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COOPERATIVE AGREEMENT ON SETTLEMENT AND RESOURCE SYSTEMS ANALYSIS

PLANNING FOR AFRICAN RIVER BASINS

by

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and

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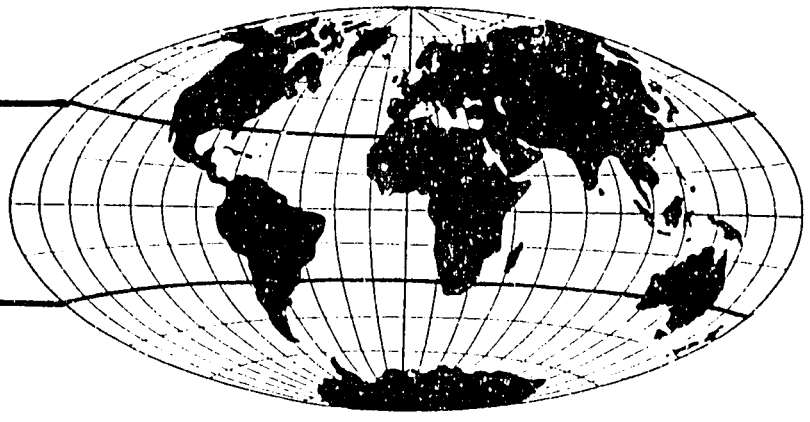
June 1988



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Note to the Reader

This document contains two separate reports by two different authors on the topic of river basin planning. Their complementarity made it appropriate to include them under one cover. The first report by Richard Perritt is an overview on the evolution of the concept and application of river basin planning; the planning paper by Harry Schwarz is more for the practitioner as it identifies stages in river basin planning specific to Africa. The two reports are separated by a title page with a table of contents.

RIVER BASIN PLANNING FOR REGIONAL DEVELOPMENT

by

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1

INTRODUCTION

A fundamental change in the general ideas about river basin development has slowly occurred since its conception as a narrow engineering approach to manipulate a water course for a single private or public purpose. In some parts of the world, integrated river basin planning means developing a multipurpose strategy, applying the unifying concept of a river drainage system to plan for hydroelectricity, irrigation, transportation, domestic and industrial water supply, fisheries, flood control, and the maintenance of environmental quality. Ideally, integrated river basin development is expected to create socioeconomic change for improving standards of living and increasing levels of production that includes, but is more than, implementing projects for the optimum uses of water. In the developing world, this broader issue of a river basin development scheme has not yet acquired the significance of regional development, for power and irrigation seem to be the dominant goals.

Planning for multiple purposes in basin regions and considering alternative ways to reach objectives have sparked considerable debate on how to best unlock the vast resources in large river and lake systems, especially in the Third World. Multiple purposes and means to replace the single-sector, construction-oriented approaches of the past now seem to be receiving attention among Third World nations. No new comprehensive framework has emerged to adequately provide planners and others with a real means to integrate structural projects for water resources with the more comprehensive needs of developing the basin area as a whole for local as well as national interests. This chapter reviews some advances and limitations about the practice of river basin

planning and why it has not achieved the desired result of a more effective, local, and integrated approach to river basin development.

THE CONCEPT OF INTEGRATED RIVER BASIN DEVELOPMENT

Gilbert White (1957) has provided a detailed account of river basin planning and integrated basin developments in the United States and its application in other countries. White related four principles that are central in the evolution of ideas for integrated river basin development. These are: technology; multipurpose storage; basinwide administration; and comprehensive regional planning. There are wide differences in interpreting how and if these principles are combined in any way so as to create an integrated development outcome. The ideas for developing river basins evolved and were implemented slowly, and are characterized more by differences in their application and results rather than as a unifying set of principles.

One of the basic issues in river basin planning has to do with the perception of what constitutes integrated river basin development. The concept of integrated development proposed by White (1957), reemphasized and stated by international agencies like the United Nations (1970), perceives the land and water environments drained by river systems as untapped resource networks constituting both natural and human regions. This basin resource network, if developed effectively, provides the backbone and catalyst for considering possible uses and designing projects which should be interrelated to reinforce each other, creating a unified system of multiple purpose activities that promote regional growth. This view seeks to promote a balanced growth of the region whereby single sectors are subjected to the checks and balances of a multi-objective planning integrated management system. A high level of

coordination between government units and private actors in development is required.

Ideally, integrated development means a well-programmed and coordinated effort on the part of key institutions involved in the process to plan for the divestment of project management and operation. Planning and management begins in larger centralized agencies of national government but should follow a pattern of gradual decentralization to regional and local authorities. Because the aims are part of a multiple rather than a single sector perspective, White (1969) envisioned a planning process in which objectives were recognized as constantly evolving with public preferences which, in themselves, would be shaped as the process unfolded. Alternative methods for creating desired change would be explored, including projects not directly dependent on regulating the flow of water or constructing large-scale projects. For example, a regional goal for increasing food production would consider the full range of options available, such as improved on-farm storage. The goals would require a mixture of public and private administrative and management instruments encouraging as much decentralization in decision making among individuals, local agencies, and communities as consistent with broad guidelines supported by the public consensus.

White (1969) believed that an integrated approach should move away from the rigid application of standards and criteria for economic cost-benefit, water quality, and hazards reduction. Decisions would be based on the criteria of keeping the range of choices and alternatives as wide as practicable and of working toward short-time horizons within frameworks describing long-term human needs and real appraisal of the physical and social limits of the basin environment. This would require intensive research, analysis, and monitoring of resources and the theoretical possibilities and social consequences of altering

them. For example, because new patterns of settlement and livelihood would emerge, river basin planning should take this type of change into account right from the beginning. The capability of local government and management systems would have to be considered and possibly built up at the start of the process. Finally, integrated river basin planning should apply the natural unity of watersheds in a flexible fashion. Alert to the uniqueness and distinctive features, constraints, and opportunities of each drainage basin, it should not ignore social processes or restrict change so as to conform only to the physical entities of watershed lines.

Especially in the western world, ideas about integrated river basin development continue to have a wide appeal and have established almost a mystique in terms of their promise to streamline bureaucracies or promote the social good (Wengert 1957). Lowry and Carpenter (1985), commenting on the relationship of natural resources and regional planning, point out that by establishing jurisdictions roughly congruent to natural systems, regional planning and management can correct the imbalances and overcompartmentalization of prevailing sectoral interests and line ministries. Faniran (1980) extends this unity argument by stressing that since many developing countries are either too poor or too small, or both, to prosper, development of river basins is seen as a means by which cooperation among countries can and should be fostered. Cooperation among the nations within a drainage basin will yield benefit to all parties. The river basin and its resources are considered more tangible, commonly owned assets than shared language, culture, history, and ideology and should be developed within a framework of cooperation, if not integration, to be rationally developed and equitably shared.

Saha and Barrows (1981) summarize the literature by advocating that river basin planning must be equivalent to integrated regional development.

> For too long the emphasis has invariably been on construction and not on end-use planning. New components, in addition of structural projects must be added to the whole process: (1) the planning of linkages between construction, programs, and the needs of the population and; (2) the planning of measures to correct dislocations in the ecological balance caused by these construction programs . . . . River basin planning seems to offer a conceptual framework for the integrated development of the environment which can bypass inadequate existing agencies and procedures (1981, 11).

Integrated river basin development has been widely perceived as a powerful social and technical means for achieving desired change. However, like any social resource and technical tool, river basins are not inherently foolproof systems for development. How much they are effectively developed to serve humanity is ultimately a question of human management. Management and the institutions associated with river basin planning have generally frustrated most of the earlier perceptions about regional integration and seriously clouded the future contribution of basin planning to development. In actual practice, many countries have failed to evolve effective planning processes and responsible institutions for integrated river basin development (Howe 1986). In fact, the perceived qualities of river basin development have far outdistanced the institutional experience. The actual results have been disappointing in many countries.

THE GLOBAL EXPERIENCE OF RIVER BASIN PLANNING

It is useful to briefly describe the practical course of events that is characteristic of applied river basin planning in order to explain why the practice of basin planning comprises generally failed expectations for integrated development. The overemphasis on exploiting basin water resources accounts for some of this failure. The planning practice for water-related projects has generally been developed at the expense of considering other sectors and needs of river basin populations. We limit this description to the

effects on planning procedures and institutions with the understanding that this is not the full picture of problems[1] or tangible benefits.[2]

Recently, Adams (1985) identified some of the factors by which river basin developments in tropical Africa have been critized on environmental, social, and economic grounds. Most often in Africa and elsewhere, the downstream ecological impacts of dam construction are a subject that has drawn the interest of river basin researchers in general (Freeman 1977), and specific basins like the Volta, (Hilton and Kuwo Trsi 1970), the Tana (Hughes 1984). Adams (1985) refers to Hart's work (1980) for criticism about the political context of major dam development, illustrated by British and American interests in Ghana's Akosombo Dam. There has also been concern over the whole pattern of water resource development in particular river basins, for example, the Senegal (Adams 1979; Watt 1981). The record of the lack of environmental appraisal in project development is another factor (e.g., Hughes 1983). Scudder has documented the problems of resettlement (1976); and he (Scudder 1980) has described the apparent failure of river basin planning throughout Africa to take account of the importance of recessional agriculture for local farmers.

The five principles of technology, defining basin goals, basinwide administration and institution building, multiple-purpose storage, and comprehensive regional development are helpful in discussing how development only of water resources limits river basin planning.

Technology

On the surface, the qualities of river basins as a natural derived region for development are not hard to perceive nor difficult to promote, especially for economic reasons. River basins are bounded by water divides that clearly mark the area of land and water resources, plus their human uses that are

drained by the master stream. As such, it demarcates a natural region that provides maximum physical opportunity for water resource development and economies of scale (Ackerman and Lof 1959).

