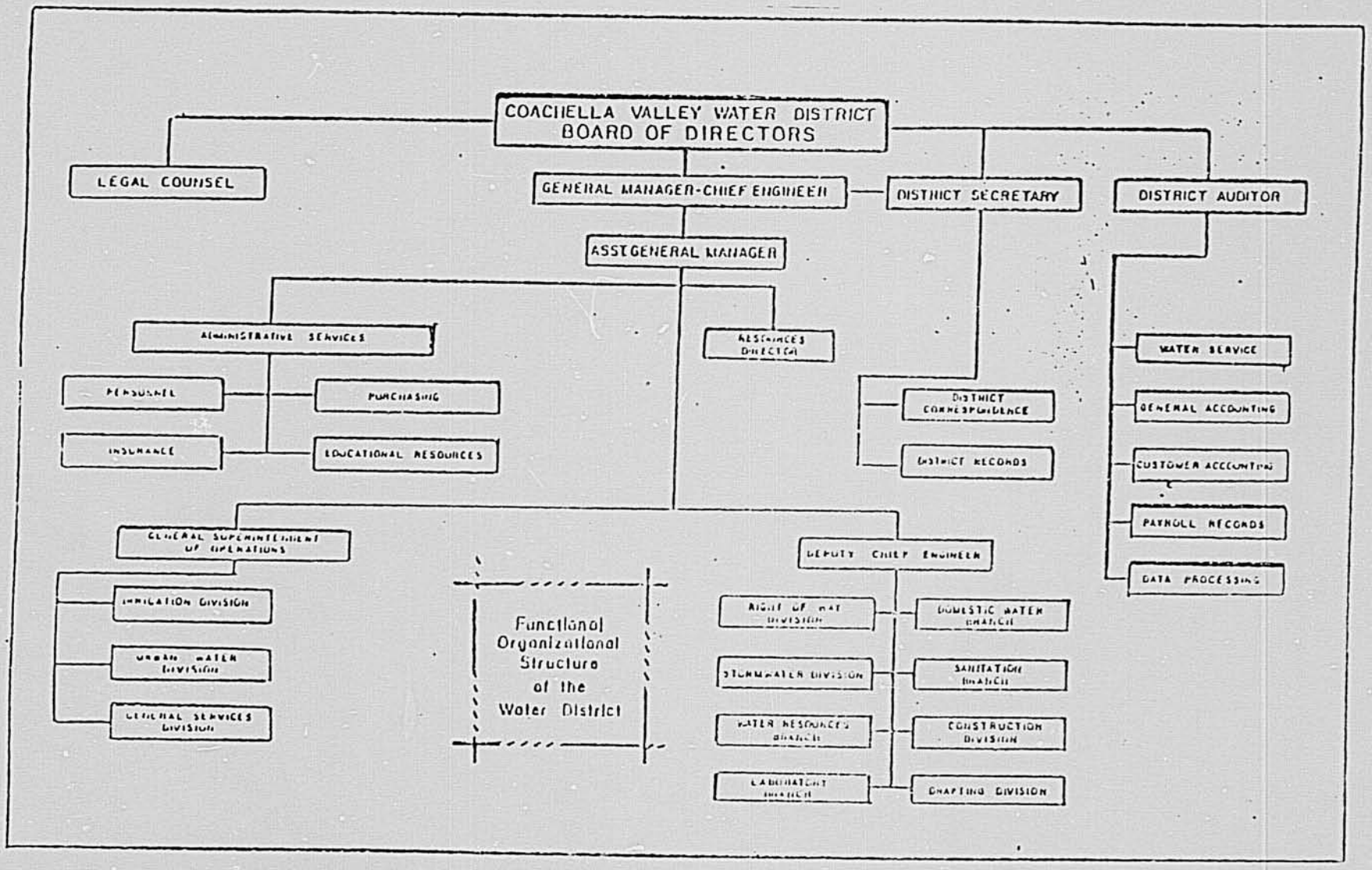


Figure 19. Organization chart of Coachella Valley Water District.

4. Formalization

The degree of formalization of each organization will be measured on a qualitative scale of high, medium, and low.

5. Centralization

The degree of centralization (the distribution of decision making authority in the organization) will be measured on a qualitative scale of high, medium, and low.

6. Complexity

Only the horizontal complexity of each organization will be considered. This will be measured by the number of departments in the organizational structure.

7. Size

The number of employees of each organization constitutes its size.

8. Age

The number of years that an organization has been in existence is a measure of its success.

Table 2 shows these eight organizational characteristics for the four organizations considered in this chapter.

The four water resources organizations considered in this chapter are all public agencies and have evolved to fulfill the objectives that have been set for them by the public through local, state and federal governments. All of these organizations have been criticized, from time to time, for their inefficiency and overdevelopment of natural resources resulting in mixed opinions about the usefulness and success of these organizations. However, it

Table 2. Organizational characteristics of four U. S. institutions.

Organizational Characteristics	TVA	UCRB	CDWR	CVWD
Specialization	15	12	24	25
Departmentalization	Mixed	Mised	Mixed	Mixed
Span of Control	15	23	6	8
Formalization	High	High	Medium	Low
Centralization	High	High	Medium	Low
Complexity	15	23	24	25
Size	37,000	1200	2600	362
Age	51	41	28	50

would be difficult to make conclusions about their success without tangible criteria for measuring success. If economic criteria is picked as the standard for measuring success, the four organizations will be labeled as successful. However, if other criteria were chosen, such as environmental, ecological, and social, it would not be easy to come to a consensus about the success of these organizations.

CHAPTER V

THE DEVELOPMENT OF INTERNATIONAL RIVER BASINS

Water is an essential element in the development of a society. In any integrated national development program, water resource development must play an important role. Until recently, the water resources of the humid region of the world were taken for granted and the scarcity of water in arid areas was accepted as an unchangeable fact of life. However, with the expansion of population and increased demand for water, attention has been focused on the development of new water resources and improved management of existing ones.

The hydrologic characteristics of a river are unchanged as it crosses a political boundary or runs along one. However, major changes often occur in the political atmosphere in which the waters can be utilized. Changes in the quantity or quality of water in one reach of a river often affects conditions in other reaches. For instance, natural upstream erosion in one country may adversely affect navigation, fishing or timber floating in downstream countries. In addition, a well integrated water development program cannot ignore the interdependence of the surface and underground sources of water. They affect each other both in quality and quantity.

A river basin is a geographical location in which all waters within the basin originate and terminate in a common location. Because of the interdependence of the components of a river basin,

the basin concept is important. When the flows or the timing of it is changed in one part of a basin, the conditions of other parts will probably change. However, alterations in the flow regime of a basin are unlikely to affect the conditions in another basin. Therefore, for the purpose of establishing an institutional and legal framework for the development of international water resources, single basin planning is appropriate.

International Drainage Basin Development

The basin concept

The Helsinki Rules (1966) of the International Law Association define an international drainage basin as "a geographical area extending over two or more states determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus". The Salzburg resolution (1961), on the utilization of international (non-maritime) waters of the Institute of International Law formulated its definitions as comprising "waters which form part of a watercourse or hydrographic basin which extends over the territory of two or more states". The Inter-American Bar Association's Buenos Aires resolution (1957) on the principles of law governing the use of international rivers applied the principles to "every watercourse or system of rivers or lakes (non-maritime waters) which may transverse or divide the territory of two or more states" (United Nations 1975) Therefore, a more accurate term to use is "international drainage basin" instead of "international river". Under modern international law, agreements

between nations on the development of common water resources extend (geographically) over the entire drainage basin.

Hydrologic boundaries of the basin

In addition to the geographical boundaries of the basin, the hydrologic boundaries must be recognized as an important parameter in the institutional arrangement of a basin. In other words, all phases of the hydrologic cycle that may affect the water resources of the basin must be dealt with in international agreements for the development of a basin. These may include: surface water, groundwater, frozen water, atmospheric water, precipitation, and consumptive use. For instance, if weather modification is being contemplated, international agreements and regulation must be made to facilitate the development of this atmospheric water resource. Such regulations are necessary because weather modification (such as cloud seeding) can affect precipitation and storm patterns in another country.

Another source of water that, when applicable, must be included in international agreements is the international fresh water resources. These include glaciers, continential ice mantles, and polar ice. Any large scale melting of polar ice may affect the climatic conditions of the world and must be very carefully considered and agreed upon by all nations of the world. In the case of glaciers that naturally melt and contribute to runoff in an international basin, any supplemental man-induced melting practices must be agreed upon by the affected states.

The planners of an integrated water resources development program must also recognize the interdependence of the exploitation

of certain natural resources and the quality and quantity of water in the basin. The development and exploitation of many natural resources either require certain quantities of water or have an impact on its quality. Extraction of oil from shale is an example of a process that requires large amounts of water. Logging in the high elevations of a watershed can increase the sediment load of the streams and damage downstream navigation and fishing industries.

The need for inter-basin cooperation

As population in a basin grows, demand for land and water resources increases. There is often need for the "control" of the river, either because of the lack of sufficient water or excessive water. Examples of these types of control are water supply reservoirs and flood control measures such as channel modification. Any alteration in the flow regime of a river is bound to affect the entire river system (for example, channel modification for flood control may cause downstream flooding in a neighboring country). Therefore, in order to efficiently develop the water resources of an international basin, riparian states must cooperate. This cooperation is necessary even if a particular state is interested only in collecting hydrologic data for possible future development. A stream gaging or precipitation gaging network must be designed and set up based on hydrologic characteristics of the entire basin. Some type of institutional arrangement must be made by the co-basin countries in order to operate, maintain, and process data from the gaging network.

The cooperation of inter-basin states is also necessary for policing international waterways. Enforcing navigation regulations

in a common waterway can be greatly improved by communication and cooperation between the two sides of a political boundary that runs across or along the waterway. The treaty, Regime of Navigation on the Danube (United Nations 1948), is an example of such cooperative arrangements.

The mitigation of undesirable conditions in an international river is another case where inter-basin cooperation is essential. These may be quantity or quality related. An oil spill is an example of an undesirable condition which will affect the downstream segment of a river and must be cleaned with the cooperation of all basin countries.

Legal and Institutional Arrangements

International water treaties

Informal agreements between countries on the use of common rivers are very old. However, the first formal international water treaty was signed in 1921 in Europe. This was done under the supervision of the League of Nations and dealt with a number of navigable rivers in Europe (League of Nations 1921). Later in 1923, several European countries signed a treaty dealing with hydropower generation on international rivers. In 1933 the American States at the Seventh Inter-American Conference adopted the Declaration of Montenideo (OAS 1968). This declaration is concerned with the industrial and agricultural use of international rivers. Although this is not a legally binding treaty, some of the American States have used this document as the basis for their treaties on the use of international rivers. For example, Chile and Bolivia have adopted

the Declaration of Montenideo as their legal treaty for the shared use of the Rio Lauca. Many formal and informal agreements and treaties have been made on the utilization of international rivers and to mention them all is beyond the scope of this report.

