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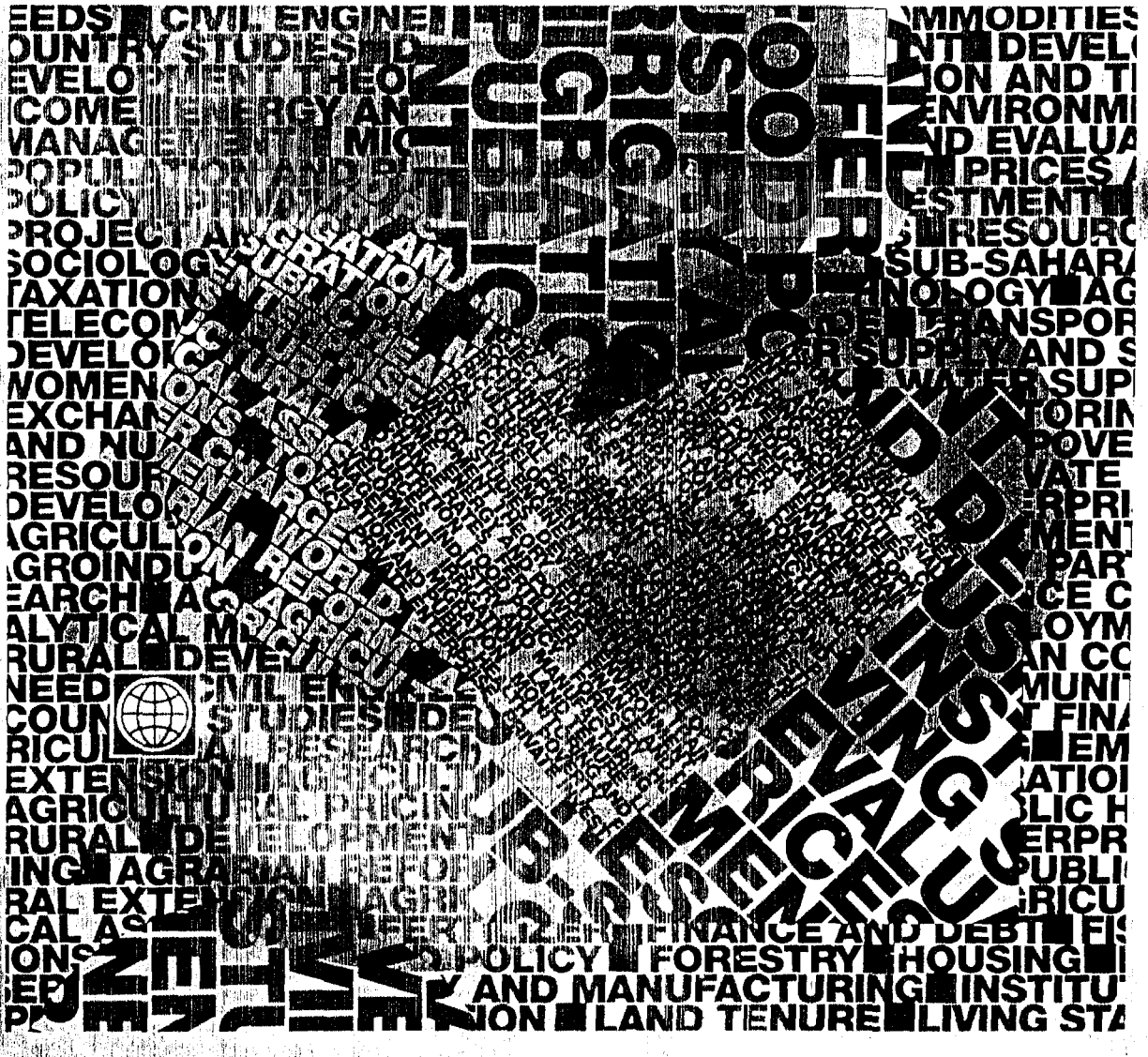
Principles and Practices for Dealing with Water Resources Issues

Harald D. Frederiksen, Jeremy Berkoff, and William Barber



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ABSTRACT

The dominant water resources issues and the principles and practices proven effective in dealing with the issues have been placed in four categories: Institutional, long-term management and planning, real-time management and operations, and financial. Such an arrangement provides a perspective for examining issues across all economic sectors and allows formulation of solutions that will constitute a truly comprehensive, balanced approach to the situation encountered in managing these resources. The presentation reflects information gathered from various sources, most important being, a review of current successful resources management in numerous countries throughout the world that identified basic principles and best practices that apply across a range of governmental structures, cultures and physical conditions.