In a purely physical sense, the potential exploitation of the major river basins of the world is still largely untapped. In the regions of the developing world, only a few streams have been regulated and used, and even these are in a developed state much below their potential (United Nations 1970). Indeed, the limits are not so much the volume of unused floodwaters that flows nor the energy of rushing streams that remains unharnessed, but they are problems of institutional planning and coordination, social feasibility, and political cooperation which remain formidable.

Development implies at least two physical changes in the natural stream flow. One is regulation of flow by storage, diversion, or land management so that water is available when and where it is needed rather than as dictated by natural fluctuations over days, seasons, and years (White 1957). The other change seeks to capture the use of water in order to maximize in an economic sense the returns from other resource uses or productive processes. Both forms of development change in river basins are most often translated into projects for hydroelectric power and irrigation. Under this definition, basin drainage systems and water courses are considered fully developed if flow has been so regulated as completely to serve whatever purposes can, on grounds of social needs and economic growth, be shown to be important to the society involved. Since very few drainage basins are free from annual periods of water deficiency, there is increasing interest to be able to control such variations. The ideally regulated stream would fluctuate in its main channels only to meet fluctuating human demands, the natural variations having been evened out and redistributed according to particular end-uses.

Technology for river basin development is associated with the engineering means -- dams, diversion canals, water distribution devices -- at hand to regulate water resources. Because technology is available to carry out such control in all but a few cases, regulation for some made it into an end in itself, with the measure of success being an ever-increasing portion of average streamflow regulated through some structural means. Thus, river basin planning and institutions responsible for managing basin development seem to carry a built-in bias towards planning only for the implementation of large-scale water storage projects. The practice of thinking of development only in terms of large-scale water storage projects is equally carried over in the functioning of river basin institutions. These are often incapable, in any real measure, of changing their limited focus to effectively coordinate multiple objectives and integrate large- and small-scale projects with local, regional, and national needs.

Defining Goals for River Basin Development

The technological ability to achieve great economies of scale through multipurpose storage projects and basinwide operations stimulated proponents of development to identify the basin region as a singular raw material or water resource on a grand scale. The basin area was often perceived in terms of locational points that offer the physical opportunities for technology to harness. The goals of hydroelectricity and irrigation established themselves as priorities which have continued to dominate most river basin plans and project designs.

The use of hydroelectricity proved to be directly linked with industrialization by lowering the cost to the consumer of the production of electricity. Improved hydroelectric projects tended to lower the costs of electrical energy

below the prices consumers had been accustomed to paying. Hydroelectricity also had a high security value, since it could be operated with relative freedom from international political changes. The economic savings and relative guarantee of constant supply would, in turn, stimulate investment and economic growth. These economic returns from hydropower induced basin development planning to consider first the construction of large dams and reservoirs. The greatest possible production of kilowatt-hours was established as a design goal and other purposes were altered or forced to conform to the design needs for large-scale hydroelectricity. Proceeds from the sales of electricity would be great enough to substantially reduce the cost of expensive construction, making it possible to develop other purposes. Additionally, the multiplier effects of cheap hydroelectricity would be redistributed so as to benefit other sectors and national economic growth. For example, the prospect for development of hydropower on the Rhone River shows this "rent" value where the total costs of navigation and flood control projects were to be repaid by sales from the river's hydroelectric dams. After twenty years of operation (United Nations 1970), this original estimate has proven to be accurate.

The goal of agricultural development also figured importantly in the application of river basin development in the developing world. The reasoning for focusing on large-scale irrigation projects had similar justifications to that of hydroelectricity. Socioeconomic benefits are widely cited in irrigation projects, although rarely verified by post-cost evaluations. Worthington (1977) lists six potential socioeconomic benefits of irrigation development: (1) national economic efficiency; (2) acting as a catalyst for development of modern agriculture and the modernization of the rural economy; (3) gaining of foreign exchange through export crops; (4) sedentarization of nomadic people; (5) drought damage prevention; and (6) stabilization of rural systems.

The scale and cost of works planned for developing a basin's water resources were so large that goals for hydroelectricity and irrigation carried much greater importance in river basin planning than other multiple purposes. Priorities for energy and irrigation have continued to bias basin development schemes by building in the practice of consideration of other sectors and programs only after the successful operation of large-scale hydropower dams and reservoirs has been secured.

Basinwide Administration and Institution Building

Focusing only on the potential of large-scale development of hydropower and irrigation did not limit the growth of large centralized institutions devoted to the planning, funding, design, and operation of river basin projects. Water resource planning requires a basinwide administrative approach. Individual water projects cannot be undertaken with optimum benefit for the people affected unless there is a broad plan for the entire basin. One definition of integrated development underscores the importance of developing a water course on a basinwide basis by equating integration with the orderly marshalling of water resources through a system of coordination and harmonious development of the various water works in relation to all the reasonable possibilities of the basin (United Nations 1970).

Basinwide planning for the optimum uses of water, more so than the concepts of integrated basin development, influenced the conception and stimulated the growth of large-scale administrative systems like river valley authorities. Basinwide administration permitted fuller utilization of water resources by linking them under a single administrative structure in a defined and self-contained area. The greater the increase in the demand for water resources, the more desirable such administration became. At the same time, the

technology and resource survey techniques were available to make such administration for entire basins feasible.

The idea of basinwide administration perhaps has no stronger example than the United States' Tennessee Valley Authority (TVA). The administrative model of the TVA captured imaginative support with the belief that similar institutions would be beneficial in river basins of the Third World by generating growth in regions regarded as traditionally stagnant or underdeveloped. The formation of basinwide authorities in India (Damodar Valley Authority 1948), Sri Lanka (Gal Oya Development Board 1949), and Colombia (Regional Corporation of the Cauca Valley 1960) exemplified the faith in such basin institutions to promote comprehensive regional growth and improve standards of living. The arguments made in favor of the Damodar Valley Authority stated that:

> The Corporation is to execute and operate schemes for irrigation, the generation of hydropower and flood control. Besides those three main purposes, the Corporation will promote navigation, afforestation, public health, and industrial, economic and the general well-being of the people of the Valley.[3]

In practice, establishing basinwide administrative units and making claims to accommodate multi-objectives did not produce a balanced, multisectoral framework for integrated river basin development. To take the original TVA model, although its legislative act cited the possible need to

> . . . make surveys and general plans for said Tennessee Basin and adjoining territory as may be useful . . . in guiding and controlling the extent, sequence, and nature of development that may be equitably and economically advanced through the expenditure of public funds or through the guidance or control of public authority, all for the general purpose of fostering an orderly and proper physical, economic, and social development of said area . . . .[4]

the authority was not explicity designed to occupy itself with these issues (White 1957). The new Tennessee Valley Authority in 1933 set up its own engineering staff and proceeded to revise earlier plans so as to design a series of

high dams having large hydrolectric output, rather than the moderately low-output dams considered earlier by the US Corps of Engineers.

As the TVA worked out its revised designs over the years, it developed a system of twenty-seven multiple-purpose dams serving navigation, flood control, and hydroelectric power, operated so as to regulate flow throughout the main stem and major tributaries and to reduce flood damage to the lower Mississippi. White (1957) emphasizes the importance of the TVA experience as the prototype for unified basinwide programs for multiple-purpose water storage projects. By accomplishing this, the institution further demonstrated that the technical means were at hand to implement such a water storage regional development approach.

Some proponents of the TVA also emphasized the contribution of the authority in sparking modernization and economic change in a depressed region. They used the region's indices for increases in nonagricultural employment, increases in variety of economic opportunities, rapid growth of high-wage industries, a new pattern of industries processing raw materials, electrification of farms and rural self-improvement projects as proof of growth stimulated by the TVA (Clapp 1955; White 1957). However, White (1957) contests the image of the TVA as a comprehensive river basin development authority and for this reason a realistic institutional model to be copied to promote multisectoral and balanced growth in basin regions of the developing world:

> Regional effects were intimated but not planned, then enjoyed but not managed. They were dimly perceived at the start, hailed when apparent, and subject of earnest study after the crucial decisions to major river regulation works had been made. In each case, the criteria for selection and financing of the construction work were restricted to a showing of feasibility for the stated purposes of water control. Such gauges of economic well-being as per capita income, diversification of industry and agriculture, and stability of employment did not figure in decisive ways. These entered the discussion of the wisdom of the projects more as rationalizations than as prior justifications (1957, 173).

The idea of integrated river basin development modeled after the reputation of the Tennessee Valley Authority and the endorsement by the Secretary-General of the United Nations in 1956 (Tecalff 1976) was recognized as a persuasive model for development in Nigeria (Faniran 1972; Adams 1985). By 1976, the Nigerian government established eleven river basin authorities as well as the National River Basin Development Coordinating Committee. The river basin authorities were given a wide range of functions and were intended not to be limited to the development of water resources alone (Faniran 1980).

In a review of the practice of river basin planning in Nigeria, Adams (1985) points out the disappointing economic performance and social impacts of the country's River Basin Development Authority (RBDA) model, whose statutory functions are described in Table 1.

TABLE 1

Functions of RBDA in Nigeria

(1) To undertake comprehensive development of both surface and underground water resources for multipurpose use.

(2) To undertake schemes for the control of floods and erosion, and for watershed management including afforestation.

(3) To construct and maintain dams, dykes, polders, wells, boreholes, irrigation and drainage systems, and other works necessary for the achievements under this section.

(4) To provide water from reservoirs and lakes under the control of the Authority for irrigation purposes for farmers and recognized associations as well as for urban water supply schemes for a fee to be determined by the Authority concerned, with the approval of the Commissioner.

(5) The control of pollution in rivers, lakes, lagoons, and creeks in the Authority's area in accordance with nationally laid down standards.

(6) To resettle persons affected by the works and schemes specified in this section or under special resettlement schemes.

(7) To develop fisheries and improve navigation on the rivers, lakes, lagoons, and creeks in the Authority area.

(8) To undertake the mechanized cultivation and clearing of land for the production of crops and livestock and for forestry in areas both inside and outside irrigation projects for a fee to be determined by the Authority concerned with the approval of the Commissioner.