When there are two or more countries that are interested in developing their common water resources, an agreement of some type must be made between the co-basin countries in order to facilitate communication and cooperation. This may be an informal or a formal agreement. These agreements prepare the way for further investigation and planning and must be flexible enough to allow the institutional framework to evolve and expand. In preparing such agreements, the expertise of water resources engineers must be utilized in addition to the input from experienced international lawyers and senior government officials and diplomats. There is no single format for international water agreements that will be suitable for all circumstances. The socio-political and economic conditions of a basin determine the appropriate form of the agreement.

Informal agreements. An informal agreement between the riparian states is not legally binding on the participating countries. It merely sets the stage for a future formal and detailed agreement. This type of arrangement facilitates communication and consultation between interested countries and is often the appropriate form of arrangement for countries that are not certain of the benefits of such a development program. An example of this type of arrangement is the 1968 agreement between the five co-basin countries of the Plata River in South America (OAS 1968). An Intergovernmental Coordinating Committee composed of the foreign ministers of the

participating countries was first formed. One year after informal agreements were made by this committee, a formal treaty was signed by all of the countries drained by the Plata River.

Formal agreements. Formal agreements between the riparian states of an international basin are made in the form of official treaties and are subject to ratification. Most international water treaties are formal in nature. When outside financing is involved it is essential to have a formal agreement. The agreement may be for a limited period of time or indefinite. It may deal with only one aspect of water development or a comprehensive basin-wide development program. Most formal international water agreements are bilateral. In 1963, there were more than 200 bilateral treaties related to international basins (United Nations 1963a). The Columbia River Basin Agreement of 1961 between Canada and the United States is an example of bilateral agreement. There are some multilateral treaties that are usually broader in scope than the bilateral treaties. The Senegal River Development Program is a result of a multilateral agreement between the countries of Senegal, Mauritania, and Mali. Its scope of activities is: "coordinated management of the Senegal River Basin to achieve rational exploitation of its diverse resources." (United Nations 1975).

Institutional frameworks

First, an agreement must be made between the parties. Then, the organizational machinery can be designed to carry out or implement the agreements. It is essential to define, at the outset, the authority and responsibility of the established organization. The organizational machinery must be designed to fit the scope of the

development program. A limited and inefficient organization cannot carry out the plans of a comprehensive development program. In the same manner, an elaborate and complex organization structure can make a simple development plan prohibitively expensive.

Most of the existing organizational structures fall under the following four categories (United Nations 1975):

Single coordinating institution. A single body is established to coordinate all common works in the basin. It usually is composed of high level diplomats from the participating states, and concerns itself with policy making and setting regulations. However, in some cases a limited technical staff also is included. Because of the size and nature of such an institutional structure, associated development programs are limited in scope. An example of this type of institutional arrangement is the International Boundary and Water Commission created by the United States and Mexico.

Differential coordination. In some cases it may be more efficient to establish several organizations, each dealing with one aspect of water development in the basin. This arrangement may be used for the management of several projects in a basin. In such a fragmented institutional arrangement there is always the possibility of inefficiency due to insufficient communication and integration. The 1946 agreement between Uruguay and Argentina for the development of the Salto Grande (United Nations 1946) is an example of such an arrangement.

Dual arrangement. This is a combination of a single coordinating body and differential coordination. A single body is created to coordinate all development projects in the basin. In addition,

several single-purpose organizations may be established to operate under the supervision of the coordinating body. These organizations may concern themselves with different sub-basins or major projects within the basin. The Plata Basin in South America is an example of this kind of arrangement.

Composite central organ. In the case of comprehensive water development, it may be appropriate to establish single-function organizations or departments (such as design, construction, and personnel) under the coordination of a joint commission. This type of institutional arrangement is similar to the structure of a bureaucratic organization. Each department is limited to its subject matter and has a manager that reports to a higher level administration. The River Niger Commission (United Nations 1963b) is an example of this type of arrangement. Figure 20 is a schematic illustration of the four types of organizational structures discussed above.

Post-construction management

In the post-construction phase, criteria must be set for the operation and maintenance of the common works. An institutional arrangement suitable for the needs of the post-construction phase must be established to carry out the operating rules agreed upon by the policy makers. A private firm or an autonomous public corporation may be contracted to operate and maintain the entire project. However, the setting of user fees and the enforcement of regulations is the responsibility of the international commission. The organizational and personnel needs of a project are quite different in the post-construction phase than during the construction period.

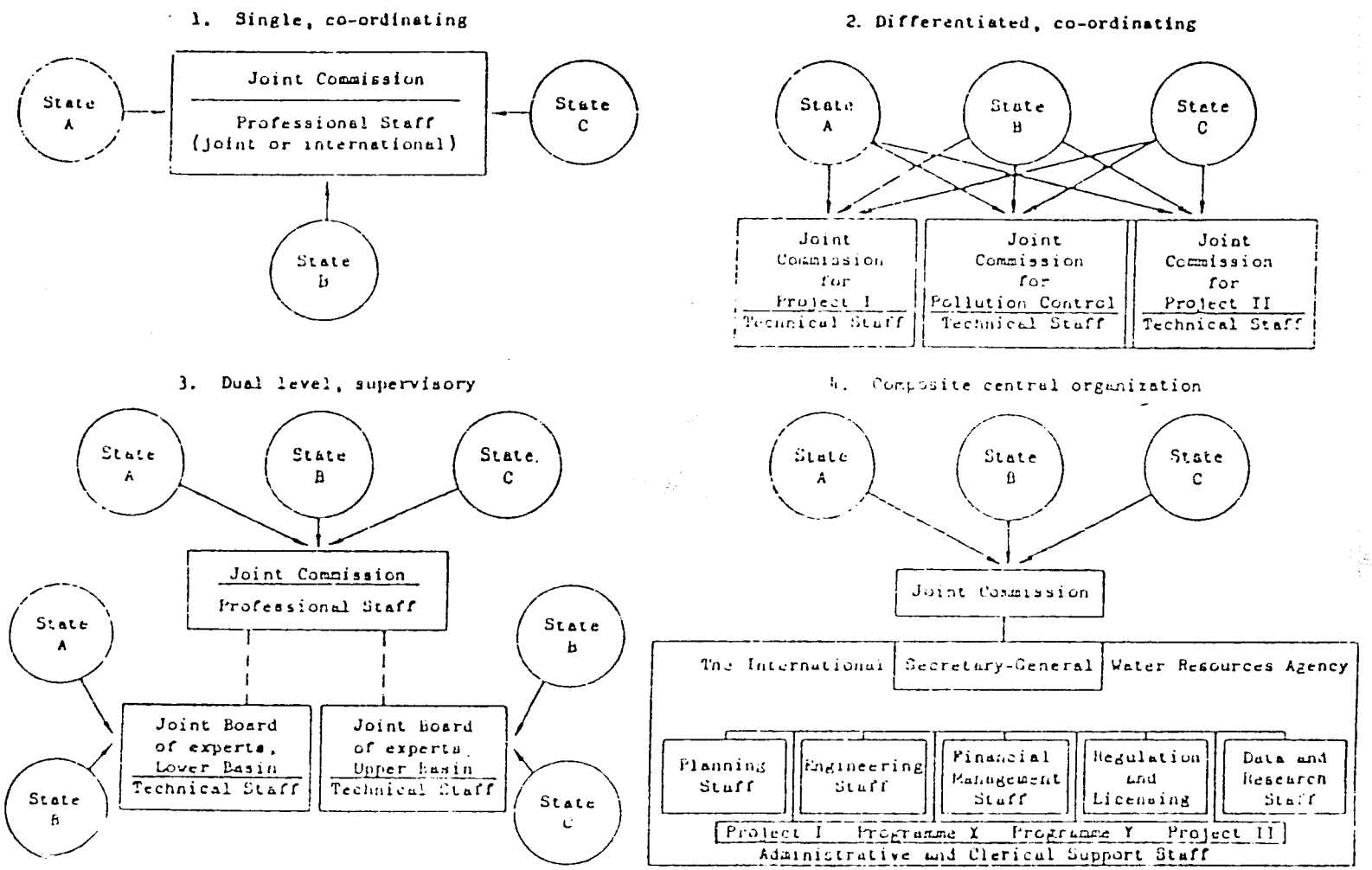


Figure 20. Four basic types of organizational structures for the development of International River Basins.

Some of the engineering staff and supporting personnel may be retained in addition to a small portion of the skilled laborers after the completion of the construction phase. However, the organizational structure must be altered to suit the needs of the project operation and maintenance.

In a situation where a water resource is shared by two or more countries two basic types of arrangements are normally made for the management of the project: (1) a single international agency is established and charged with the management of the resources on behalf of the riparian states, and (2) each participating country forms its own national agency. In the latter situation, the day-to-day operation of the hydraulic works is done by a board consisting of representatives from each country. The Austrian-Bariarian Hydroelectric Company is an example of the first type of arrangement and the International Lake of the Woods Control Board (set up between the U. S. and Canada in 1925) is an example of the second type.

It is very important that the components of an international water project are operated in a coordinated manner because of their interdependency. By doing so, the common resources are efficiency utilized and equitably distributed.

CHAPTER VI

SENEGAL RIVER DEVELOPMENT PROGRAM

Background Information

Geographic location

The Senegal River Basin, located in West Africa, lies between 10° 20' and 170° 30' latitude north and between 70° 00' and 170° 30' longitude west. Figure 21 is a map of the basin.

The Senegal River

The Senegal River is the second largest river in West Africa (after Niger River). The Senegal River system is about 1800 km long. During its course, the river flows through Guinea, Mali, Senegal, and Mauritania and drains into the Atlantic Ocean near the port of St. Louis. The flow regime of the Senegal River is quite irregular, both during a year and between years. The maximum mean annual discharge is 1241 m^3/s, whereas the minimum mean annual discharge is only 270 m^3/s. The 100-year peak flow of the river is 10,700 m^3/s. The average monthly discharge is 3,423 m^3/s in September and only 10 m^3/s in May. The waters of Senegal River originate in the Fouta-Djalon mountains of humid West Africa. River flow is high between July and October and reaches a low flow state from November to May. High flood peaks occur in late August or early September.