FOREWORD

The World Bank has been engaged in water resources development and management since its inception. Nowhere has the impact of this program been greater than in Asia. It has helped provide adequate food for the population (about 52 percent of the world's total), water for its immense urban centers and energy that both improves the people's quality of life and underpins the region's overall development. Several of the countries are emerging from conditions of extreme poverty to participate in Asia's accelerating economic growth. But the task of timely, effective development and management of water resources is far from complete.

Indeed, it is this very growth in Asia's population and economic development that has multiplied the demands on water resources. In the case of water supply today, these demands are exceeding availability in several areas. And the excess demand applies against normal runoff creating conditions for disaster under the inevitable drought conditions that will occur. These countries now confront requirements that cannot be met by additional development alone. New institutional arrangements, more sophisticated management and altered uses of water are essential to meet their needs.

The report, Water Resources Management in Asia, will serve as one of the references for formulating the type of changes that can meet this challenge. It identifies and categorizes the problems and issues from a broad perspective on water resources management. Building largely on the experiences of successful management elsewhere, alternative programs and projects are set forth within a framework of proven practices. But improvement in water resources management can only be realized if the leaders of the individual countries and participating agencies have the foresight and political will to aggressively address the most daunting issues -- many of which are very unpopular. Otherwise, reports such as this are of little value.

Annex 1 to the report, Water Resources Management in Asia, details proven principles and best practices for dealing with the primary issues encountered when instituting effective, comprehensive management of water and related resources. Its focus includes the issues set forth in the Bank's water policy paper examined in the context of the situations found in Asia, though the cited principles and practices may apply more broadly. The variation of existing institutions and cultures found among nations requires that the set of actions and the time frame for its enactment, though built upon proven principles and practices, must be tailored to each particular country. The consequences of misguided actions demands that society and its leaders carefully consider all aspects. The set of actions finally adopted must be practical and "doable" within the time and means available to the individual country.

Daniel Ritchie
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INTRODUCTION

This report is Annex 1 of the Bank's Technical Paper No. 212, "Water Resources Management in Asia : Volume 1 - Main Report."

Every country is confronted with problems pertaining to the management of its water resources. Some of the problems have straightforward solutions, though the countries may lack funds. Most problems, however, entail issues that warrant debate yet remain undebated, and proposed policies are found to be counter to those generally professed. Common issues include the allocation of resources, mechanisms for managing resources, social equity, regional stability, poverty alleviation, the responsibilities of government and the private sector and ways to finance the costs of a given action. Indeed, issues multiply as resource constraints increase and the environmental objectives become more explicit.

Unfortunately, policy debate often commences in limited subject areas before many of the preconditions that should form the basis for the discussion have been resolved. The extent of the resources and their allocation must be established before development can be efficient, organizations can be structured or management mechanisms devised. Longer-term goals and plans are essential guides for the formulation of effective, consistent near-term plans and real-time operations. And, of course, all programs and responsibilities, including the responsibilities of the beneficiaries, must be decided before financial policies can be detailed. Thus, each issue and each proposed policy must be considered in the context of all other issues and policies. The issues and policies in the following paragraphs are presented in the general sequence in which they should be resolved, with the understanding that many policies, because they are interdependent, are formulated concurrently.

Policies may be formally stated or they may be only implicit in an agency's actions. Typically, both in developing countries and in lending agencies, internal guidelines in the water resources area are limited in scope and vague in content. Though some aspects receive considerable attention, key areas remain unaddressed or lack sufficient detail to guide staff in formulating programs. For example, although data collection may be inadequate to measure and assess environmental conditions or even to devise sound projects, no policy is enforced to remedy the situation. Proposals to address water planning and management at the basin level as a precondition to sound project planning and operation have met with indifference or outright opposition. Fortunately, this situation seems to be changing.

Some countries have evolved an extensive framework of policies and enacted measures that, in their view, are essential to manage their water resources. By contrast, others lack these and now must formulate detailed policies to address the more difficult water problems that have resulted. General policies do little but further postpone crucial decisions. Difficult as it may be and agonizing as the debate will be, developing countries must take action to better meet their responsibilities. And that requires prompt formulation of specific policies in the entire water resources sector. Similarly, some believe that assistance agencies should not set forth detailed policies to guide staff in advising borrowers on actions pertaining to water development and management. But is this sensible in light of the results of past efforts during simpler times and the conditions that must be dealt with today?