(9) To undertake the large-scale multiplication of improved seeds, livestock, and tree seedlings for distribution to farmers and for afforestation schemes.

(10) To process crops, livestock products, and fish produced by the farmers in the Authority's area in partnership with state agencies or any other person.

(11) To assist the state and local governments in the implementation of the following rural development work in the Authority's area:

a. The construction of small dams, wells, and boreholes for rural water supply schemes and of feeder roads for the evacuation of farm produce;

b. The provision of power for rural electrification schemes from suitable dams and other types of power station under the control of the Authority concerned;

c. The establishment of agro-service centers;

d. The establishment of grazing services;

e. The training of staff for the running and maintenance of rural development schemes and for general extension work at the village level.

Source: River Basins Development Authorities Decree 1979 in Adams, 1985.

In the above table, Adams provides a brief evaluation of Nigeria's efforts at actually implementing the statuatory requirements to use river basins as a basis for regional development and planning. He observes that the country's predominate focus has been on dam construction and irrigation development (functions three and four), while river basin administrations have generally failed to achieve a comprehensive development of resources as stated in function one. Population resettlement affected by basin development schemes and physical projects "has been tackled ineffectively," (Adams 1985, 305) and there has been little work in the fields of watershed management and afforestation, pollution control, navigation, fisheries, seed multiplication or agricultural processing, objectives two, five, seven, ten, and eleven. Finally, the river

basin authorities have been largely unsuccessful in establishing an effective partnership with otherstate development agencies.

The arguments made in favor of integrated development were used to ease the way for justifying large-scale, basinwide schemes of water projects. The experience of the TVA model was emulated in similar fashion without making the distinction between structural projects which are planned and carried out with the sole purpose of gaining direct benefits, such as power production or irrigated acreage, and projects which are intended to promote basic changes in the quality of life of the region's population. Under the second view, at least two new considerations are made which are ignored in the first. The direct benefits of basin projects and programs are planned and operated as a means to achieve a broader goal rather than as the single focus of river basin development; design and operation of large hydropower dams become one of many possible investments to serve the needs for regional change.

Multiple Purpose Storage

The practice of designing and operating reservoirs and other structures to serve multiple purposes more so than the other principles aided the development of an integrated basin planning approach. At the same time, a multiple-purpose construction strategy complemented and strengthened water resources development. After a long period of single-purpose, single-method construction by both public and private agencies, the multiple-purpose dam and reservoir were a genuine revolution in engineering techniques (White 1969). Multiple-purpose projects substituted one structure for a number of structures and in so doing gained economies of scale and a combination of potential benefits which otherwise would have been lost. All this was accomplished while traditional goals like hydropower gained importance.

Stored water could be managed for diversion downstream for use on irrigated farmland. It could also be diverted and distributed over great distances to ensure the water consumption needs for large cities, urban towns, and rural villages and to meet the demand for water from commercial and industrial uses. The design capacity afforded by constructing large-scale structures greatly increased the basin region's service area by permitting long-range, inter-basin transfers of water and hydroelectricity.

The reservoir and dam could be designed to reserve a portion of stored water to control flooding downstream or released in such a fashion as to reproduce the possibility of traditional forms of recessional agriculture along man-made lake shores or downstream. The dam and reservoir could be engineered to permit navigation, to facilitate recreation, to promote wildlife management and resource conservation, and to aid in pollution abatement.

The range of purposes varies almost as to the number of public agencies and private interests active enough to promote their particular viewpoint or powerful enough to influence planning and design so as to include their project. The possibility of constructing multiple-purpose projects enabled groups who had not participated before to identify with river basin development. It also meant that the traditional actors like the electric power and construction/engineering sectors of the economy could continue to have active or even dominant roles. For the first time, the limits of the river basin which has been perceived as a boundless resource network, were questioned when conflicts between different proposed uses emerged. As new interests gained form around basin development goals and regional problems, the struggle to be included in the list of multiple purposes could become quite intense.

The idea of multiple-purpose storage captured some of the range of diverse benefits which large basins seemed to offer from the beginning of

conceptualizing integrated development and river basins. Yet, the process of identifying multiple purposes through construction and operation of diverse storage projects resembled a political struggle over river basin resources more than an agreed upon set of planning procedures to support an integrated strategy to basin development. Wengert (1957) describes how perceptions about river basin development and multiple storage attracted and benefited a plurality of interests. Government agencies with particular programs to sell flood control, irrigation, watershed protection, public power, etc. supported river basin development without changing their sectoral focus.

> . . . for the mandates of most agencies (the TVA is a possible exception) are not to develop a region or a basin, but to prevent floods, save the soil, irrigate the land, protect the forests, etc. The result is often a mere use of river basin development terminology because it is expedient and gains public support, without really adjusting programs to regional development criteria (1957, 262).

Allied with government agencies were numerous local groups and interests (including political parties) and including industry and labor (particularly construction, heavy equipment, transportation, and power related), with each river basin scheme presenting a diverse coalition of interests and motivation. By 1958, for example, the Southeast Basins Study in the United States (White 1969) proposed eleven different purposes, each supported by its own special interests and relevant survey of basin resources.

Multiple-purpose construction strategy brought with it a series of changes in the nature of decisions involved which affected river basin planning. First, the quanity and quality of purposes associated with water-oriented basin development changed by considering new purposes and investments beyond directly regulating water that aimed at stimulating regional growth. The practice of multiple-purpose storage opened up public and professional thinking to the possibility of contemplating additional needs and purposes for developing river

basins. The accretion of new aims did not, however, appreciably affect the perception of means appropriate to or necessary for integrated river basin development (White 1969). Attention was focused on the large-scale construction of dams and reservoirs. The total number of development means became no larger than the combination of uses under single purpose dam projects, the chief difference being that of designing multiple-purpose rather than single-purpose structures. The mechanisms and institutions to control and clarify conflicts and explore alternatives in order to permit choices with respect to the goals of river basin development were weak or largely absent. White (1969) indicates, by describing the experience in the United States, that there seemed to be an unofficial understanding among proponents of programs to expedite acommodation of certain interests by avoiding stalemates and not exploring alternative programs in depth.

> When some members of the Department of Agriculture challenged the assumption behind the reclamation program that construction of water projects was an obviously effective means of advancing agricultural productivity in the arid regions, tensions heightened so that it finally became apparent that the constituencies could coexist by letting that issue rest undiscussed and unresolved (1969, 40).

The process of analysis for multiple purpose projects tended to sharpen the recognition of the uncertainties and trade-offs involved with combining development objectives under one river basin strategy. As a first step towards some framework of integrated project planning, it became apparent that individual goals and programs included their own means of evaluation and criteria for success. When it became necessary to house different programs and criteria under the same project plan, discrepancies in the available forms of analysis became more apparent, making it difficult to evaluate the multiple-purpose package as a whole. For example, when flood control and irrigation components were included in the same project, it became clear that whereas flood control

was to be evaluated in terms of losses prevented, irrigation was to be considered more of an economic potential to be developed than of a prevention of losses by those suffering from water shortage (White 1969).

RIVER BASINS AS A COMPREHENSIVE BUT LIMITED FORM OF REGIONAL PLANNING

The practice of river basin planning described thus far could more accurately be defined as comprehensive and multisectoral rather than integrated regional planning. Such planning is comprehensive in that it treats the entire drainage basin as an administrative unit which interacts with physical, social, and economic systems creating opportunities and constraints for development purposes. The resultant plan-making for basin regions, however, is a selective process in which basin resources and populations, their potentials and problems, and consideration of projects are treated unevenly. Designing multiple-purpose projects has widened the scope of objectives and constituencies served by river basin development, but multipurpose plans are, in effect, a form of multisectoral planning, operating within the boundaries of the specific purposes considered and developed.

In this form of limited comprehensive and multisectoral planning, water resource development tends to set the boundaries from within which other development initiatives are evaluated and planning takes place. First, planning for the efficient regulation and control of water resources affects the functional interdependence among multiple purposes and activities for basin development. Structural projects for regulating storage are designed and operated to take advantage of combining activities, but there is incomplete interdependence in the sense that certain activities like downstream control of flood levels for irrigation purposes cannot be achieved before considering the effects this would have on maintenance of the efficiency and integrity of storing water for

primary purposes like hydroelectricity, while the hydropower component can be implemented and is typically operated independently from the other purposes. The interdependence of basin projects and overlap of supporting interests are a desirable concomitant rather than a required condition for this type of river basin planning to function.

Because river basin planning covers the entire basin region and is both influenced by and influences planning and changes in surrounding areas, it fits squarely under the category of a regional planning approach to development. Although the importance of the relationships of a natural resource orientation for regional planning has shifted in emphasis, scope, and content (Hufschmidt 1969), river basin planning shares a common core of assumptions and procedures with other forms of regional planning. Planning practice for the development of basin regions finds a congenial framework in the tradition of rational, comprehensive planning also known as the synoptic tradition (Hudson 1979). The approach is flexible and practical, well-suited to the kind of perceived mission that large, centralized government agencies, such as river valley authorities, engage in so as to plan for the construction and operation of costly multipurpose projects and to accommodate broad interests for economic development without straying too far from a narrow range of dominant projects. Perhaps the greatest strength of the synoptic approach is its basic rational appeal by the way in which it organizes overlapping planning functions into a continuing process roughly encompassing the following steps:

1. a preliminary planning or reconnaissance stage to determine the appropriate institutional setting, areal focus; consider previous plans and commitments; and to establish the terms of reference for prefeasibility studies;

2. definition of goals and objectives or refining existing ones;

3. inventory of resources and demands;

4. formulation of strategies, programs, and project alternatives generally according to pre-established criteria for siting and design, and financing;

5. evaluation of strategy, program project options according to achieving goals and criteria for economic feasibility, and sometimes social and environmental impacts; and

6. decisions for implementation and institutionalization for sustaining management.