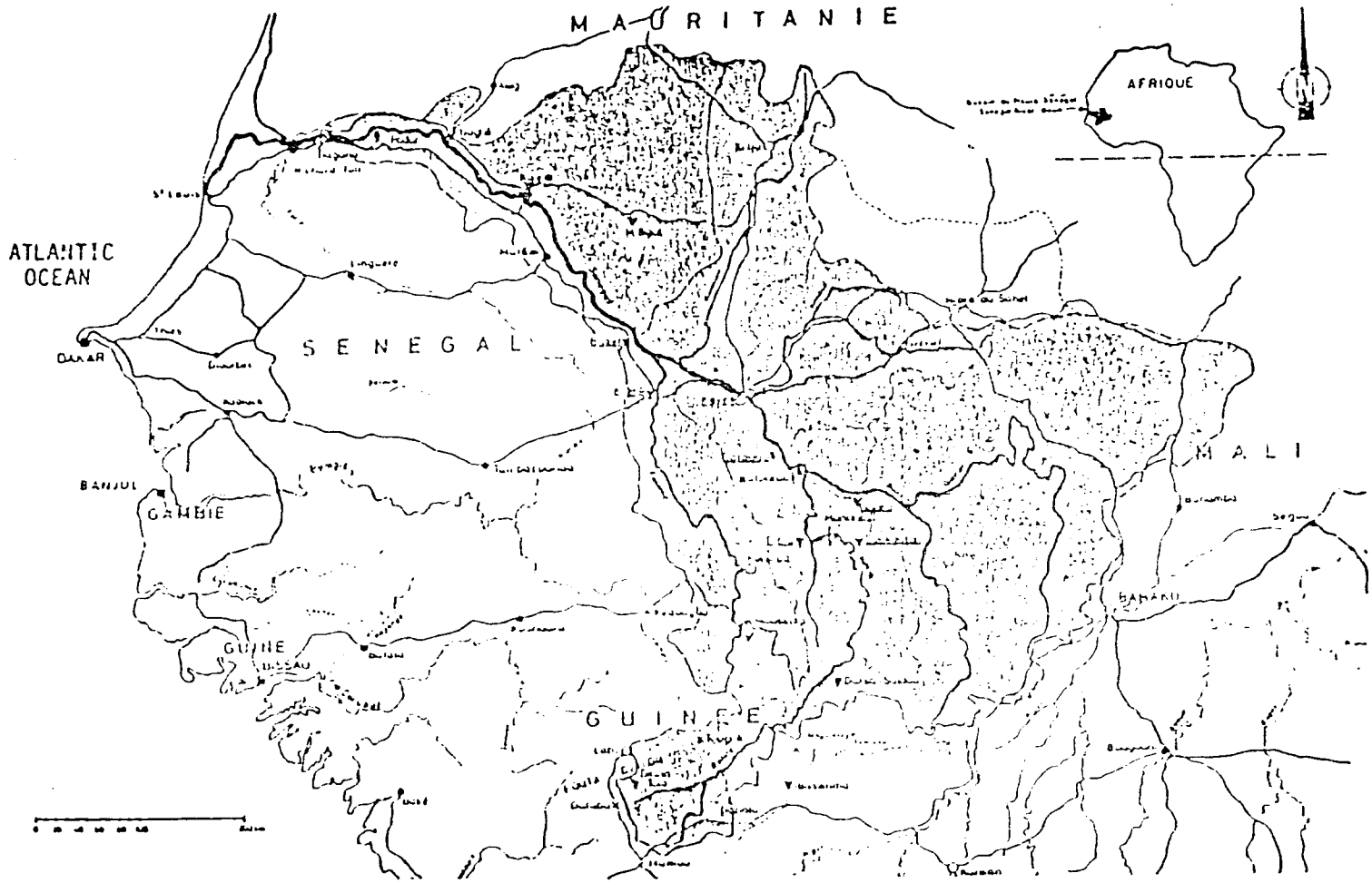


Figure 21. Location map of the Senegal River Basin (from Groupement Manantali 1977).

The Senegal River basin

The Senegal River basin covers an area of approximately 300,000 km^2. It can be divided into three distinct regions with topographic, geologic, and hydrologic characteristics:

1. The Upper Basin supplies most of the water and extends from the Fouta-Djalon mountains to Bakel. This is a humid region with annual rainfall ranging from 700 mm to 2,000 mm. The annual river floods that occur between July and October are caused by heavy rainfalls that take place in the mountains between April and October.

2. The Valley is a semi-arid alluvial plain that extends from Bakel to Dagana (see Figure 1). The flood plain of the river is 10 to 25 km wide and forms a rich agricultural plain.

3. The Delta is the lowest region of the basin and extends from Dagana to the Atlantic Ocean. This area is influenced by tidal fluctuations and becomes inundated by sea water during the dry season.

The area of the basin is distributed among the riparian states in the following manner:

- Mali: 155,000 km^2 (50%)
- Mauritania: 75,000 km^2 (25%)
- Senegal: 27,500 km^2 (9%)
- Guinea: 42,500 km^2 (16%)

Climate

The Senegal River basin lies in a region of the tropics which is influenced by the windflows of both the northern and southern hemispheres. Therefore, the climate of the basin is dependent on the climatic conditions of the two hemispheres. The basin is affected by

the Intertropical Convergence Zone (ITCZ) which migrates with the sun's apparent movement but has a one-month lag. Rainfall is caused by the ITCZ which comes from the humid south. Northeast trade winds which come from the Sahara preclude the possibility of precipitation. Therefore, there are two distinct dry and rainy seasons. The dry season occurs between November and June and the rainy season lasts from July to October. Average annual precipitation of the basin ranges from about 250 mm in the north to 2000 mm in the south. Figure 22 shows a map of the basin with isohyets of average annual rainfall.

Agriculture

The national economies of the three riparian states depend heavily on agriculture. The majority of the 1.2 million people living in the Senegal River basin are farmers whose livelihoods depend either on the erratic rainfall or the river floods. Few agricultural inputs such as fertilizer and improved seed are currently used. Yields are low and most agriculture is at a subsistence level (Gannett-Fleming Corddry and carpenter, Inc. 1979).

At present, there are three agricultural practices in the Senegal River Basin:

1. Flood-recession agriculture - This is the practice of planting crops in flood plains as the annual floods recede. The area cultivated by this method is dependent upon the extent of annual floods and varies from 20,000 to 200,000 hectares.

2. Rainfed agriculture - This type of agricultural practice is dependent upon the timing and the amount of annual rainfall. Rainfed

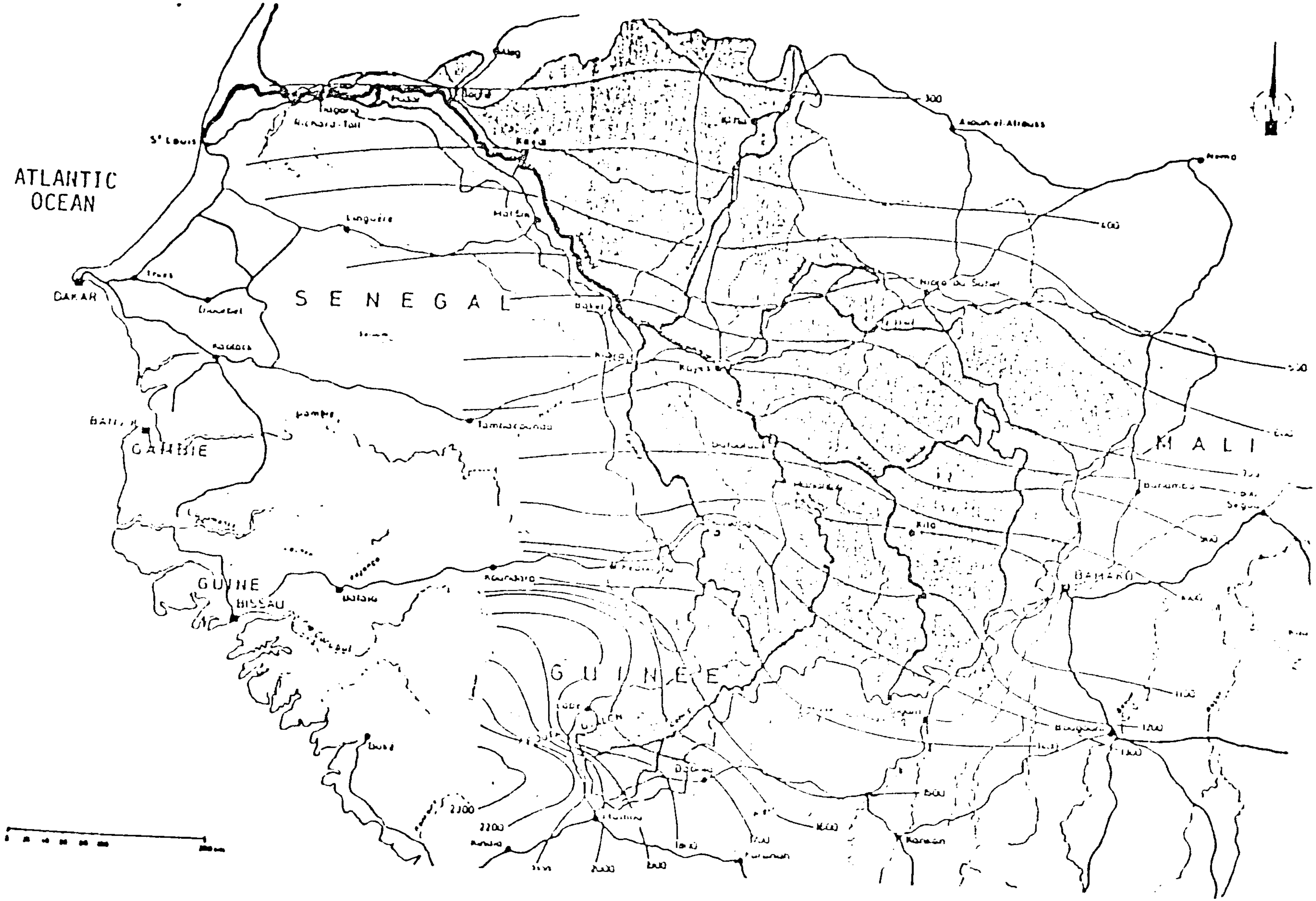


Figure 22. Senegal River Basin with isohyetal lines of average annual precipitation.

agriculture is more widely practiced in the upper valley of the Senegal River.

3. Irrigated agriculture - Intensive irrigated agriculture is fairly new to the basin. Farmers are shifting progressively from dryland and flood-recession agricultue to irrigated villages or "perimeters". The total area under irrigation throughout the Senegal River basin at the present time is approximately 12,000 hectares, mostly located in the delta region.

Socioeconomic conditions

The population of the Senegal River basin is about 1.6 million persons. This constitutes about 16 percent of the national population of the three co-basin countries. Table 3 shows the distribution of population among the three riparian states.

Table 3. Demographic distribution of the region and the basin.

Country	Area of Country in km^2	Total population in millions	Population living in basin	Rate of growth of population in basin
Mali	1,240,000	5.4	809,000	2.4%
Mauritania	1,037,000	1.2	300,000	2.3%
Senegal	196,722	4.2	512,000	0.7%
Total	2,473,722	10.8	1,621,000	

The primary economic activity of the basin population at present is based on subsistence agriculture. Of the approximately 80 percent of the population that live in rural areas, more than 70 percent are

involved in agriculture and the rest work in fishing, herding, or artisanal craft industries. In addition, some workers migrate to France for seasonal employment. Many of the urban residents of the basin are also involved in subsistence farming. About 50 percent of the income is generated from agricultural activities. Herding is also a traditional activity in the basin and generates about 20 percent of the income of the population. Fishing is a seasonal occupation and employs about 20,000 people. Industry and commerce are not developed in the basin. Most commercial activities are limited to small businesses and traveling salesmen.

The Need for Water Resources Development

The most limiting factor in the social and economic development of the Senegal River basin, as well as most of the Sahel region, is water. The basis for the development of the valley is the existence of a year round supply of good quality water.