This paper presents a detailed set of Recommendations to address issues in the principal water resources management areas (and the related land resources issues) to serve as a framework for formulating and executing policies, programs and projects. These Recommendations have been distilled from a number of references. A primary source is the topic papers prepared under the Water Resources Management in Asia, which are among the references listed. These, in turn,

are founded on the experiences of countries successfully dealing with their situation. Further information may be found in those reports.

The proposals are forward looking and form a practical set that will deal with the crucial problems in a way that will best sustain development into the future. The principal issues common to many water-related problems are identified and constitute the basis used in this paper for considering water resources development policy options. The list is extensive, as each issue has been narrowly focused to facilitate debate and the formulation of unambiguous Recommendations. The issues and associated proposals are grouped in the categories selected for framing the presentation in the following chapters of this report: Institutions; Resources Planning and Long-term Management; Real-time Management of Water Resources; and Financing Aspects of Water Resources Programs. Each issue is briefly discussed followed by recommended actions. Some apparent repetition was found necessary to assure each area is addressed in a comprehensive chapter that can essentially stand alone.

1

INSTITUTIONS

I. PREAMBLE

The institutional policies cover such matters as resources allocation and rights, resources monitoring, standards and regulations, government and nongovernmental roles, and organizational structure and responsibilities. The first issue is, perhaps, how the entire institutional area should be addressed. Then, the resources ownership area should be confirmed. After resource policy is set, policies on the standards and regulations for measuring compliance and for monitoring conditions can be formulated. Lastly, the policies on government/nongovernment responsibilities, organizational structure and responsibility for managing the resource can be devised. The issues and proposed policies are presented below under five groups: General; Water Resource Allocation and Rights; Standards, Regulations and Administrative Rules; Resources Monitoring and Data Compilation; and Government/Public Responsibilities. (Further details on this subject may be obtained from World Bank Technical Paper 191, "Water Resources Institutions: Some Principles and Practices.")

II. GENERAL INSTITUTIONAL ISSUE

COMPREHENSIVE MODERNIZATION OF INSTITUTIONS

People see a need for various changes in the institutional area of water resources. Those frequently cited include the contention that existing water rights should be altered; water should be priced on a different basis; operation and maintenance (O&M) of government-built systems should be shifted to beneficiaries; agencies should be decentralized and functions should be consolidated. Unfortunately, problems are frequently addressed in isolation and solutions formulated without an assessment of their impact on other aspects of water resources management. Often narrow issues are resolved on a basis of urgency largely because comprehensive institutional reform is considered to be too difficult.

It is generally agreed that the major causes of problems in the entire water resources sector stem directly from a number of institutional deficiencies and that the solution to these problems is to treat the sector in its entirety. The deficiencies are inevitably interlinked throughout the country's legislation, organizational structure, rules and procedures and the exercise of public/governmental responsibilities. Consequently, the remedy entails an all-encompassing approach. The nature of reform of water institutions demands a will to attack the situation in a coherent, comprehensive manner. There are no piece-meal or simple solutions. Though several developing countries have started to change their institutions to better meet today's demands, even they would benefit from a broader view. The first step is to formulate a framework for institutional reform to guide all activities.

Recommendation

Borrowers should initiate a comprehensive review to reform their water resources institutions, including legislation, policies, the functions and organization of government and the participation of the public and beneficiaries. A commission composed of government officials, academics and outside specialists should be created to draft a set of Recommendations and a framework for action. The Bank could assist in the exercise by examining the borrowers' water institutions and preparing detailed discussion papers with proposals for change. This would open

a dialogue with the borrowers so that aspects of change could be incorporated into existing and proposed Bank lending.

III. Water Resources Ownership, Allocation and Rights Issues

Issues of water resources allocation objectives, water allocation mechanisms and water rights are often introduced interchangeably in debate. Most often, allocation mechanisms are put forth without a clear statement of national allocation objectives or an understanding of how the mechanism will, indeed, help to effect national objectives. And water rights are formulated without a clear decision on the combination of allocation mechanisms to be adopted. Care must be taken to distinguish among these. For the purpose of discussion, it is assumed that the nation owns the water resources. This is true in most developing countries.

Water Allocation Objectives

Water allocation among categories of uses involves a political decision that reflects broader social, economic, environmental and security objectives. Indeed, in every country most water is allocated directly through project authorizations by the legislative bodies -- the legislation both states the objective and serves as the allocation mechanism. Water, after all, is only one resource whose availability and cost affects broader economic growth, human well-being and the environment. Water allocation objectives may be stated in terms of general priority of use at the national level, but they are often made more specific or modified at regional or basin levels to reflect local conditions and objectives. The linkage for meeting land-use objectives is often implicit, particularly when the objective is to control pollution or meet environmental purposes.