The process is not always performed in any single sequential order; steps can be treated unevenly or omitted altogether. Each step is flexible, permitting multiple iterations, feedback loops and elaboration of subprocesses with data collection and information gathering going on throughout the process. The sequence of activities is more of a logical framework for an internally consistent, self-reinforcing network of assumptions, procedures and methods, data requirements, disciplinary skills, and operational styles (Hudson 1979), than it is a rigid planning exercise. Nevertheless, the synoptic approach addresses the fundamental issues of any planning endeavor. It is action-oriented, considers ends and means, brings the best available resources and technology to bear on problems, considers trade-offs, proposes solutions, and pragmatically finds ways to carry them out.

River basin planning seems to adopt the rational, comprehensive mode to produce a peculiar style of analysis. The basin approach shares at least three basic assumptions with regional planning. Together with other forms of regional planning for development, the river basin approach assumes: (1) that socio-economic change and development can be promoted and guided by planning; (2) that regional development (growth) will result in economic benefits to the region and its population; and (3) that regional economic growth will foster improved social conditions (Castillo and Hoffman 1981). The river basin practice is distinctive, however, by predicating the region's development potential on its attribute of hydrological continuity and treating water resources as the

key variable in promoting social change and economic growth. A basin region is singled out for development because of its comparative advantage for manipulating the physical qualities of water resources -- surface, groundwater, and precipitation -- their location and availability. Other attributes such as transportation, urbanization, and commercial networks in and outside the region in question can be overlooked. Investigating local systems of production as a basis of regional development projects for river basins can also be neglected. Changes brought on by human development do affect the availability of water resources, and estimates of population growth and economic change enter as important tasks in river basin analysis.

Another persistent theme of river basin planning has been to integrate water development with land use management. The linkages are readily perceived for at least two reasons. Land use is traditionally dependent, to a large extent, on the availability of water resources; and water management, that is the magnitude, variation, and quality of water moving in a drainage basin, is in some measure influenced by land use changes. Despite recognition of the interrelatedness between land use, vegetation, and water management and the elaboration of extensive land, and water resource surveys, the tendency is to treat them as separate issues in the final analysis (Lundquist, Lohm, and Falkenmark 1985; Estudos Integrados da Bacia do Rio Jacui, Comite Executivo dos Estudos Integrados do Rio Guiaba, CEEIG, Porto Alegre, Brazil 1981). Thoroughly articulated programs of land and water management in the same basin are often nonexistent (White 1957).

White (1969) captures the barest essence of combining water as the chief variable, inventorying land and water uses, and forecasting supply and demand to characterize river basin analysis as practiced in the 1950s and 1960s.

> most of the basin studies a similar style of analysis prevailed. The procedure was to make an inventory of hydrologic and associated physical phenomena in the basin, including precipitation, runoff, groundwater, soils, agricultural land use, forest use and related aspects of the natural environment. Economic base studies were intended to build up demographic and income data as of the time of the study, to assess trends in population and in production over preceding years, and to project these into the future in terms of estimated population and levels of manufacturing and agricultural activity. Upon that base, projections were made of estimated demands upon water and land for a wide variety of uses, particularly for power, irrigated land, urban water supply and recreational facilities (1969, 36).

One conventional output of such analysis and planning process paralleled the format of other regional planning efforts. Often a discrete, master basin plan was produced, identifying policies, programs, and projects in terms of long-range (i.e., 50 to 100 years) time horizons and linear projections of demand in order to regulate a finite supply of water.

River basin planning also stimulated opportunities to develop innovative techniques and mobilize special research efforts to effectively apply fundamental data and information on land and water resources. The practice of requiring detailed natural resource surveys, covering huge basin areas, put pressure on basin planners to seek cost-effective means and new technologies to gather, display, and store complex and large quantities of data. Aerial photography and later more sophisticated remote sensing techniques combined with computer technology were applied to prepare basin atlases, and display data in order to convey a synthesis of fundamental information on the basin's water resources, soils and vegetation cover, population distribution, settlement patterns and major land uses.

Benefit-Cost Analysis

Any new project or program proposed for basin development leads to benefits and costs, and the technique of benefit-cost analysis intersects with the perceived needs of river basin planning at several crucial objectives and

related tasks. Public agencies responsible for allocating huge sums of capital and other resources for relatively long-run construction development programs were eager to acquire tools which purported to improve the economic efficiency of project decision making. The principles of cost-benefit analysis derived from theories of western welfare economics rest upon the assumptions of efficiency and maximization of net returns. Briefly, the technique recognizes that implicit or explicit decisions about projects are made on the basis of economic costs and expected benefits. The criteria for considering benefits or costs are expressed in terms of the relationship between willingness to pay to satisfy wants via willingness to sacrifice other wants or forego opportunities. Overall benefits are considered to be derived from the aggregation of the willingness to pay of individuals in society. The economic costs of resource inputs to a project are the opportunities foregone in using these inputs to obtain benefits in some other way. A second aspect of costs considers the adverse effects of resource allocation and the equivalent value in economic terms that would be needed to compensate society for the harm done.

Whenever possible, the means for measuring the value of benefits and costs is represented by monetary terms. The marginal analysis is rigorous and predominately normative. Because the economic values of society itself are relied upon to evaluate specific programs or projects, value judgements are kept to a minimum and, where required, are described explicitly to society's decision makers (Hufschmidt 1981).

Multi-objectives and System Approaches

Selecting alternatives only on the basis of economic efficiency does not accommodate conflicting goals which cannot be expressed in commensurable units defined in terms of the net national economic welfare. Most river basin

development decisions are multi-objective in nature involving economic, social, and environmental dimensions and values. Decisions are made in terms of compromise and conflict resolution rather than objective benefit-cost accounting. Recognizing this limitation, the benefit-cost analysis school has developed multi-objective assessment techniques intended to include evaluation criteria beyond those specifically measured on the basis of economic efficiency. The theory of multi-objective assessment assumes that decision makers will select the non-inferior project that would maximize their perception of the overall social value or utility obtained from different mixes of multi-objective (Loucks and Somlyody 1986). In multi-objective assessment there is no single optimum, rather selection of projects represents the best compromise choice. Applying this concept of multi-objective optimization, modeling techniques have been devised which present the range of choice as differing development scenarios or clusters containing a different mix of specific goals, projects, and programs. The United States Corps of Engineers first applied this method in their study of the Susquehana River Basin. Three major goal clusters -- national economic efficiency, regional development, and preserving environmental quality -- were defined in terms of planning three alternative scenarios including the corresponding benefit-cost analysis. The aim was to make the most economically efficient scenario the baseline least-cost plan and to compare the other proposed scenario plans with it (O'Riordan 1981).

A wide variety of multi-objective planning tools have been developed to aid the decision maker to identify efficient projects and to take into account the multiplicity of often conflicting but equally legitimate river basin goals for development (Haimes and Hall 1975; Major 1977; Cohon 1978; Major and Lenton 1979; Goicochea et al. 1982; Zeleny 1982). These include statistical sampling and associated analytical techniques for identifying the significant

parameters, decision variables and appropriate structures for building models of river basin systems (Loucks and Somlyody 1986). Another widely used technique of river basin planning, systems analysis, is particularly important to technology-oriented basin development because of the complex project interlinkages and the local context of physical and socioeconomic interactions involved. A variety of optimization and simulation modeling techniques are used to aid in understanding models and refinement to more detailed subsystems.

Recognition of Social-ecological Impacts

If finding innovative solutions to the problems of economic efficiency in planning projects received strong support and wide application by river basin authorities, the social and ecological disruptions resulting from construction of water control devices went largely unheeded. Solutions and planning methods to deal with socioecological impacts were developed largely outside the routine planning process and mission orientation of institutions traditionally involved with river basin development. In the beginning of multipurpose strategies, there was some recognition of potential adverse effects from large dams and reservoirs, but serious consideration to solving such problems was set aside sometimes on the grounds of lack of evidence. White, even in 1969, cautiously observes that

> Three statements can be ventured about the effects of multiple-purpose projects on the environment. The consequences undoubtedly were widespread. They were extremely difficult to track but in their effects upon atmosphere, water regimen, and ecosystems. On balance, gains probably outweighed losses in most areas, but firm conclusions cannot be drawn . . . concluding . . . it seems likely but not certain that most deleterious short-term consequences over a few decades have been identified in some fashion, that the long-term consequences remain to be measured, and that in the greater number of instances the damages do not yet appear so serious as to outweigh the benefits which have accrued to society.

As soon as post-audit evaluations were produced and disseminated, evidence of the effects of ecological impacts and possibly serious damage to the living resources of rivers and estuaries evoked concern from scientists and the public alike over similar large-scale proposals. Because of the huge areas potentially affected and the sheer scale of the projects involved, inter-basin transfer schemes sparked international debate about the technical soundness of such projects. For instance, experts were alarmed by the continental North American Water and Power Alliance (NAWAPA) proposal, for transferring water from Alaskan rivers through Canada into western United States river systems (Tecalff 1976). In 1966, one scientist warned that the NAWAPA project would put new load stresses on the earth's crust posing a danger of earthquakes, would place volumes of unfrozen water over permanently frozen ground with the likelihood of setting off landslides, and would deliver large quantities of cold water to warmer latitudes, where it would increase evapotranspiration and bring about irreversible change in climate (International Water Quality Symposium, Montreal, 1966 in Tecalff 1976).

In general, as the scale of projects increased, their effects could no longer be ignored. It became necessary to take into account the detrimental effects of dams, reservoirs, canals, and other water projects which hitherto had been unquestionably accepted as being wholly beneficial (Tecalff 1976). Among the impacts recorded were pollution, salinization and sedimentation, loss of wetlands through dredging and filling, loss of free-flowing rivers through flood control and channelization, damage to fisheries, saltwater intrusion in coastal areas, and injury to estuarine habitat and estuarine living resources through reduction of freshwater flow. Some of the impacts were felt in the area of impoundment, some downstream from water storage and diversion projects, some along the conveyance route of water and some in the area of use. Other

impacts were delayed temporarily to produce unexpected consequences much later. The Kamburu Dam on Kenya's Tana River completed in 1975 was found to have sedimentation loads and silting far above average, and, in some cases, ten times higher than the estimates used by consultants in designing the useful life of the dam (Odingo 1979).