The national economies of the riparian states of the Senegal River basin are vulnerable to climatic changes. These changes have adverse effects on the ariculturally-based economies of the Sahel region. Droughts are frequent occurrences and often bring economic disasters to the basin population. To illustrate the effects of climatic fluctuations on the agriculture of the valley we can consider the following: The acreage of flood-recession agriculture in the Senegal River basin fluctuates from 200,000 to 20,000 hectares depending on the extent of annual flooding, while average yields might drop from 800 to 200 kgs per hectare (OMVS 1974).

The Sahel was stricken by a severe drought that culminated in the disastrous harvest of 1972-73. Rainfall was insufficient or non-existent for several years (1968-1974). As a result:

- Thousands of people and millions of animals died;
- Crops failed;
- Incidence of disease and severe malnutrition rose sharply
- Millions of people experienced hardship and privation;
- Thousands were uprooted and became destitute.

Low flows in the river during the dry season inhibit river navigation and cause sea water intrusion that disrupts irrigation for about 200 km upstream of the delta.

Electrical energy is necessary for the indusrial and urban development of the riparian states. Most of the electricity of the region is generated by imported oil. Less expensive hydroelectric power will greatly assist in the development of the industries of the region.

River navigation is an important mode of transportation in the valley especially for land-locked Mali. An upstream water storage will facilitate year round naviation in the river.

The lack of adequate fresh water in the river during the dry season does not allow the development of intensive irrigated agriculture in the valley. All three of the riparian states import food. The availability of adequate fresh water in the river will permit double cropping in the valley.

The Development of the Senegal River Basin

Historical background

Interbasin cooperation for the development of the Senegal River valley dates back to the colonial period. In 1934, the colonial administration created a sub-regional organization having the goal of promoting and coordinating joint development programs within the basin. After their independence, the co-basin countries (Guinea, Mali, Mauritania, and Senegal) realized that the most efficient way to develop the resources of the Senegal River basin is through an integrated and basin-wide development program. As a result of this realization, an interbasin organization was formed in 1963. In 1964, this organization adopted the following objective as the aim of its development programs:

a. agricultural development

b. the production of energy and industrial development

c. enhancement of navigability of the Senegal River

Several studies were conducted under the supervision of this organization which meanwhile was going through certain political difficulties. Finally in 1972, Mali, Mauritania, and Senegal denounced their membership in the interbasin organization and formed "Organisation Pour La Mise En Valeur Du Fleuve Senegal" (OMVS). The Senegal River, including its tributaries, was declared an international river on the territories of Mali, Mauritania, and Senegal. At present, the OMVS is the legal internatinal organization charged with the development of the Senegal River basin resources. Under its mandate, the OMVS conducts two types of activities: the construction of common works, and the management of these facilities. Any state

that wishes to withdraw from the OMVS must negotiate with the other member states and interested third parties for liquidation of its rights and obligations.

The permanent institutions of the OMVS

The OMVS has four permanent bodies:

1. The Conference of the Heads of State is the supreme authority of the OMVS and sets policies for the cooperation of member states and the overall economic development program. The presidency of the Conference is for two years and rotates among the Heads of State.

2. The Council of Ministers elaborates the overall policies of the Heads of States. It also sets priorities for the development programs and fixes the contribution of each member state to the organization's budget for operation, studies, and projects. The presidency of the Council of Ministers is also for rotational two-year terms. All decisions are made unanimously.

3. The High Commission is the executive body of the OMVS for the decisions of the Council of Ministers. It reports to the Council of Ministers on the execution of its policies. The High Commission is headed by a High Commissioner who is appointed by the Conference of the Head of States for a renewable four-year term. During the periods between the Council of Ministers meetings, the High Commissioner represents that organization. He also represents the member states in dealing with international agencies regarding the development of the Senegal River basin. He may enter negotiations on behalf of member states to seek financial aid for development programs. The High Commissioner is assisted by a Secretary General

who is also appointed by the Conference of the Heads of State and acts as his deputy. The Secretary General is the head of the administration of the OMVS and is assisted by Directors appointed by the Council of Ministers. Advisors appointed by the Council of Ministers cooperate with the High Commissioner and work under his directions.

4. The Permanent Commission on Water is composed of the representation of the member states and allocates the waters of the Senegal River among the member states and different economic sectors (i.e. agriculture, energy, and navigation). It also advises the Council of Ministers on such matters.

Consultative bodies of the OMVS

Two consultative bodies were created by the Council of Ministers in 1976:

1. "Comite Inter-Etats de la Recherche et du Developpement Agricole" (the Inerstate Committee for Agriculural Research and Development) - This consultative body has the responsibility of harmonizing national agricultural research and development programs of the member states. It is composed of two representatives from each country and one from the High Commission. The presidency and secretariate of this body are assumed by the High Commission (OMVS 1979).

2. "Comite Consultalif" was formed as a communication forum between the OMVS and organizations and countries that assist in the development of the Senegal River basin (such as these countries which

provide funding as either sifts or loans for the project). The presidency and secretariate of this consultative committee are also assumed by the High Commission.

The Proposed Development Program

After several years of investigation and planning, the OMVS has adopted the following program for the development of the Senegal River basin:

1. Construction of a low dam at Diama, Senegal,
2. Construction of a high storage dam at Manantali, Mali,
3. Development of a deep water harbor at St. Louis with navigation infrastructure upstream as far as Kayes, Mali,
4. Development of 255,000 hectares of irrigated agricultural perimeters in the basin,
5. Development of industries in the basin.

The OMVS integrated development program is based on a minimum river flow regulation of 300 cubic meters per second. The above program will have the following overall functions:

1. Generation of hydroelectric power,
2. Providing a year-round supply of fresh water for irrigation,
3. Providing year-round navigation in the river.

A more detailed description of the components of the program follows:

Diama Dam

This is a low dam that will function as a saltwater barrier to prevent sea water intrusion to areas upstream of the dam during the dry season. It will be constructed 27 km upstream of St. Louis. In

addition to being a saltwater barrier, Diama Dam will provide a supply of fresh water for the city of Dakar and some irrigation in the Delta region. The dam will maintain the water level above Diama at 1.5 meters IGN. Additional storage can be realized by increasing the height of the dam and the dikes to a water surface elevation of 2.5 meters IGN. Table 4 shows some of the characteristics of the Diama Dam.

After the construction of Diama Dam, a new channel will reroute the river through a combination of gates and spillways. A 190 meters by 25 meters navigation lock will allow the passage of river traffic. The dam will also serve as a bridge as a part of a proposed highway between Nouakchott, Mauritania, and St. Louis, Senegal. The construction of Diama Dam will cost $133 million (1979 prices). The completion of the dam is scheduled for the mid 1980's.

Manantali Dam

Manantali Dam is the backbone of the Senegal River basin development program. It provides low flow augmentation for the purposes of providing a year-round supply of water for municipal, industrial, and agricultural uses. It is the major water storage facility of the Senegal River system. Manantali Dam will be constructed on the Bafing River (a major tributary of the Senegal River) some 1200 kilometers upstream of St. Louis. Controlled releases from the reservoir will provide the following (Gannett Fleming Corddry and Carpeter, Inc. 1979):

1. A year-round supply of fresh water for the irrigation of 255,000 hectares of land in the basin.

Table 4. Diama impoundment characteristics at water level of 1.5 meters and 2.5 meters IGN (after Gannett Fleming Corddry and Carpenter, Inc. 1979).

	At 1.5 m IGN	At 2.5 m IGN
Reservoir length	360 km extending to Guede-Boghe area	380 km extending to Boghe-Cascas area
Reservoir Width	0.3 o 5.0 km	0.3 to 5.0 km
Enclosed Surface Area	235 sq. km	440 sq. km
Water volume	0.25 billion cu. meters	0.58 billion cu. meters

2. A year-round flow of 100 cubic meters per second in excess of irrigation and other requirements to provide water depths needed for navigation.

3. A firm hydroelectric power generation of 800 GWH/year.

The elevation of the spillway will be 208.0 meters IGN. When water surface is at this elevation, the reservoir will extend 125 km upstream from the dam. The dam is designed to effectively control releases for a flood with a return period of 10,000 years. The construction of Manantali Dam will cost $463 millions (1979 prices). Table 5 shows some of the characteristics of Manantali Dam and reservoir.

Since a large area of the basin is cultivated in the traditional method of flood recession agriculture, there will be a transitional period of about 15 to 20 years from recession farming to irrigated agriculure. During this time, releases from Manantali Dam will provide a minimum flow of 2500 cubic meters per second at Bakel between August 15 and September 15 of each year. These releases will

Table 5. Manantali impoundment characteristics (after Gannett Fleming Corddry and Carpeter, Inc. 1979).

	At Spillway Elevation	At Minimum Water Level to be Allowed During Reservoir Operation
Water Level (meters IGN)	208.0	187.0
Corresponding Surface Area of Reservor (square kilometers)	477	275
Reservoir Water Volume (cubic meters)	11.3 billion	3.4 billion

Maximum Useful Water Volume = (11.3 - 3.4) billion cubic meters = 7.9 billion cubic meters.

create an "artificial flood" that will inundate about 100,000 hectares of land in the basin that can continue to be used for flood recession agriculture.

Proposed agricultural development program

At present, the majority of agricultural crops in the basin are either rainfed or cultivated by the traditional method of flood recession. The proposed agricultural development program of the OMVS will alter traditional farming practices of the basin. Flood recession farming will be phased out and converted into irrigated agriculture. Most of the rainfed areas of the basin will be used for grazing livestock. By 2028, approximately 255,000 hectares of diked agricultural perimeters are scheduled for completion in the basin. Modern agricultural practices combined with available fresh water for irrigation will allow production of two crop harvests yearly. The proposed rates of irrigated agricultural development are as follows:

Years	Rate of Development (hectares per year)
1977 through 1986	4800
1987-1996	4400
1997-2006	4800
2007-2016	5300
2017-2026	5800

Proposed development of river navigation

River navigation is an important element in the development of the resources of the Senegal River basin. Regulated releases from Manantali Dam combined with channel modification will allow year-round navigation between the Atlantic Ocean and Kayes, Mali. The following is a summary of the proposed development program related to navigation (after Gannett Fleming Corddry and Carpeter, Inc. 1979):

Development	Purpose	Location	Data
Off-shore Approach Channel in Atlantic Ocean	To provide shipping access from the ocean to the proposed entry channel	Extension of proposed entry channel into the ocean perpendicular to shoreline	Length: 1500 meters Width: 150 meters Depth: 8.5 meters
Ocean Breakwaters	To protect off-shore approach channel and entry channel from wave action and sand deposition	Ocean side of Langue de Barbarie parallel to off-shore approach channel	
	northern breakwater: primary sand trap		800 m length initially with sions as sand accumulates
	southern breakwater: prevent channel filling by occasional northerly drifts		250 m length initially with sions added when needed
Entry Channel and Channel to Proposed Port Facilities	To provide shipping access from the off-shore approach channel to the Senegal River	7 kilometers south of Faidherbe Bridge	Length: 2000 meters Width: 150 meters Depth: 10 meters
Estuary Port Facilities	To transfer goods from ocean-going to river-going vessels		Length: 1500 meters Width: 300 meters Depth: 8.5 meters
Modifications to Faidherbe Bridge	To allow river-going vessels access to areas further upstream	Senegal River at Saint-Louis	Not available

Source of Information: Groupement LDE (1978)

Proposed municipal and industrial development program

The municipal and industrial development plans of the riparian states are related to and are based on the construction of Diama and Manantali dams and the agricultural development program. Table 6 summarizes the proposed industrial development program. The exploitation of the mineral resources of the riparian states is dependent upon the availability of energy and means of transporting them out of the basin. The proposed OMVS development program will provide both the energy and the transportation facilities of the mineral industry in the basin. As the population of the basin grows, so does the need for municipal services such as housing, water, waste disposal, power and transportation.