Water allocation should support long-term goals and related investments, optimize overall benefits by mixing complementary uses, have geographical bounds that facilitate administration and be flexible enough to meet interannual variations. Water allocation should ideally incorporate a review/renewal mechanism (such as multiyear licensing) so that the changing priorities of future generations can be accommodated. The specific economic objectives -- be they directed sector development, regional strengthening, equity, poverty alleviation or efficiency of returns on unit of water -- must be decided and clearly stated so that the allocation mechanism selected is compatible with and will help to meet the adopted objectives. Water allocation mechanisms cannot be considered productively without clear, unambiguous allocation objectives firmly set forth by a country.

Recommendation

In order to address this issue, borrowers should formulate detailed allocation objectives in economic, social and environmental terms that may be readily understood by the public and can be effected through public and private actions. Explicit interdependency with land use and other resource allocations or rights should be set forth. Particular attention should be given to assure that the allocation objectives are presented in terms that allow factual evaluation of the appropriateness and effectiveness of potential allocation mechanisms.

Proportioned Allocation of All Classes of Priority Under Normal Hydrologic Conditions

Most countries set general priorities for water to meet the diversion needs of communities, industry and agriculture and the needs of various instream uses. The allocations based on these priorities will be different in periods of normal and of abnormal supply. Thus, the allocations of a given fully committed supply are shifted without question to satisfy high-priority needs as they expand. Sufficient attention, however, is not given to the effects of such resource

reallocation policy under different hydrological conditions, specifically in periods of normal conditions and in periods of prolonged drought. As stated, as demands grow and exceed supply, resources are shifted to the higher priority users, permanently increasing the absolute volume of the resource upon which high priority users rely. In an extreme situation, all of a resource available in normal years is used to meet highest priority community needs. However, when large absolute volumes of a given resource available under normal conditions are committed to priority uses, severe stresses will occur during droughts on even the highest uses. There will be no cushion of low-priority supplies available to temporarily divert to the higher need. Both economic and human crises will arise, particularly in the urban areas in developing countries, where systems have little internal luxury uses that may be cut back. A more prudent management and resources allocation policy is based on meeting high-priority uses in times of prolonged droughts and allocating the excess under normal conditions to progressively lower priority uses.

Recommendation

Borrowers should take account of the possible impacts of severe droughts when allocating water resources. They should ensure that priority uses can be met under such conditions and should permit no further commitments of that type that would exceed that limit. Additionally, plans for the long-term management of the water resources should clearly define proposals for meeting priority requirements under conditions of extreme shortage. Permanent allocation of supplies among the range of priorities from the highest to the lowest under normal conditions will necessitate firm policies and enforcement of land-use and urban growth limits.

WATER ALLOCATION MECHANISMS

Countries have adopted a variety of water allocation mechanisms to attain their water allocation objectives. The most commonly applied mechanisms are designated use by legislation; riparian land ownership; rigorous priorities of use; "first-in-time, first-in-use" appropriation and a limited-period use. As noted previously, because allocation objectives change through time, allocation mechanisms also may have to change.

Currently applied mechanisms usually reflect the type and location of uses, including consumptive or nonconsumptive uses and diverted or instream uses. An allocation mechanism may simply consist of regulations that set priorities among categories of use of whatever water is available at a given time. These regulations may dedicate a proportion of water for each category of use and include more elaborate allocation mechanisms for the users within each of the categories. There may be a changing share among users as resource deficiencies occur -- long term, annually or seasonally. Although the environmental needs often do not have to compete, the mechanism for determining their allocation must be clarified.

The use of free-market mechanisms has been proposed for guiding water allocation. Conflicts with other objectives and issues of market failure and pervasive externalities, however, rule out economic efficiency pricing in almost all situations. The broad national and regional water allocation objectives cannot be simply distilled into the ability to pay. Quasi free-market mechanisms have been used in a few instances within one category of use or within one geographical area, and the application of this approach may be expected to expand particularly at the community level. But, no long proven examples of completely free-market examples of consequence are found today in either developed or developing countries. Chile enacted legislation and is now in a period of trial. Modification through court proceedings and further legislation are being made so it can better assure that other objectives are met.