Awareness of the environmental damage due to large-scale basin development proceeded from developed to developing countries. The United Nations, in a report on integrated river basin development in 1970, concluded that construction of dams, man-made lakes, the creation and expansion of irrigation systems, and the draining of swamps and marshes have far-reaching effects on the health of man and animals in the developing regions (UN 1970). A number of issues relevant to developing country environments, institutions, and river basin planning were revealed. First, the environmental damage done by basin development underscored both the fragility of tropical ecosystems and vulnerability of local Third World populations. Impacts were expected to be more severe, especially in the tropics, than in largely temperate developed areas (Tecalff 1976).

The question of fragility is complicated because of the general lack of scientific knowledge and data pertaining to tropical rivers, lakes, and the conversion of a river into a tropical reservoir. Physical changes created by such a conversion within a basin provoke so much turmoil that the new aquatic environment itself remains ecologically confused and unstable for a long time being neither wholly lacustrine nor riverine in nature (Obeng 1977). The new lake's chemical and physical characteristics vary widely, and with them, essential biological factors. Aquatic fauna and flora unadapted to the change can perish.

Conversely, tropical reservoirs can create higher yields of adapted fish species than those in colder climates (Lowell-McConnel 1973). Increasing the size of stationary water control projects afforded the possibility of utilization by surrounding populations and, at the same time, stimulated the spread of pests and vector borne diseases. Water weeds and the intermediate snail hosts of schistosomiasis proved to be the most serious health consequences of tropical man-made lakes and irrigation systems.

The sociocultural effects of this type of river basin development on local populations were perhaps the least understood and most lightly regarded of all types of impacts. For example, four African dam projects directly disrupted the lives, homes, and livelihood of nearly one and a half million people within twenty years. Research on such projects as the Kariba, Volta, and Kainji dams and the Aswan High Dam showed that compulsory relocation produced great stress and problems for both relocatee and host populations, which can remain unresolved ten to twenty years after the dam construction.

In spite of studies describing the socioecological effects related to water resource oriented projects, development of procedures and methods to assess impacts which could weigh directly on their justification and design took place outside the routine practice of river basin planning. Formal requirements have changed development planning which now has to accommodate consideration of environmental and social values in addition to economic goals. The experience of assessing new values in river development decisions should contribute to a more comprehensive regional and local perspective of basin development strategy.

Assessment of Environmental and Social Impact

Evaluation in natural resource planning usually employs some form of accounting technique which seeks to insure that on balance the favorable effects of projects and programs outweigh the negative consequences. The practice of evaluatory accounts is strong in planning for river basin development; economic criteria for cost-benefit analysis set the standards which most influence final evaluations to justify the capital-intensive, large-scale projects dominating basin development strategies. Multiobjective approaches recognize that development decision making is multiobjective in nature involving economic, social, and environmental values, however. To date, the process of multiobjective planning is not well established or effectively integrated into traditional types of economic evaluations (Loucks and Somlyody 1986). The experience or record to date from investigating past river basin projects indicates that (1) these can and do have significant, and often unanticipated, effects on both people and natural environments, and on the ability to utilize natural resources, and (2) that these effects add to the real costs or real benefits of the undertaking (Farvar and Milton 1972). Most proponents of projects have acknowledged that environmental effects should be included in the accounting process in order to measure the real costs and benefits of any project. However, environmental effects are usually treated externally in determining project costs and beneficiaries; they are most often nonpecuniary, at least in a direct sense, and their value cannot be generally measured. Consequently, there is little incentive to insure that environmental values are directly considered in the conventional and economically-biased course of formulating and judging the feasibility of river basin plans.

The practice of conducting a separate environmental analysis or assessment in addition to economic analyses is primarily the result of external guidelines

or legislated requirements that intercede with and become part of the conventional practice of river basin planning. Such guidelines aim at assuring that environmental values are taken into account and weighed together with the more easily measured impacts -- the "hard economic facts" (Knetsch and Freeman 1979). Perhaps, the United States Environmental Policy Act of 1969 (NEPA) and the assessment procedure it outlined has been the most well-known model of an administrative and analytical process to account for environmental impacts in project planning. Since then a similar environmental accountability strategy stipulated as formal requirements in the project planning cycle has been adopted by the major international lending and development assistance agencies. The intent is to require a practical means by which environmental values can be considered in project planning. Although the NEPA legislation intended such requirements to be part of achieving a broader prescription of environmental goals, internationally the use of environmental assessments has been limited to a more procedural role. Third World agencies can participate in the assessments of internationally funded projects, however, the requirements are typically carried out by external consultants. The available methods developed in industrialized countries for identifying environmental and social impacts have not been appropriate for application by developing country institutions. The requirements generate data intensive reports which rely on mathematical modeling and analysis expertise, computer technology and the possiblity of litigation to support the need to perform and document assessment procedures. All of these are largely absent in Third World countries. Interest in providing an environmental analysis is more motivated by the expectation to receive development aid rather than a commitment to building a broader policy of national environmental goals.

Environmental impact assessment initially was dominated by analysis of the effects and impacts in the physical, chemical, and biological environments. More recently, recognition that concerns about project-environment interactions are usually determined by human environmental concerns and risks has forced the requirement for socioeconomic as well as environmental impact assessment. The disciplinary response, and methods for what in the United States have been labeled "social impact assessment" is much more diffuse and less institutionally regulated than the environmental impact procedures (Wolf 1977). The discipline is currently undergoing growing pains characteristic of that experienced by biophysical environmental impact assessment in the 1970s (Conover et al. 1985). There seems to be an overemphasis in trying to legitimize the practice, leading to the notion that social assessments should be organized and conducted along the same standards and format of assessment techniques applied to environmental or economic impacts. The methods that emerge tend to emphasize the need to classify and quantify in order to produce a list of social indicators comparable to environmental and economic indicators. As a consequence, the application and search for an appropriate format for the analysis of social impacts is still emerging while some international developmental agencies are experimenting with social soundness reviews to broaden the evaluation of projects. The two types of impact assessments, environmental and social, are not yet amalgamated into a coherent and interactive framework. However, with the increasing need and the growing number of advocates for both, the process involving social and environmental impact analyses should continue to develop and influence river basin planning.

In general, all assessment procedures call for analysis of current social and environmental conditions in the area of the project and that possible changes due to the project be specified. In order to achieve some influence on

the overall feasibility of projects, requirements seek to introduce assessments as early as possible into the project planning sequence. Identifying possible adverse changes before formulating final designs or committing a specific location would facilitate a further objective of impact analysis to provide mitigating measures or modify designs to reduce potential negative impacts. Assessments have been the most detailed and comprehensive in identifying and devising measurements for impacted social and environmental factors. To accomplish this, techniques focus on the effective organization and display of classifications of social-ecological impacts. Based on past experience, impact classifications could become complex, reflecting increased knowledge about how a specific project scheme like dams and reservoirs could affect physical, chemical, and biological environments and relating this to specified impacted zones or areal boundaries.[5] Variations of methods and the organization of analysis applicable especially for environmental impacts is well documented (Munn 1975; Bisset 1980). These are generally typed according to methodological approaches such as: (1) checklists; (2) matrices; (3) networks; (4) map overlays; and (5) computer simulation.

Because of their origin as a compliance mechanism or regulation, the prescribed procedures for assessing environmental impacts were intended and designed to influence decision making and planning already pertaining to a fairly clearly defined project. This type of impact assessment which responds to development goals and projects that have already been defined tends to be carried out in isolation, producing a separate social or environmental analysis. This separation of socio-environmental accounting from economic evaluation can discourage the practical consideration of impacts jointly with economic feasibility studies which are determined before impact assessment results are adequately formulated. Instead, assessment requirements can act as an

incentive to make decisions sequentially, first, on the basis of identified economic gains with consideration of impacts on the physical and human environment in later stages. In such a planning and adjunct assessment process, there is little or no explicit trade-off among possible alternatives raised in the formulation and design stages. The onus of proof requirements concerning social and environmental factors identified as impacts are then such that an extremely strong case is needed to affect change, at such a late stage. At this point in large-scale water-resource planning, change is often costly and specific interests, national and international, are well entrenched, making it unlikely that the original development strategy and overall goals will be altered significantly.

To achieve a clearer focus on the explicit trade-off being made when evaluating multiple values and goals for development including impacts, an alternative approach to the separate assessment procedure calls for linking the study of socioecological effects directly to the exercise of determining economic gains and losses. As a consequence, social and environmental effects would be part of the feasibility test, that is needed to initiate any development planning process in addition to technically and economically justifying the project. Some would apply this environmental and social feasibility approach by tying it directly to the criterion of benefit-cost or multiobjective analysis and prescribing the necessity of weighing all the economic and noneconomic factors together (Knetsch and Freeman 1979; Loucks and Somlyody 1986). Shifting the focus of environmental analysis to a more inclusive project feasibility test rather than isolation of a separate impact assessment still requires a meaningful process of comparing values. Comparison of values is beset with difficulties. Social and environmental values are difficult to measure and when they are considered, they are often conflicting with each

other and with economic objectives. Indeed, the immediate economic gains associated with support of a large dam project may continue to be judged more important than any longer term, environmental or social loss, regardless of requiring that noneconomic objectives be considered.