Table 6. Summary of proposed industrial development in the Senegal River Basin.

Industry (listed alphabetically)	Proposed Plant Location(s)	Projected Time Schedule
Bauxite Processing	Manantali, Mali	After 1990
	Moussali, Mali	After 1990
	Kayes, Mali	After 1990
Brewery	Kayes, Mali	NA[1]
Brick Manufacturing	Rosso, Maur.	NA
Cotton Mill	Kayes, Mali	NA
	Bogue, Maur.	NA
	Magama, Maur.	NA
	Leggah, Maur.	NA
Dairy	Rosso, Maur.	NA
Edible Oil Refinery	Rosso, Maur.	NA
Fertilizer Factory	Kaedi, Maur.	NA
Flour Production	Matam, Sen.	Project Implementation 1985-1989
Lime Processing	Diamou, Mali	Commence construction in 1978-1979
Peanut Oil Refining	Kita, Mali	Included in present 5-yr. plan for Kayes Region
Refrigerated Abattoir	Rosso, Maur.	NA
Rice Processing	Kayes, Mali	
	Matam, Sen.	
	Thilogne, Sen.	Processing by 1985
	Aere Lao, Sen.	
	Podor, Sen.	
Shoe Factory	Kayes, Mali	NA
Sugar Cane Processing	Sane, Mali	Commence construction 1984-1985
	Gorgol Valley, Maur.	Processing by 1983
	Matam, Sen. or	NA
	Richard Toll, Sen.	
Tanning	Trapoma, Mali	First Production in 1979
	Kayes, Mali	NA
	Kaedi, Maur.	Enlargement of existing tannery: first stage to be in production by 1983
Textile	Kayes, Mali	NA
	Rosso, Maur.	NA
	Saint-Louis, Sen.	NA
Tomato Canning	Rosso, Maur.	Commence construction in 1979
	Matam, Sen.	First stage to be in production by 1983

[1] NA = Not Available.

CHAPTER VII

ALTERNATIVES FOR THE ORGANIZATIONAL STRUCTURE OF THE SENEGAL RIVER BASIN PROJECT

Organization design is an evolving and dynamic process. It must begin from the macro level and design the overall organization structure. Specifying the details of an organization structure at the outset, creates a rigid and non-evolving organization that cannot adapt to the operating circumstances of its environment. When a new organization is being contemplated, such as is the case for the management of the Senegal River Basin Project, the overall management structure must be designed and specified. During the initial stages of its operation, the performance of the organization is continuously monitored. Subsequently, on the basis of this information, the organization structure is modified to fit the needs of the evolutionary process of the organization. Therefore, the following attempt to design alternative organization structures for the Senegal River Basin management authority is merely a first attempt at this evolutionary process and cannot address the micro-organizational design aspects.

As a starting point, a preliminary organization model is proposed (Figure 23) for the Senegal River Basin management authority. Alternative designs can be developed by moving along a continuum, with functional departmentalization at one extreme and product at the other. For an explanation of this procedure, refer to the chapter titled "Organization Design". The basic characteristics

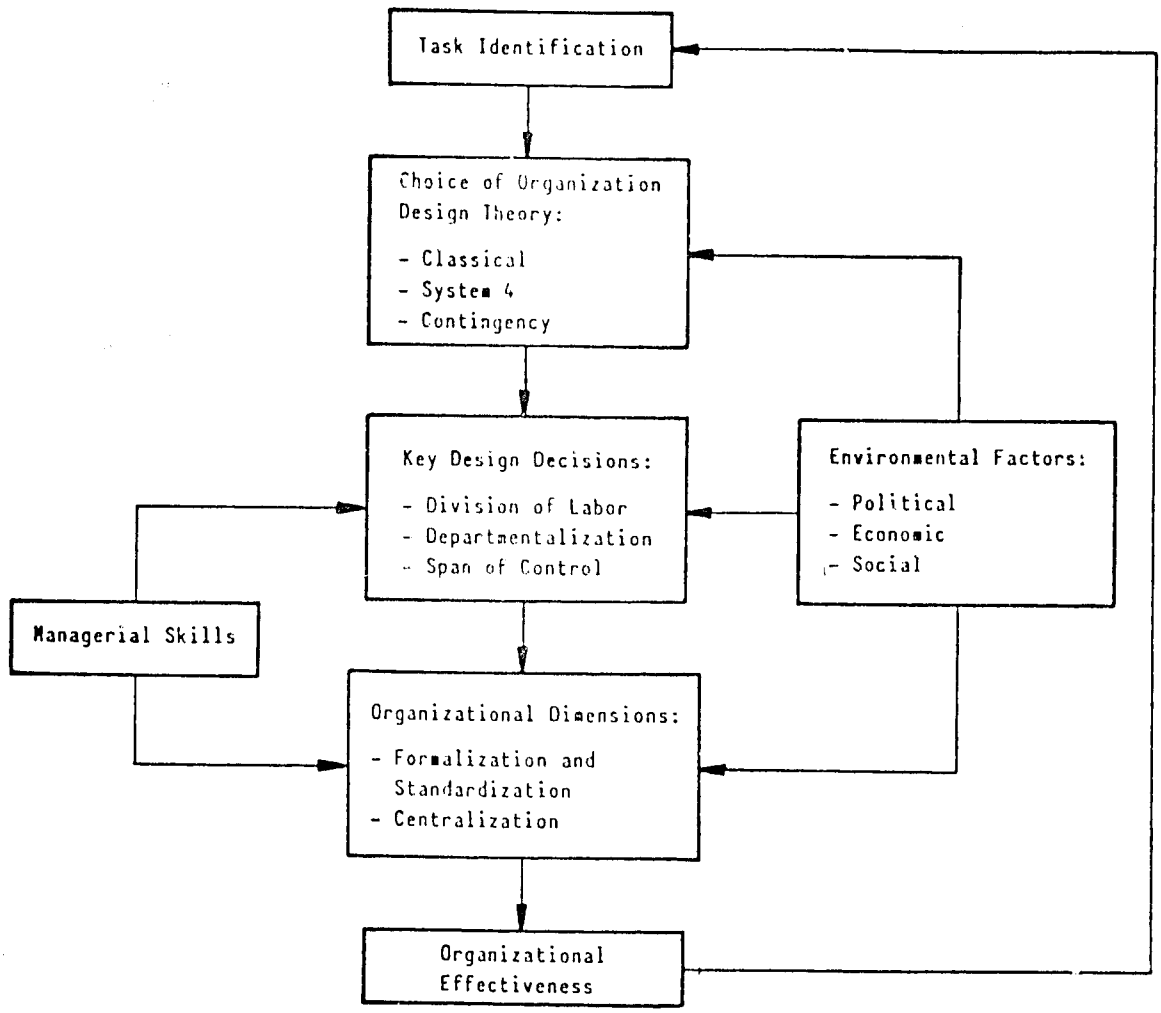


Figure 23. An integrated organizational design model.

of the organization will first be specified by use of the model in Figure 23. Then three alternative structures will be proposed by varying the basis for departmentalization. The alternatives will be based on the following modes of departmentalization:

1. Functional
2. Product
3. Mixed

The Basic Characteristics of the Proposed Structure

In order to establish the basis characteristics of the proposed management organization, its tasks and responsibilities will be defined.

Task identification

The overall responsibility of the proposed organization is to develop and manage the resources of the Senegal River basin. Accordingly, the following tasks are identified as the functions of the organization:

1. To create the legal framework for the cooperative development of the basin
2. To coordinate the planning process
3. To acquire the financial requirements of the project
4. To administer the construction of the common works
5. To operate and maintain the common works, namely:
   a. Manantali Dam
   b. Diama Dam
   c. Navigation system

6. To manage the outputs of the project on an international level:

   a. Water

   b. Electricity

   c. Navigation

7. To set prices for the outputs of the project and to collect user fees from co-basin countries

8. To manage the financial aspects of the project

9. To manage the internal affairs of the organization

   a. Personnel management

   b. Training and safety

   c. Purchasing

   d. Payroll

   e. Public information

   f. Publications and records

10. To administer contracts

11. To provide engineering services

    a. Design

    b. Construction

12. To provide data processing services

The choice of organization design theory

The contingency design theory is selected as the basis for the organization structure of the management authority. The contingency theory attempts to match the organization design with the needs of the organization as briefly discussed in the following paragraphs.

Environmental factors The political, economic, and social atmosphere in which the organization must operate influences its

design and continues to exert an influence throughout the life of the organization. In the case of the Senegal River Project, a great deal of flexibility must be built into the organization in order to provide adaptability to changes that occur over time.

Managerial skills. The span of control and the degree of centralization of an organization is dependent upon the training and capabilities of its managers. Highly skilled managers are a limiting resource in most developing countries. We will assume that this is also the case for the Senegal River basin countries. This issue will be discussed in more detail in subsequent sections.

Key design decisions

1) The division of labor. This issue addresses the degree of specialization of the employees. This is a highly variable factor depending upon the task to be performed. The desired degree of specialization increases as the task becomes more technical. For example, a construction worker does not need a high degree of specialization because he is expected to perform many different tasks which do not require much specialization. However, a welder must have a high degree of specialization due to the narrow nature of his work. It is anticipated that, with the exception of a few engineers and technicians, most employees of the management organization must have fairly broad backgrounds and then be trained on the job for the particular tasks that they perform.

2) Departmentalization. This issue addresses the common basis for the creation of units within an organization. The three

proposed alternatives for the organization structure of the organization differ only in the common bases on which they are departmentalized.

3. The span of control. Organ and Hammer (1982) have stated, based on their research, that the number of subordinates responsible to any one supervisor should be limited to a range of 3 to 8. It is recommended that this range of the span of control be observed in the structure of the organization.

Organizational dimensions. These dimensions refer to the general characteristics of an organization and are identified as follows:

1. Formalization and standardization. Formal organizations are more effective in societies where there is a long tradition of bureaucracy. Most water resources projects in developing countries (for example, the Indus River Irrigation Project in Pakistan) suffer from lack of maintenance and inefficient management. In order to ensure proper and timely system maintenance in the case of the Senegal River Development Project, a high degree of standardization and written procedures and regulations must be developed and effectively implemented. The mere existence of standard procedures and regulations do not guarantee their implementation. Senseless and ineffective procedures and regulation contribute to the unwillingness of employees to observe them. Therefore, great care must go into the development of standard procedures and regulations for performing different tasks. Their implementation must then be monitored. It is of paramount importance that appropriate financial support exists for routine maintenance.