"Water banking," which allows water-rights holders with stored water within a basin to exchange water during droughts, has been introduced for trials in some of the western states in the United States. The only firm exchanges are from jointly owned reservoir systems. Water is also

allocated through a mechanism of a supply of "water shares" that are purchased by cities and leased back to farmers during periods of surplus. But this is carried out only within a defined rural area covered by the serving district in which all have a common interest in the economic health of the region. And, in this case, the water subject to sale is imported to the basin with explicit laws precluding third parties to gain ownership to return flows. An increasingly more common allocation mechanism is the use of limited-duration specific-use licenses that facilitate reallocation as objectives change. This system is widespread in countries with recently enacted constitutions.

In many countries, society desires to govern land use to meet various objectives, including environmental, rural economic development, poverty alleviation, agricultural production or reduction in migration to urban areas. In such situations, the water allocation mechanism will be a process of committing water to the designated land use. Most countries allocate through a combination of mechanisms that are linked both to broader non-water objectives and to the hydrologic conditions.

Recommendation

Borrowers should establish water resource allocation mechanisms that are carefully tailored to attain their national, regional and local resources allocation objectives. The mechanisms should assure transparency in meeting the allocation objectives in the social, economic and environmental areas. Administrative practicality, a means to establish the rights of the investor/user/third parties and a provision for future change should be inherent in provisions of the combined group of mechanisms.

WATER RIGHTS SYSTEMS

Most countries set forth primary water resource ownership in their constitutions and clarifying legislation. In some countries, this may be somewhat vague, particularly as it pertains to groundwater. Other countries legislate detailed provisions for type and ownership that include regulations for its administration. Some agencies in developing countries do not, however, understand the concept of rights, nor do they apply a water concept to assist in orderly water developments. Farmers dependent on a given irrigation supply lose water to farmers on newly added lands in the same project. New government projects are constructed that compete with established projects for the same resource, ignoring prior established demands. In federal countries with poorly defined water-rights systems, downstream riparian states in a basin lose supplies to established projects when upstream states divert to new uses.

National water resources allocation objectives cannot be assured, nor can practical allocation mechanisms be implemented without a system of water rights. Sound investment protection for all -- government, water utility and user -- and real-time water allocation can only be managed effectively by detailed rights assignment and the effective administration of those rights. The nature and duration of the right may, indeed, vary from permanent rights to a liberal adoption of licenses for limited duration and use. But, if rights are clarified, all can invest and act with full knowledge of resource availability, and the government can carry out its responsibilities to manage the resource.

Recommendation

To address the issue of water rights, borrowers should enact comprehensive legislation on water and land rights as they affect water use and water quality. This legislation may build upon existing laws, but it should address all aspects relative to surface water, groundwater and coastal waters; category and class of use; quantity and quality implications; priority, time and duration of use; and administrative procedures. The legislation should define the source of water; geographical restrictions on its use, including linkages to land use; limitations such as class of use

(nonconsumptive versus consumptive); water quality restrictions on source and return flows; and the extent to which there is a freedom of sale or transfer of right.

INTERSTATE WATER RIGHTS AGREEMENTS IN FEDERAL GOVERNMENT SYSTEMS

In many countries with a federal system of government, the states or provinces own the water resources. A number of federal countries with this arrangement confront internal concerns that arise from or affect their long-term management of water resources. Each state may have a quite comprehensive water rights code, but the riparian states of a shared water resource may not have fully formulated rights agreements. Impending conflicts over the resources resulting from lack of agreements influence basic policy decisions and development strategies. States construct new projects, ignoring what other states have already built. The great advantages of regular data exchange and joint real-time basin water operations by riparian states are lost. No means exist for effective long-term planning and management, and the complex measures necessary to manage droughts, water quality and toxic pollution spills are not in place.

Recommendation

Borrowers should secure comprehensive interstate water rights agreements on all shared bodies of water for the purposes of data exchange, resource planning and long-term management and real-time operations under normal and emergency conditions of flood, drought and pollution spills. The agreements should provide for basic allocations and detailed real-time operations to meet quantity and quality rights.

INTERNATIONAL WATER RIGHTS AGREEMENTS

Because there are relatively few comprehensive water rights agreements on international bodies of water in the developing world, riparians are confronted by serious problems in resources allocation and cannot devise solutions with confidence. They cannot rationally commit their internal resources without knowing their share of the international resource. Sound national and regional water planning and management are impossible without information on the availability and conditions of use of all resources. Serious conflicts that exist on a number of international rivers have an impact on the economic and environmental conditions in the affected countries. Under severe drought conditions, these conflicts could extend far beyond economic considerations to issues of security.