The inclusion of social and environmental effects should increase the possibility that river basin planning must explicitly canvass a wider range of alternatives over a region that would be more likely to be less costly socially. This search in turn draws more attention to the plight of local resource users who stand the most to lose if such factors are neglected. In the case of river basin development, projects have been based on a narrow range of means, typically only a few feasible hydropower sites. If the economic gain is judged to be equally narrow when considering the heavy social and environmental damage or loss, the justification for constructing such a project will be far more dubious, thus increasing the possibility to reconsider the validity of water resource development as the predominant object of river basin planning; if such reconsideration is compelled to take place then the direction of basin planning would inevitably lead to experimentation with a more comprehensive, regional strategy in which water could play a secondary role.

CONCLUSION

The ideas and general practice of river basin planning according to this review have fashioned only a limited tool relative to the full meaning of a comprehensive regional development approach. Reviewing some of the central attributes of the evolution of applied river basin planning aids in explaining why the visionary concept of integrated river basin development, idealized in the beginning of the paper, remains unfulfilled.

The past record of developing river basins owes much to advances in technology which, while costly, have permitted large-scale regulation of water to serve national economic goals by primarily sparking the country's industrial development. The technological possibility of such transformation has stimulated decision makers to perceive the basin region in terms of relatively few sites to locate hydropower and irrigation control devices which offer immediate benefits from harnessing a basin's river "power." The earlier economic goals, available technology, and undeniable rate of returns from promoting particularly hydroelectricity production continue to shape the direction of planning for river basins and its transfer internationally.

The fundamental change that occurred over two decades ago -- that is, programming basin development so as to accommodate a diverse and multiple range of purposes within a single water storage project -- continues to influence basin planning throughout the world. Multiple-purpose schemes attract a broad constituency, but the importance of the idea is more applicable to basin development in the industrialized nations. The sheer quantity of economic resources for investing in such schemes and the degree of coordination it requires should continue to be difficult to accomplish in Third World countries under present conditions. Application of the multiple purpose strategy has not significantly led to acceptance of the idea for applying alternative means beyond water regulation to develop a basin region's physical and human resources.

The spread of unified basin administration is linked more to the need to optimally plan for the utilization of water resources rather than recognition that basinwide authorities should promote a comprehensive or multiobjective form of regional development. The basinwide administrative model of the Tennessee Valley Authority found expression in Third World countries. While similar Third World river valley authorities laid claim to promoting regional

multi-objectives beyond the immediate control of water uses, most of these institutions concentrated on dam construction for hydropower or irrigation.

River basin planning has adopted the rational, synoptic mode of regional planning, which best fits its role as a development strategy embracing the broad goals of an economic modernization policy without straying too far from its narrow construction-orientation mission. It shares some of the basic tenets of synoptic regional planning for development, assuming that socioeconomic change can be developed and guided by a centralized planning scheme, and that regional growth will result in improved social conditions as well as widespread economic benefits. The river basin approach to regional development is distinctive by predicating the region's development potential on its attribute of hydrological continuity and treating water as the key variable in promoting social change and economic growth. Water and efficient management of its uses, set the boundaries and criteria from which overall planning takes place including consideration of other initiatives in which water resources or river engineering is secondary.

Despite its narrowness in development objectives and inclination towards structural and technological programs, river basin planning has stimulated research and progress in developing planning techniques and raised concern about how to evaluate project costs and benefits. A prime motivation of public and private actors in basin development is to optimize economic benefits. To achieve economic efficiency, the technique of benefit-cost analysis has been widely employed in national and international river basin planning. Benefit-cost analysis assists decision makers in making the most efficient economic choice of projects which can best maximize net economic returns. The technique has undergone progressive refinement and some of this improvement is directly related to the experience and work of researchers associated with basin

planning. The problems of valuation, particularly measuring noneconomic values, have been recognized by the benefit-cost analysis school which seeks to improve project evaluation by developing multi-objective assessment techniques. Multiobjective assessment takes into account that decision making on river basin development does not select alternatives on the basis of a single optimum project, rather the selection process represents the best compromise choice. And choice is more often made among conflicting goals involving environmental and social values and dimensions in addition to judgments for economic efficiency. Applying the idea of multi-objectives, modeling techniques have been devised and applied to basin schemes which present the range of choices among differing development scenarios or packages containing a different mix of social, environmental, and economic goals, programs and projects.

Solutions for the problems of impacts and methods for social and environmental analyses were brought to bear on river basin planning largely because of requirements originating outside the traditional basin development process. Unlike the development of benefit-cost analysis, the application of environmental impact assessments as part of the basin development planning cycle was a response primarily to the requirements of international donors. The procedure they use requiring a separate impact assessment study is reminiscent of similar impact assessment procedures initiated under the United States Environmental Policy Act (NEPA), and is applicable when international funding affects project planning. The need to account for potentially adverse consequences is well substantiated by numerous descriptive studies documenting socioecological disruption and stress due to basin developments. The imposition of assessing environmental and, less frequently, social impact without the commitment to develop longer-range environmental or social goals to guide development tends to produce a separate impact analysis, distinct from the earliest planning

stage, and after the economic justification for a project has already been established. This separation of the socio-ecological from economic goals for basin development discourages the practical consideration of impacts jointly with economic feasibility studies. As a consequence, decisions to accept a project are made sequentially, first on the basis of economic gains with consideration of social and environmental impacts in the later stages.

An alternative approach to the separate impact procedure calls for linking the analysis of socioecological effects and prescribing social and environmental goals at the beginning of the exercise for determining a project's overall benefits and losses. Some would achieve this by converging economic benefit-cost or multi-objective analysis with socioecological analyses into a single feasiblity test and frame of reference for river basin development. This trend recognizes the need for a practicable framework which includes the objectives of economic efficiency but does not deny the equally legitimate river basin goals of serving local populations and applying resources for development beyond transforming rivers for power.

Notes:

1. There is extensive literature on the problems identified with the worldwide application of river basin planning and development (Lowe-McConnell 1966; Warren and Rubin 1968; Lagler 1969; Dasmann et al. 1973; Ackerman et al. 1973; Freeman 1974, 1977; and Goldsmith and Hilyard 1984).

2. According to Jose Goldemberg et al., "Hydropower is especially promising in developing countries, where only 7% of economical reserves have been developed. We assume that the hydropower share of global electricity increases from 20% in 1980 to 25% in 2020, by which time the worldwide level of hydroelectric development would be about half the level projected for 2020 by the World Energy Conference in 1980 or about one fifth the total technically usable hydroelectric potential (87)." "An End-Use Oriented Global Energy Strategy," pp. 613-88 in Annual Review of Energy, Vol. 10, 1985. Edited by Hollander, Jac M. et al. Palo Alto, California: Annual Reviews Inc. On hydroelectricity, see The World Bank, A Survey of the Future Role of Hydroelectric Power in 100 Developing Countries. Washington, DC: The World Bank, 1984, p. 9.

3. Economic Commission for Asia and the Far East, Multiple-Purpose Development Part 1, p. 78 (U.N. Publication No. 1955, 11 F. I.).

4. 49 Stat. 69 (1933), 16 U.S.C. 83 IU (1952) in Gilbert White, 1957, 172

5. One such classification details impacts specific to large dam projects and is presented by Peter Freeman, The Environmental Impact of a Large Tropical Reservoir, 1974, p. 12.

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AFRICAN RIVER BASIN PLANNING

by

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INTRODUCTION

This paper discusses the problems facing certain institutions involved in river basin planning with emphasis on the institutions and situations that are of importance in Africa. Specifically, it will deal with those institutions that are usually engaged in basin planning on a national or regional scale such as river basin authorities, their local or expatriate consultants, and ministries with broad planning authority. The paper provides a general model of a planning process identifying the generic functions for river basin planning. It can be used as a reference for measuring actual performance and to assist in institutional analysis in the field. Finally, some broader comments are presented on the planning process in general, in the underdeveloped world and in Africa as culled from the literature available.

River basin planning in Africa, from the national or regional viewpoint is conducted usually by institutions internal to the region such as river basin authorities and ministries, and institutions of external origin such as engineering firms and other professional contractors. Their actions are usually strongly influenced by such groups as the World Bank, other bilateral and multilateral donors and by multinational firms. Planning should consider all interrelations between man's needs and works, and nature; among different parts of man's needs and actions; among different places; different times; and different groups of people. Planning is a process that should lead to action. As a process, it is continuous and should involve consideration of all phases of the planned action. While planning theoretically is a continuous process, practical limitations usually focus on a plan, which could be considered a picture or snapshot of the process at some moment in time.[1] This utopian approach to planning must yield to reality and boundaries must be drawn that

limit the planning effort spatial, temporal, and often sectoral. The practical limitations are particularly important when one considers planning in Africa. Limitations of managerial capability, in available trained manpower, in available data, and in the peculiarities of African geography, climate and culture must be carefully considered in every step of the planning process. "Planning," "Regional Planning," "River Basin Planning," "Water Resources Planning," and "Project Planning" can be considered each as a subset of the aforementioned term. Water resources planning within river basin planning and its relation to other aspects of planning and management are the focus of the remainder of this paper. The next section of this paper will cover some of the general problems in river basin planning in Africa, while the following one will break river basin planning into its components, emphasizing water resources planning and its relation to water project planning. The final section will present a first cut of an interview guide for fieldwork specifically directed towards the local or expatriate technical planner.

PROBLEMS OF RIVER BASIN AND WATER PLANNING

The concept of a region defined by the watershed of a river or river system as a planning unit has been in vogue, more or less, since the beginning of the twentieth century when the notion that such a physically defined boundary would make a viable planning unit was first introduced. It appeared very reasonable then, as almost all population centers developed at and expanded from the banks of a river, a river that was a source of water and power and an avenue of commerce. Human development, political boundaries, and the ability to transfer resources between regions have diminished or at least limited the use of hydrologic boundaries as the only limits of a planning unit. River basin and, by extension, water resources development plans must consider economic, political, and social divisions that may encompass an area greater or smaller than the hydrologic basin. Further, the transfer of water by man-made means, as well as the movement of energy, other commodities, and people in or out of a river basin as well as natural water transfers, usually by subsurface aquifers, must also be considered. Equally, the territorial limits of national, regional, and local governmental agencies may define the planning area. Thus, the region under consideration by the planner may have a number of boundaries for different purposes or functions.