2. Centralization. A certain degree of centralization is necessary in order to maintain a coherent organization. However, excessive centralization creates inefficiencies and causes alienation among employees. Lower level employees do not feel that they have a part in the decision-making process of the organization. The operation of the dams, for example, must be performed by a relatively decentralized branch of the organization because of the need for rapid response to changes in the system at any point. However, divisions such as Maintenance and Administrative Services can be more centralized. A decentralized organization requires skilled and responsible managers who can delegate authority to their subordinates. It is recommended that the organization which manages the Senegal River basin project should be fairly centralized at first and slowly move toward decentralization by training its managers.

Organizational effectivenss. For a dynamic system, evaluation and subsequent evolution of the management model is an important concept. In the model of Figure 1, this feature is achieved by a feedback loop. The effectiveness of the organization is continuously assessed and the results are used to alter the organizational structure and its goals. The process of project evaluation is an important component of any wise management. It reveals the degree to which the organization is achieving its planned aims. As more data become available after the implementation of a project, managers can refine their practices to achieve a greater degree of effectiveness.

There is no one universal set of parameters by which the effectiveness of an organization can be measured. These parameters are dependent upon the purpose for which the organization was

created. For example, in the case of a shoe factory, the effectiveness of its organization might be measured by production and economic efficiency. The effectiveness of a rural education project is measured by the change in the literary rate. In the case of the Senegal River basin project, the following parameters might be chosen to indicate its effectivness:

1. Economic efficiency
2. The change in the standard of living of the people of the basin.
3. The rate of change of irrigated acreage
4. The rate of change of the population of the basin
5. The rate of change of the crop yields
6. Changes in the health of the population
7. Changes in income distribution
8. Fertilizer use
9. Rate of change of unemployment
10. Employee and user satisfaction

When the above set of parameters are applied to the project as a whole, regional or within-country differences are marked. It is conceiveable, therefore, that the international organization might appear to be functioning effectively with respect to its intended goals, and yet ineffectively with respect to a particular co-country because of deficiencies in the implementation of the project within the particular country. For this reason, it is recommended tha evaluation criteria, in addition to being analyzed for the entire project, also be applied on regional and by country bases. This type

of analysis will help to identify ineffectiveness as being the result of project management or of the policies of co-basin countries.

Proposed Alternatives for the Structure of the Management Organization for the Senegal River Development Project

In this section, three alternatives are presented for the overall organizational structure of the Senegal River Basin Development Project. Only the major units of the organization are outlined. Further subdivisions will be created by the managers as the need arises. The alternatives differ in the way that they have been departmentalized. They move on a continuum, with functional departmentalization on one extreme and product on the other, and a mixture of the two inbetween. The three alternatives are as follows:

1. Functional departmentalization. Figure 24 represents an organizational structure for which functions are the basis for departmentalization.

2. Product departmentalization. Figure 25 represents a product oriented structure.

3. Mixed departmentalization. Figure 26 is an organizational structure which is based on a mixture as the criterion for grouping the tasks and creating departments.

Evaluating the alternatives

The preceding three alternatives are mutually exclusive so that only one can be selected. The selection process is qualitative and is based on an assessment of structure in terms of organizational requirements.

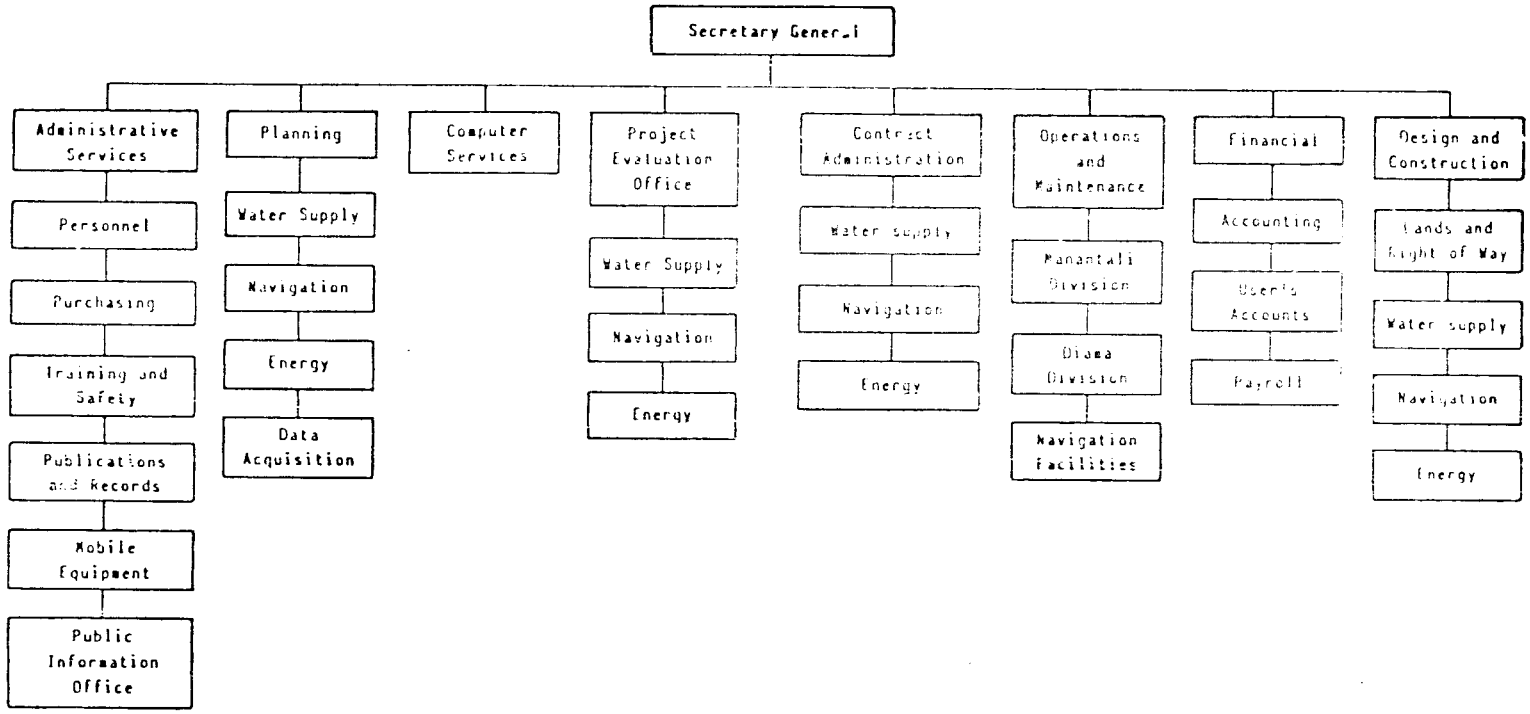
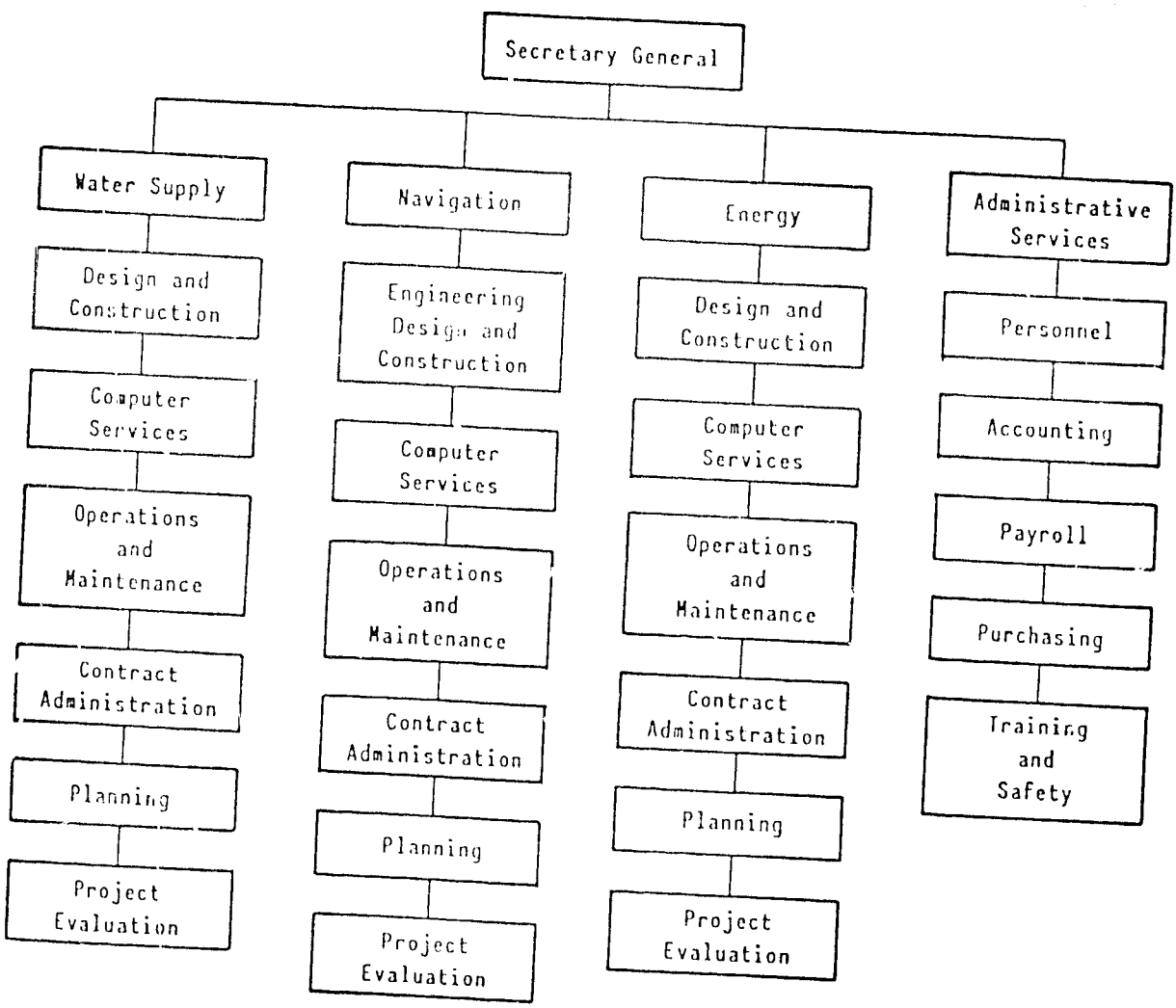


Figure 24. Functional departmentalization, for the organizational structure of the Senegal River Development authority.



igure 25. Product departmentalization, for the organizational structure of the Senegal River Development authority.