The setting of boundaries for river basin studies is an important step. The fewer externalities that must be considered the better will be the planning effort. National boundaries must always be one set of boundaries. Other administrative boundaries are equally important. This is made necessary by the fact that project development and management must be carried out by institution, often more than one, that fit into the existing pattern of the administrative order. Special agencies formed may plan or give overall direction, but

day to day management, if not carried out within the existing administrative framework, is likely to fail. It is, therefore, necessary to define the river planning area by overlaying political boundaries and drawing a new basin outline following those boundaries as close as possible encompassing the hydrologic basin. Economic boundaries of the planning area may often be even more different than the hydrologic ones. In many basins the area to which benefits accrue, especially from the generation of hydroelectric power, may lay at considerable distance from the hydrologic basin. Also, the markets for the products of irrigated agriculture may be, to a large extent, outside the basin. This does not indicate that one must include the whole world into every basin study if export products may be involved. The economic boundary should incorporate those areas where their economic and demographic conditions directly and significantly affect the type and degree of basin development. Long distance exports then are treated as economic externalities. Finally, social, ethnic, and cultural boundaries may have to be considered. It should be recognized that whatever set of boundaries are established, some awkwardness will be experienced during the planning, and changes in the boundary definition during planning are the norm rather than the exception. African conditions make the consideration of nonhydrologic boundaries especially important as development projects and their beneficiaries are often distant, population shifts are often contemplated, and cultural differences are great.

Water planning, that is, the planning for the management of water on the surface of the earth, became synonymous with river basin planning and the planning of specific projects to serve the region's water management needs. This period was also the time of unprecedented technological advances in man's ability to shape the environment; technological fixes for development problems

through the solution of water problems with major construction projects became the norm for river basin plans. This approach continued almost unabated into the late 1940s in the developed world and is still the norm in the underdeveloped parts of the globe and especially in Africa.

It cannot be stressed enough that planning for a major dam is not water resources planning, and water resources planning is not river basin planning. Each of these is a part of the other. The United Nations Industrial Development Organization (UNIDO) recommended the consideration of the following objectives of water resources planning for developing countries:[2]

1. Aggregate consumption,
2. Income redistribution,
3. Growth rates of national income,
4. Employment level,
5. Self-reliance, and
6. Merit wants.

As can be seen from this list, water is not even mentioned once, nor is any specific structural or managerial device. The objectives of water planning are social objectives, the achievement of which water is an important ingredient.

Water resources planning is planning for the advancement of goals set for the region through the management of the waters of the region either by structural measures or by management and legal techniques that do not require constructed facilities.[3] A Consulting Panel on Water Resources Planning to the US National Water Commission (1972) suggested eight criteria for a "good" plan. These were:

1. Be a document that is, indeed, a plan, including display of alternative courses of action and recommendations on the desired course of action in terms of explicit structural and nonstructural measures.

2. Meet stated goals.

3. Cover a rational planning area.

4. Have adequate detail to fit the type of action proposed, depending on whether it is a policy, framework, appraisal, or implementation plan and whether it is functional, sectoral, multisectoral (land use, water resources, energy supply, etc.) in scope.

5. Fit into a multisectoral plan, or anticipate the components of such a plan.

6. Illuminate the alternatives that were considered, including the advantages and disadvantages of each.

7. Equitably allocate the resources, based on reliable information on direct and indirect costs, economic benefits, and intangible consequences.

8. Have proper balance to meet uncertainties, by devising plans that maintain flexibility, so that adjustment to future conditions can be made readily and irrevocable allocation of water resources can be avoided.

While these criteria for a good plan were developed for the United States, they are equally applicable in the underdeveloped world, at least in general terms. There are, of course, significant differences between plans prepared for an underdeveloped country from those made for a developed one. Aaron Wiener (1972) states[4] that the differences between the planning processes of underdeveloped and of developed countries stem from major structural differences between the two types of economies. These differences indicate the need for:

1. To plan and organize public intervention for viable transients in all planning dimensions in the underdeveloped world, instead of planning only for a final target in the physical investment dimension, as in the developed world.

2. To plan and implement upgrading of transfer functions (i.e., functions brought into play by the application of resources inputs, that result in desired outcomes) in the underdeveloped countries instead of operating with practically unchanged transfer functions, as in the developed countries.

3. To rapidly overcome the lack of parametric information in the underdeveloped countries through the implementation of pilot projects, as

against the situation in the developed economies where such information can usually be assumed to be available.

4. Finally, to allow for the fact that response lags in a number of vital nonphysical dimensions are of far greater importance in the underdeveloped countries, whereas in the developed countries, responses are as a rule, adequate.

Related to the criteria for a good plan set forth for the US National Water Commission, Wiener's statements call for maximum flexibility in any plan prepared.

The point mentioned by Wiener as desirable in an underdeveloped country are often extremely difficult to achieve in Africa. This is mainly related to the limitations in the managerial capacities of existing African institutions on all levels from the national to the local. This requires judicial adaptations of and shortcuts in the planning process, and/or the upgrading of the available institutions.

WATER RESOURCES PLANNING

Water resources planning, within the context of river basin planning encompasses planning for all the uses of water, for the protection from water and planning for the land uses closely related to water. This indicates that water resources plans must consider: withdrawal uses, such as water supply for human and industrial use; irrigation and interbasin transfer; instream uses, such as hydroelectric power generation, recessional agriculture, fish and wildlife propagation, and navigation and environmental objectives; protection measures, such as land drainage, flood protection, bank and overland erosion control; and land uses that affect the water resources or are affected by them. As important as the consideration of the full range of uses for water (the purposes of water resources management) is the consideration of the full range of technologies available to serve these purposes. Dams and reservoirs are only one of them. Other structural measures are intakes and diversion structures, pumping stations, canals of various sizes, treatment plants and drainage facilities. Of equal importance are the nonstructural measures, including management schemes that either reduce demand or increase efficiency of water use, legal and institutional changes, training and education. The key thought here is that all purposes and all technologies are initially of equal importance, be they large or small. It is further important to remember that planning, as it progresses must focus on the broadest time horizon within which the water resources plan is expected to function.

In the African context the planning for institutions using water may have to precede the water resources planning process. This process can be divided into seven major elements.[5] These are:

1. Establishment of goals and objectives -- broad policies; legal and other constraints

2. Problem identification and analysis -- collection of data; projection of demand/supply relationships; uses of water and land; opportunities for development and management;

3. Solution identification and impact assessment -- structural solutions; nonstructural (management) solutions; preliminary assessment of impacts;

4. Formulation of alternatives and analysis -- criteria and procedures for comparison of alternatives; formulation of alternative systems of structural and nonstructural measures; detailed assessment of impacts;

5. Recommendations, including priorities and schedules for implementation;

6. Decisions; and

7. Implementations -- organization for action, if required operation and management.

On a practical working basis, these elements must be further broken down into smaller ones. As previously stated, the entire planning, design, implementation, operation, and maintenance process of water management must be considered in planning. It is, therefore, necessary to describe all the stages of this process in somewhat greater detail. In this report, the entire process is broken down into twelve stages, many of them with several substages. The first six are the planning phase, followed by design, construction, testing, operation, review, and rehabilitation stages. It should be re-emphasized that this view of the water resources planning process is taken from the viewpoint of one particular institution, that of the local or contract planner and engineer.

Pre-planning Stage

This is the initial phase of planning leading to the decision to employ technical expertise in a more formal planning process.

The Perceptual Stage

This refers to the initial phase of pre-planning. In this phase, a problem is recognized, or a "grand vision" may be formed in the mind of a top decision maker, like a president, prime minister, or king. However, experiences in Africa indicate that ideas for individual large projects, often developed by explorers and geologists as well as by political figures and promoted by national and expatriate commercial interests, provide the first impetus for a basin plan.

The Conceptual Stage

The second phase of pre-planning. In this phase a concept is developed and agreement reached on a ministerial or similar level. Questions answered in this phase in a very general way are:

Why (abstract objective)

What (concrete idea)

Where (spatial location)

When (time dimension)

Who (finance and manage)

Here technical experts, as advisors to the ministers, should first be introduced into the process.

Goal Formulation Stage

Societal goals are set in this stage, such as improvement of the living standard, the increase in national income, the redistribution of income to certain areas or groups, or the improvement of the environment of an area. These broad goals are then translated into sectoral objectives, such as those

related to water, that will assist in reaching the broad goals. Water objectives must always be described in quantitative terms that set forth quantity, quality, location, and time. This activity requires close coordination between technical experts, national regional government, and if possible, the people likely to be affected by the development.

The two stages described above are often not recognizable as distinct steps in the planning process. Often they occur only in the mind of as planner or decision maker. In spite of this, they should be recognized as very important as they will set the pattern for much of the work that will follow. Questions raised in discussions by the prospective donors could be used to elicitate the information these stages should produce and thus make the development concepts and objectives explicit.

The Inventory Stage

In this phase of obtaining baseline data, it is important to scope each inventory such that only those data considered absolutely essential for planning and decision making are collected. This is not to be a complete inventory of all data for a basin. Again, cooperation of experts and indigenous personnel is needed and maximum use should be made of indigenous expertise.

Inventory of Needs

The determination of specific, quantified needs that the program should provide. Number of cubic meters per day of water, miles of feeder roads, or limits on cattle to be provided for, are examples. For each need, in addition to magnitude, quality of water, location of the need, and time by season must be specified. Demographic and economic studies are needed in this phase as the

basis for projecting needs over time. Usually needs should be projected for up to 50 years. It must be recognized that such projections are very tentative and upper and lower limits of likely development should be developed and considered in planning. Boosterism, that is, making pie in the sky estimates of growth and development, are major dangers here.