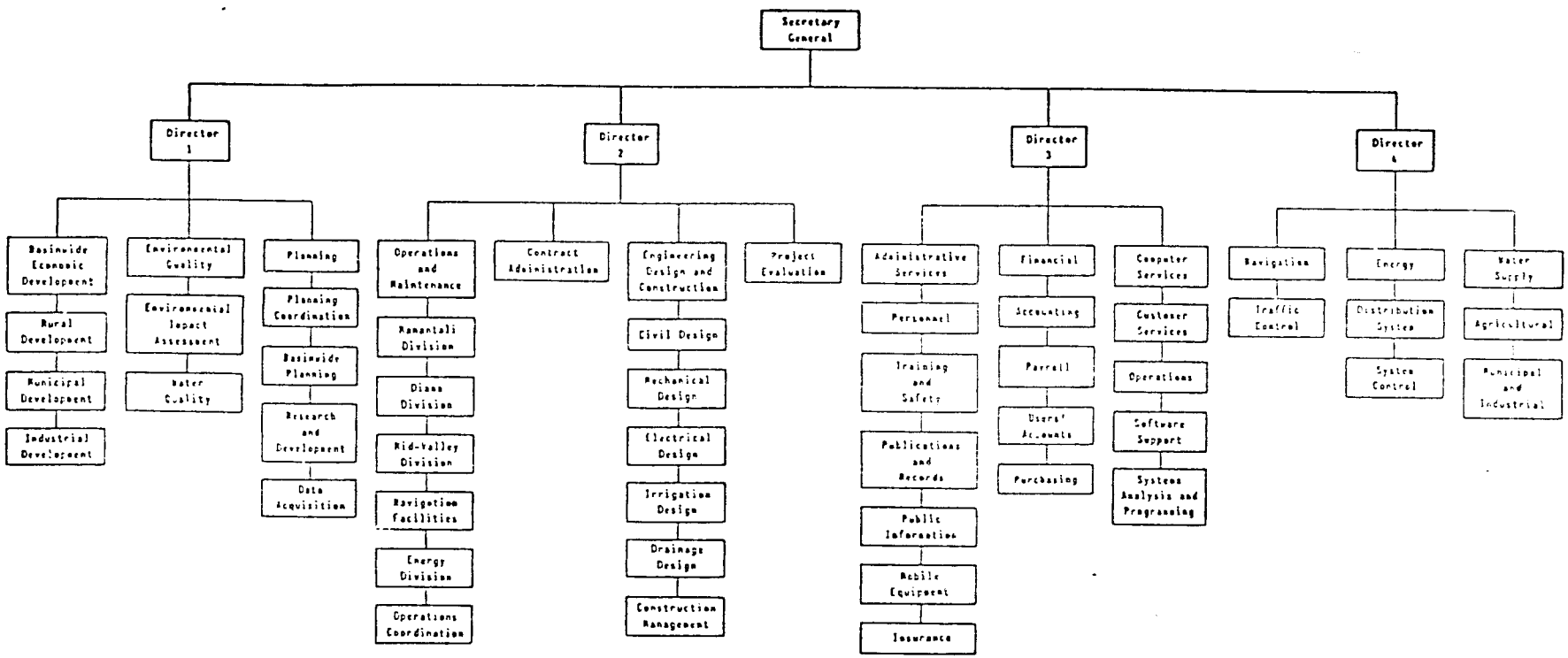


Figure 26. Mixed departmentalization, for the organizational structure of the Senegal River Development authority.

The third alternative (that is, mixed departmentalization) is frequently selected because of its efficient use of resources. In other words, this structure provides the least amount of duplication in services and resource requirements. For instance, the first alternative duplicates the efforts of water supply, navigation, and energy divisions by having small offices for each under different functions. This duplication might be regarded as an inefficient use of resources and could cause difficulty in coordinating the efforts of each product unit (that is, water supply, navigation, and energy). Similarly, the second alternative breaks up the functional units into small offices under each product division. This arrangement might also be inefficient and difficult to coordinate. The third alternative involves a mixture of both the first and the second alternatives by having both product and functional divisions. For example, only one computer services department exists which offers its services to all other departments. Another feature of the third alternative is that it limits the span of control to the recommended range of three to eight subordinates responsible to one supervisor. This limitation is achieved by having four directors under the Secretary General, with each responsible for three to four departments. In this way, the number of managers directly under the Secretary General is reduced from 13 to 4.

Explanation of the recommended organizational structure

This section will explain the responsibilities of the departments and diversions of the mixed departmentalization alternative (Figure 26).

There are four directors under the supervision of Secretary General. These directors, appointed by Secretary General, will head three to four departments (reier to Figure 26). Each director works with departments that are similar in the nature of their tasks. Director 1 is in charge of Basinwide Economics Development, Environmental Quality, and Planning Departments. Director 2 heads the Operations and Maintenance, Contract Administration, Engineering Design and Construction, and Project Evaluation Departments. Director 3 is in charge of Administrative Services, Financial, and Computer Services Departments. Finally, Direct 4 heads the Navigation, Energy, and Water Supply Departments.

The managers of each department are under the supervision of their respective director and directly report to him. We will now discuss the responsibilities of each department.

Administrative Services Department. This department administers personnel affairs, public information, and official records of the organization. The logical location for this department is in Dakar.

Basinwide Economic Development Department. The development of the water resources of the Basin is only one component of the overall social and economic development ofthe region. The Department of Basinwide Economic Development Coordinates developments in non-water related fields, namely rural municipal and industrial sectors.

Financial Department. This department manages the financial affairs of the organization including accounting, purchasing, and collecting user fees from co-basin countries.

Environmental Quality Department. Monitoring of the water quality of the Senegal River and environmental protection are the

main reponsibilities of this department. Environmental quality standards are established and enforced by this unit.

Operations and Maintenance Department. This department is in charge of the operation and maintenance of the common works, namely Manantali Dam, Diama Dam, Navigation system, and electrical network. The offices of these divisions will be located in their respective regions. Because of the long distance between Manantali Dam and Diama Dam (about 1200 km), an operations and maintenance division will be established in mid-valley at Bakel to operate and maintain the facilities in the valley. The Office of Operations Coordination coordinates the daily operation of the system and is in contact with the national agencies in charge of the implementation of the project in their respective countries.

Contract Administration Department. Most of the major facilities of the Senegal River Development project are constructed by foreign companies. The administration of these contracts will be done by this department. Contract Administration Department works in close contact with Design and Construction Department in order to make construction estimates and inspect projects that are in progress.

Engineering Design and Construction Department. Most of the engineering personnel will be in this department which designs and constructs small facilities, in addition to inspecting construction projects that are undertaken by outside companies under contract from the organization.

Project Evaluation Department. This department evaluates the performance of the project against the intended goals and objectives

of the organization. Recommendations are made to the Director about steps to be taken in order to improve the performance of the organization. The Project Evaluation Department acts as a processing unit for performance data obtained from the departments and provides the Secretary General, through the Director, with information about the performance of the organization as a whole.

Navigation Department. The management of the navigation system is the responsibility of this department.

Planning Department. The planning of future facilities is coordinated by this department. It also has the responsibility of collecting required data for planning and research.

Energy Department. The hydroelectric component of the project is managed by this department.

Water Supply Department. This department is responsible for the water supply component of the project and deals with both agricultural, municipal, and industrial users.

Computer Services Department. This department acts as a service agency providing computer services to all other departments.

Potential problems

There are several problems that are universal to most organizations in developing countries and the Senegal River Development program will not be immune to them. Therefore, it is crucial that these are recognizent at the outset and effort be made to avoid these pitfalls.

Cost control. Cost control is one of the most prevalent problems facing organizations in developing counties. This is especially true in the case of recurrent costs. A system of internal audit and

cost control must be established in order to control the ever increasing costs that render projects economically inefficient. Financial Department is a logical choice for such a system of cost control.

Size control. The size of an organization must be in accordance with its work load. The size of public organization often grows at a faster rate than its work load. This problem of over-staffng should be prevented by centralizing the hiring of personnel and by putting a limit an salary portion of annual budget.

Political polarization. The danger of political polarization is ever present in multi-national organizations such as the Senegal River Development Authority. Experience in other counties has shown that each nation will often try to hire their own citizens and pursue their own national interests rather than the overall goals of the organization. In the case of the Senegal River Development Authority, this problem may arise if one or more of the participating nations feel that the economic benefits of the project are not justly or evenly distributed among the co-basin countries and the cost burden is not being shared by all countries in an equitable manner. If this problem arises, it must be dealt with at the highest level in order to avoid the polarization of the organization at all levels.

Political polarization is often related to geographic location of the project and the distribution of costs and benefits. Moris (1984) states that "where benefits are linked to location it should be anticipated that locational decisions may become politicized." The following problematic situations are stated by Moris (1984) as

"Lessons of Experience" and pertain to the Senegal River Development project as wel:

1. "Projects whose output depends upon regular cooperation between separate agencies or ministries are very difficult to institutionalize."

2. "Agency staff constitute a primary benefit group whose influence may distort the distribution of client benefits."

3. "Invertically-oriented, line agencies, the middle level staff often constitute a weak link, and don't behave in ways needed for achieving maximum field impact."

4. "Limited and seasonal cash flow at the community level is typical of subsistence farming, and sharply constrains revenue recovery."

CHAPTER VIII

USER FEES

General Discussion

It should be clear that the user fees which are generated within the cost allocation model are for the purpose of allocating costs to countries, and calculating cash flows and repayment requirements by sector and country. As indicated in the user's manual and in other reports (e.g., Report 1), these user fees may or may not be used to price the services provided by the project, for several reasons, the most important of which are the set of assumptions which were made with respect to project development. In each case, benefits from services were based upon averages of costs, prices, and production. The use of average values to compute user fees ignores the likely occurrence of declining productivity and/or demand for those services over the range of production. For example, agricultural production will be less profitable for users having poorer soils or other limitations on productivity (e.g., local salinity problems). Further, transportation of important export goods is assumed to have an "average" cost, yet it is clear that markets are spatially distributed so that profitability would be expected to decline with distance from regional markets. Those farmers with lower profitability will be unwilling to pay user fees in excess of the value of the <u>marginal</u> product of water (compared to the value of the <u>average</u> product used in the model). Thus, there will be little incentive for

these farmers to utilize project services, and the resultant development rates will be lower than expected if the user fees generated in the model are used for printing services. The sale of electricity and navigation services may face similar average-marginal value differences. Another very important problem in pricing services is the existence, or potential for, differences in profitability or repayment capacity which can result from internal national policy. The cost allocation model uses world prices and often assumes consistent cost structures across all countries (one exception is in transportation costs). Where internal national policy, such as taxes or investment in supporting infrastructure, changes the profitability of a given enterprise among countries, pricing of services at the user fee calculated by the model may cause disincentives to occur within a given country. Establishing prices for project services must include consideration of the actual marginal values of those services, in order that disincentives for their use is not a problem. Note that if service prices are expected to be constant over all users, those prices must be no higher than the lowest value of marginal product or repayment capacity, or marginal users will have no incentive to use those services and the development rates will be less than projected. If development is slower, a change in cost allocation could be expected.

However, the financing of the Senegal River Development program is through loans from a variety of sources and must be repaid. This necessitates the collection of user fees in a practical and systematic manner. The three products of the project, water supply, hydropower, and navigation, are considered commodities produced by

the project. The Office of User's Accounts under the Financial Department (refer to Figure 26) is in charge of fee collection from the cobasin countries. There will be three branches under the Office of User's Accounts, one for each product. It must be emphasized that the OMVS collects its user fees from the cobasin countries and will not deal with individual users in each country. It is the responsibility of each nation to establish a system of setting fees and collecting them.

Water Supply

This is the most complex among the three products to collect user fees for because of the great number of users and the difficulty in measuring and monitoring the use of water throughout the basin.