Inventory of Resources

The assembly of data on the "how much, what quality, where, and when" of water. This refers to data on land conditions and use, manpower and their training levels, economic activities, and finances available. Physical constraints on development are determined. Projections of likely trends in this data over time without the development activity contemplated for up to 50 years are part of this inventory.

Inventory of Devices

Data on all structural, managerial, legal, educational, and economic means that could possibly be brought to bear on the problem in the region investigated. Special attention must be given to constraints imposed by limitations in planning and management capabilities as well as in the application of technology due to the availability and training levels of human resources. Limitations due to climate, other physical factors, social and cultural conditions further limit available options.

Socioeconomic Setting

An inventory of pertinent information on the existing social organization, cultures, and production and marketing systems of the area likely to be affected by the development.

Environmental Setting

Baseline data on environmental factors including, but not limited to, climate, flora and fauna, areas of special scientific or scenic value, and health conditions.

Institutional Setting

Data on the existing institution that may be affected by the development or may affect it; their formal and informal decision processes and the personalities involved in it.

Technical Planning Stage

In this phase, the expertise of engineers, social and political scientists, agronomists, and of managerial, financial, legal, and institutional specialists is brought to bear on the planning problem.

Review of Goals

The social goals, sectoral objectives, and inventoried needs should be reviewed in the light of the already assembled information and, if necessary, reformulated to adjust them to the now better known conditions. While this is very desirable, it is often impossible to change preconceived ideas on goals and objectives.

Development of Alternatives

Alternative ways of fulfilling objectives are developed in this phase. Alternatives should be based on different levels of objective attainment and on different technologies, location of projects, and timing of implementation. A "no action" alternative should always be considered. Each alternative should include at least the needed projects and the institutional and managerial requirements for their implementation. Projects include structural and non-structural devices to reach set goals. The studies to accomplish this development of alternatives are engineering studies combined with agricultural, economic, environmental, and social ones. The preparation of a mathematical model for screening of alternatives using linear programming techniques and for project testing by simulation can be very useful and should be attempted if data availability and the availability of trained people make them feasible. Costs of implementation, in only general terms, must be estimated for each alternative.

Evaluation of Alternatives

In this phase, each alternative is evaluated to determine the effect each alternative has on the environment, the social and economic structure of the basin and other related regions. Effects at this stage are broadly described and their magnitude, probability and time of occurrence, permanence, and spatial or human group distribution estimated. The impacts of the effects on the goals and objectives are tabulated as benefits, if they contribute to the achievement of the goals, or as costs if they cause damage to a goal.

The Refinement Stage

Public Review

While broad public input into the planning process should have been a part of it at all previous stages, again opinions should be solicited from all public groups, including national leaders, donors, and local citizens in the affected areas, as to the desirability and viability of the alternatives defined in the previous stage. In this phase, other previously unacknowledged goals are evaluated to understand the impacts on those goals by the effect of the development.

Selection of Preferred Alternatives

Based on the public review and the judgment of the planning team, a limited number of alternatives, usually not more than three, are selected for more detailed analysis. This selection should always be reviewed with the senior decision maker and, if needed, adjusted.

Reformulation and Re-evaluation of Selected Alternatives

Alternative plan formulation and evaluation is repeated using criteria established in the previous stage, but in greater detail, accuracy, and quantification of benefits, costs and impact.

This refinement stage is of great importance as it reduces the alternatives to a number that the final decision process can absorb. However, if this pruning is not done judiciously and with the full cooperation of local leadership and citizenry, the decision process will be distorted or completely derailed.

The Decision Stage

The decision to go for implementation is made in this stage. Decision should be based on agreement, as nearly as possible, between all those involved in, or affected by the development.

Final Plan Selection

With the assistance of decision makers on all levels, and with the participation of all affected, the alternatives most favored, or a single variant or compromise, is selected.

Final Plan Development

If needed, final changes are made in the plan and on the evaluation to conform to the selection made. At this time, institutional, financial, and legal requirements are reviewed to insure that there are no major obstacles to implementation. An at least preliminary, institutional design must accompany the plan at this stage. This should spell out the overall organization and the relationships between institutions involved in the design, implementation and management of the river basin plan.

The Design Stage

The output of this stage should be tender and other implementation documents including designs and specifications for construction projects, institutional, managerial, financial, and education plans as needed. Selection of contractors for all phases of the project is made and final steps are taken for defining the powers and duties of the organizations charged with or established to carry out the execution of this phase and to supervise the contractors.

Plans and Specifications

These must show in great and clear detail all the parts of the proposed project. Plans and specifications should be prepared in units of the overall project, units that will be put out for bids and construction. It is, however, very important that consistency is maintained between the units both as related to functions and quality, and as to proper time of execution. Specifications must both be strict and attainable and should not be written, normally, with one product or one supplier in mind. This is equally important for completely open bids, as for bids when the country of origin may be proscribed.

Selection of Contractors

For professional contracts, the selection criteria should be the ability and reputation of the contractor, not the bid price. It is extremely important that during negotiation with a professional contractor the name of the responsible partner and the senior team members, and the effort expended by these named individuals is agreed on and contractually fixed. For construction contracts, the bid price is the key selection criterion, but contractors' reputation, capability, and financial soundness must be first established for a bid to be actually considered. Care in reviewing bids is important to insure that the bidder understands the specifications, does not bid for work in violation of specifications, and, if it is a unit price bid, does not submit an unbalanced bid. Whenever possible within the above stated conditions, local contractors should be used, or at least joint ventures between western and Third World consultants and firms.

Preparing an Institutional and Financial Plan

At the same time that technical plans, both structural and managerial, are prepared, institutional arrangements and financial agreements must be firmly established. They should include: assignment of responsibility and authority for all foreseeable aspects of the project; clear understanding of the role of each national, regional, and local participant; a restatement of the objectives of the river basin plan; a preliminary assignment of outputs and costs to all the participants; and an administrative structure. Whenever possible, existing organizations rather than new umbrella bureaucracies should be used. Financial plans must include: source of funds, cashflow, and accounting procedures.

Developing a Training Plan

The training plan must be based on the requirement of turning the project over to local people as soon as possible. This requires the establishment of training positions in the planning organization now for individuals that will become senior staff and executives in the operation phase of the projects, and the establishment of training schools and curricula in institutions of higher learning. This training and education effort must cover the full spectrum of needed skills from mechanics to engineers, economists, agronomists, and administrative professionals. Training should be on site if possible or in the country of the project. The use of western facilities should only occur if a clear and undisputable need for such training can be established.

The Construction Stage

This stage covers the entire period of development of the river basin project. It, therefore, will overlap significantly with both the design stage,

projects may be built as soon as their designs and specifications are complete and they are required in the overall plan and with the testing and start-up stage as each element of the river basin project comes on line.

Mobilization for Construction

The period of bringing together people and equipment for the structural part of a river basin project is a socially very sensitive time. The superimposition of the construction organization on the local social and economic order is usually a great shock and if not handled carefully can cause long-term animosities that might well affect the project outcome. The laying of sufficient groundwork before any influx of workers and machines, the use of local labor and local leaders in the mobilization, and most of all the availability of some immediate and visible benefits that are perceived by the local inhabitants are helpful here.

Construction

Close and adequate supervision of construction is the key to a well-built project. Supervision must insure strict adherence to specifications both for materials and for methods employed. Supervision must also insure fair treatment of workers and maintenance of their health and safety. Furthermore, the relation between the construction process and the construction personnel must be closely monitored if serious problems are to be avoided. The maximum possible attenuation of construction nuisances: noise, dust, destruction of range or cropland, must be a priority item for the construction management. Selected local individuals, that will become operators and managers of the project, should be in this phase involved in the construction so that they are fully

familiar with the works and have a personal identification with the project. The indigenous management agency, the design consultants as well as the construction contractor must cooperate in the supervision process.

Demobilization Stage

People must be prepared for this stage and the removal of the construction organization from the site must proceed in steps and not abruptly. It is essential that something visible and valuable is left behind for the local inhabitants, such as usable infrastructure artifacts, health facilities, and community buildings. Furthermore, the changeover to the testing and operation phases should be prepared at this time.

The Testing and Start-up Stage

Each element of a river basin project should go through a testing and start-up period before becoming fully operational. This stage is also the most important training period for the local operators and the maintenance personnel.

Inspection and Testing

Each element of the overall project must be inspected and tested against the specification given. The construction organization, the original designers, and the management agency should be involved. Deviations should be noted, their importance determined and corrections made, if necessary.

Start-up

This is a repetition of the previous activity, except that instead of each element the entire project as a unit is tested, evaluated and put into operation. Users of the project output should at that time be prepared to beneficially use at least some of the output. This requires coordination with other projects implemented in a river basin plan.

The Operation and Maintenance Stage

Initially operation and maintenance may be a joint venture between the local operating agency and foreign consultants and contractors. Transfer of responsibility completely to the local management agency should occur as soon as possible. The keeping of detailed and accurate operations and maintenance records is essential and their importance cannot be overemphasized. Periodic inspection and preventative maintenance schedules are as important as the prompt repair of damaged or inoperable elements of the project. The stock of spare parts and the supply line for parts must be preplanned for timely maintenance.

The Review and Adjustment Stage

At preset intervals, probably after one year first, and at subsequent three to five year intervals, the entire project should be inspected and its operation evaluated. At the first interval, the one year review, the emphasis should be on the physical aspects of the project, its operation, and maintenance. At the subsequent ones, the emphasis should be on the benefits derived, the costs incurred, and the maintenance performed. These inspections and reviews should be carried out by a task group from the designing consul-

tants, the donors, the national supervising agency, and the local managing agency. This is also the time at which changes in operation can be suggested and accepted if changed conditions warrant and major replacements of units be arranged.

The Rehabilitation Stage

Even with proper maintenance, parts or all of the projects within a river basin plan will deteriorate over time. Consideration should be given initially to eventual complete rehabilitation of any project when the time for such action arrives. To do this, the institutions to initiate and manage rehabilitation should be from the beginning in place with the proper authorities to perform this task.

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