Water service is assumed in the model to provide irrigation benefits only, although the project does include augmentation of industrial and culinary water for both Nouakchott and Dakar, as well as some of the other localities. It would be expected that the payment capacity for culinary water would be higher than that for agriculture, if the pattern of other countries in representative. However, that repayment capacity would likely differ considerably among localities.

Industrial water use

The number of industries using water is small compared to other users of water. Therefore, it is easy to install meters or estimates monthly consumption for each industry and to charge them according to the volume of water withdrawn from the river.

Municipal water use

Communities located in the valley will withdraw their domestic water from the Senegal River by using pumping stations. These pumping plants can be constructed and operated by either the municipalities themselves or the OMVS. In either case it will be fairly easy to measure or estimate water consumption of each community based on its population.

Agricultural water use

Eventually, the largest user of water in the valley will be agriculture. The main agricultural use of water is irrigation. A great deal of attention must be paid to the economic consequences of fee collection on farmers.

The benefit estimation of agricultural production was based upon average productivity, prices, and costs for all outputs in all countries. There are many variables which may cause the marginal value of water to be above or below the average value of irrigation water. Soil quality, salinity intrusion, and location have been mentioned. In each case, those perimeters which are close to markets, have good soil, and do not suffer salinity problems might be expected to have higher than average profitability, while other irrigators will have lower. Commodity and input pricing policies may have a substantial effect on farm profitability. If commodity prices are held low for the benefit of consumers while imported farm inputs are taxed heavily, profitability might be expected to be low and relatively high service prices would cause a reduction or failure in development. While the cost allocation model assumes away most of these policies in an attempt to treat cost allocation as independent

of national policy, clearly pricing schemes must involve those considerations. Other reasons for differences in farm profitability exist, but the conclusion is the same. However, and by whomeever, prices for project services are set, the marginal, rather than average, ability to pay is the critical variable.

Energy Services

Like agriculture, the value of hydropower may vary with users and conditions. Given that the benefits to hydropower users are based on the cost savings over thermal power, policies which alter thermal power costs or prices in a country will change incentives for the use of hydropower. Various users will also have differing abilities to pay for hydropower, regardless of cost savings. There is an implicit assumption of perfectly elastic demand for electric power in the model; that is, it is assumed that all the power produced will be demanded by users. Uncertainty with respect to delivery systems and reliability could also alter the value of and willingness to pay for power to industrial or municipal. These considerations are crucial to service pricing policies among the countries.

Navigation Service

The reservation about the pricing of navigation services are the same as those for the other services: The ability or willingness to pay for these services may differ among users, based upon their specific cost savings, and among countries, as a result of national taxing or other policies. Incentives to use the navigation system

must be present in order for the development of that service to proceed as projected, so that service pricing policy must be consistent with marginal values of the services.

Pricing of Services and Collection of Fees

There are several approaches to setting prices which are used by public utilities and water agencies in the United States. Where marginal and average costs of delivering the service are increasing, the economically efficient pricing scheme is pricing at marginal cost. However, there appears to be a consensus among economists that, for projects which have declining average and/or marginal costs of delivery of services (which most large-scale water projects exhibit), some form of Ramsey optimal pricing scheme is the most economically efficient. This approach uses the ability or willingness to pay of users, represented by their elasticity of demand for the service, as the basis for calculating the appropriate prices. Users are separated into general groups for which a distinct demand for the service can be found (such as industrial, municipal, and agricultural users of water, determine the elasticity of demand the percentage change in quantity used with a small percentage change in price), and set service prices such that the difference between the price of the service and the marginal cost of providing the service relative to the price is inversely proportional to the absolute value of the elasticity of demand. Formally:

$$\varepsilon_{D_i} \left(\frac{P_i - MC_i}{P_i}\right) = \text{constant}$$

in which

ϵ_{D_i} = the elasticity of demand for the ith user group

P_i = the price to the ith group of the commodity

MC_i = the marginal cost of delivering the commodity to the ith group

Ramsey pricing practices are often approximated by public utility managers in the U.S. Household (domestic) users pay higher electric and water rates than industrial users who, in turn, pay higher rates than agricultural users.

In so far as water supply is concerned, agriculture is the major user. For agriculture there are four alternatives for setting fees:

Full payment plan. In this plan, agricultural users are charged the full cost of providing them with water. Farmers who are changing from rainfed to irrigated agriculture may not be able to afford to pay the full cost of water in addition to their initial investments in seed, fertilizer, and equipment. This is particularly true in the first few years of an irrigated agricultural enterprise.

Partial payment plan. In this plan, irrigation water is subsidized, either by the nations themselves or by hydropower and municipal and industrial water users. This scheme has been successfully used by the U. S. Bureau of Reclamation to stimulate irrigated agricultural development in the arid regions of the United States. The Ramsey pricing approach might be such a partial payment plan.

Gradual payment plan. In this plan, user fees collected from farmers gradually change from no charge in the first few years to

full charge in later years of the project life. This scheme is designed to help the farmers increase their economic base and cope with initial investments during the "warm up" period of the project.

No charge payment plan. In this case, no fees are collected from the farmers and the entire economic burden is borne by either the governments or hydropower and municipal and industrial users. This scheme recognizes the fact that agricultural users will have the lowest marginal benefits of the three major water users and therefore need the maximum financial assistance, although it is clearly not economically efficient.

Other schemes which have been used include declining or increasing block rates (where rates either decline or increase, respectivley, with increasing amounts of the use of a service), and modifications of those schemes (see Sichel and Gees 1981 for a review of U. S. public utility pricing practices and economics). These schemes frequently lead to over- or underutilization of the service compared to the economically efficient level of use.

A final issue in the pricing of services involves the specific commodities to be priced and the methods of measuring and monitoring use. Clearly, the service consumed is the appropriate commodity to which the price is applied. Thus, the user responds to prices of the commodity itself in terms of use levels. Some problems arise in the Senegal River Development, however.

First, for agriculture water is delivered in the existing channel of the river, not through means of canals which can be metered. The most efficient method of withdrawal is large pumping plants that are built and operated by appropriate national agencies

as opposed to small floating pumps operated by the farmers. In the case of large pumping plants, the volume of water can be easily measured and appropriate fees can be collected.

Historical practice has involved obtaining water from the river (recently by means of pumps) free of charge. It is doubtful that irrigators would accept charges on water which has heretofore been free, it will be very difficult to determine which water is provided by the project and which would have been available in the river channel without the project. If irrigators are willing, or can be forced, to pay for any and all water used, at whatever price, then metering of pumps will provide the use on which to collect fees. Note, however, that the success of the project depends in no small measure on the participation of users. Requiring a payment for water may cause a reduction in irrigation activity as a result of the historical "property right" to water in the river. Alternative collection approaches might include land or other taxes, but these are not necessarily linked to water use and might destroy participation and development rates, as well.

Power service is the easiest of the products to measure, monitor, and collect user fees for. All uses of electricity will be metered and charged accordingly. A situation similar to agriculture exists with regard to navigation.

Since the Senegal River runs along the borders of the counties of Senegal and Mauritania for more than 80 percent of its navigable length, it would be difficult to leave the monitoring and amdinistration of navigation to the individual nations. A significant portion of the increase in navigation shipment may be by non-

commerical enterprises (such as families). Given that river access historically has been free, and that control of the use of the river will be impossible, at least a portion of the tonnages will likely not be subject to fee collection. Incentives may exist to avoid the charges for navigation by shipping commodites in non-commercial vessels, requiring that higher fees be applied to commerical shipment. One possible organizational structure is to form a semi-public international company that will be in charge of all navigation in the basin. This company can collect user fees either by adding taxes to fuel sold at certain locations along the river or by having monitoring stations along the river that will record the distance of travel and weight of cargo carried by each vessel. A third method for collecting user fees are river navigation is the issuance of operating permits for all vessels using the river. Appropriate annual fees can be charged for these permits according to the size of each vessel. Once again, however, the effect on incentives to use the system must be considered.

In conclusion, while no intensive study of the appropriate pricing system has been made, it should be clear that the setting of prices and collection of fees is not necessarily a simple, straight forward task. There is some, perhaps large, risk of significant effects on development rates of the incentives or disincentives results from pricing and fee collection. These effects must be taken into account.

CHAPTER IX

SUMMARY

Background

Senegal River Development Project is an integrated basinwide water resources development programs. The Senegal River basin is shared by the countries of Senegal, Mali, and Mauritania. Two dams (Mantantli and Diama) are being constructed in order to produce electricity, water supply, and improve river navigation. This study focuses on the organizational structure of the managing international body and proposes three alternatives for this structure.

Organization Design Theory

Organizsation design is the process by which managers create a structure of tasks and authority. The following design decisions must be made in order to define the characteristics of the organization structure:

1. Dimension of labor
2. Departmentalization
3. Span of control
4. Delegation of authority

The following qualitative characteristics are considered to describe the nature of an organization:

1. Formalization

2. Centralization

3. Complexity

Macro-Organization Design

Macro-organization design is the process by which the overall style and characteristics of an organization structure are selected. Two major organization design theories are described: universal theory and contingency theory. The universal design theory consists of the classical, bureaucratic, and system 4 organization design theories. The contingency design theory is the state-of-the-art method of organization design.

Survey of U.S. Organizations

Four water resources organization are considered for their organization structure. These are: Tennessee Valley Authority, Upper Colorado River Basin Commission, California Department of Water Resources, and Coachella Valley Water District. The organizational characteristics of these institutions are compared in Table 2 in Chapter IV.

International River Basins

The hydrologic characteristics of a river are unchanged as it crosses a political boundary or runs along one. However, major changes often occur in the political atmosphere in which the waters can be utilized. Cooperation between the co-basin countries of an international river is necessary in order to efficiently develop the resources of the basin.

Some of the legal and institutional aspects of the development of international river basins are considered.

Proposed Organizational Structures

An integrated model is used to develop three alternatives for the organizational structure of the Senegal River Basin Project (refer to Figure 23 in Chapter VII). The following steps are taken to achieve this purpose:

1. Task identification
2. The choice of organization design theory
3. Key design decisions (i.e. division of labor, departmentalization, and the span of control)
4. Organizational dimensions (i.e. formalization, standardization, and centralization)
5. Environmental factors
6. Organizational effectiveness

The three proposed alternatives (presented in Figures 24, 25, and 26) vary in the basis for which tasks are grouped. In other words, they differ in the way that they have been departmentalized. They move on a continuous, with functional departmentalization on one extreme and product on the other, and a mixture of the two in between. The mixed departmentalization (Figure 26) is the preferred alternative because of its efficiency in the use of resources and the ease of coordination.

Organization design is an evolving and dynamic process. It must begin from the macro level and design the overall organization structure. Specifying the details of an organization structure at

the outset, creates a rigid and non-evolving organization that cannot adapt to the operating circumstances of its environment. When a new organization is being contemplated, such as is the case for the management of the Senegal River Basin Project, the overall management structure must be designed and specified. During the initial stages of its operation, the performance of the organization is continuously monitored. Subsequently, on the basis of this information, the organization structure is modified to fit the needs of the evolutionary process of the organization. Therefore, the attempt to design alternative organization structures for the Senegal River Basin management authority is merely a first attempt at this evolutionary process and cannot address the micro-organizational design aspects.

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