Recommendation

Riparian borrowers should enter into comprehensive international water rights agreements on international bodies of water for purposes of data exchange; resource planning and long-term management and operations under normal and emergency conditions of flood, drought and pollution spills. The agreements should provide for basic allocations and should detail real-time operations to meet quantity and quality rights.

LAND-USE RIGHTS

Land ownership and the associated freedom of use varies from country to country. Private land ownership is common, except in some countries where it is evolving. The custom of communal land ownership and communal determination of use is also common, though the land so classified varies greatly, as do the uses. But in developed and in many developing countries, local government and the state or central governments have powers to control land use. Historically, these powers have excluded industrial and commercial developments from residential areas, provided park lands in or near urban centers, protected forests and range lands and limited urban

expansion into agricultural lands. In some instances, governments have sought to retain highly productive lands in crop production.

A rapidly growing trend is to impose land-use restrictions for the purpose of water pollution control. Examples include restrictions on the application of agricultural chemicals, the density of livestock feeder/fattening operations, operation of mines, siting of industries and thermal power plants and urban configuration as affecting the quality of drainage runoff. The effectiveness of such actions has been recognized, and it has been realized that they offer one of the best available means to control major pollution sources. These resources management actions are gaining increased public support, even though they may infringe on historic ownership rights. They now constitute a basic water resources management tool.

Several countries have social and regional development objectives that require land use to support a selected level of healthy agriculture. Rain-fed agriculture is sufficient under some climatic and soil conditions, but, under others, irrigation is essential. Water is also required to support the associated agricultural processing and supply industries. Thus, again, land use may dictate water use.

Land-use restrictions can also help assure the availability of enough water to meet regional priority purposes during periods of severe water stress. As the high-priority class of uses increases as a percentage of total water available, the cushion of low-priority allocations that can be transferred to priority needs during droughts shrinks. When a region's entire water supplies are fully used by domestic users and critical industries under normal conditions, human welfare problems and economic stress will occur during shortages. An obvious solution is to retain a suitable mix of low- and high-priority uses of normal supplies to assure the flexibility to manage available water in times of drought. Thus, it is prudent to limit total high-priority water use allocation, and hence related land use, to the water supply level available under a prolonged drought. The water supplies above the critical drought quantities should be set aside and allocated to lower priority uses.

Recommendation

As a policy, borrowers should jointly evaluate water and land resources and formulate land-use objectives and land-use rights in parallel with water rights. The land-use rights should contain explicit statements concerning any reserved water rights or restrictions on surface water and groundwater use or on land uses that affect water resources management (including water-quality restrictions and floodplain reservation). The rights statements must be in terms easily understood by the public and should be easy to enforce by the appropriate agencies.

ACQUISITION OF KEY WATER DEVELOPMENT SITES

Water demands are compelling countries to construct a range of physical works to develop their remaining water resources. But the use of the sites essential to develop and efficiently manage the waters are also under conflicting pressures. The topographical and geological characteristics of the sites often makes them location specific. The costs of relocating the inhabitants from needed sites is rising dramatically, as are the political consequences of such relocations. Yet, dams and associated reservoir areas, groundwater recharge areas, water conveyance channels, flood plain reservations, drainage by-passes and routes for large pipelines are essential to water resource development and substitutions cannot readily be made. Pollution control often dictates restricted use of watersheds and lands that overlie sensitive aquifers.

The majority of potential sites for future water resources development are already known or can readily be identified. But, traditionally, sites are not acquired until projects are authorized or, much later, funded. Meanwhile, public and private investments in infrastructure, industry,

urbanization or intensified agriculture expand on these sites. Acquisition costs become immense. Resettlement is proving to be a great obstacle to site acquisition, and it has become the rallying point for all that wish to halt use of a site, even if society pays dearly in funds and loss of scarce water.

Recommendation

Borrowers should identify the sites for facilities that are essential for efficient water resources management in the longer term and, to the extent possible, acquire such sites before relocation problems become ur surmountable. Acquisition alternatives include fee title and vacating the seller, fee title with leaseback to existing owners for restricted use of the land until it is needed and land-use zoning with compensation paid to existing owners for land-use restrictions.

IV. Standards, Regulations and Administrative Rules Issues

Standards, the regulations and administrative rules for their administration and the means and will to enforce them must all be in place if a nation is to manage its resources in a way that will meet its objectives. Nothing will result if any one of the three is missing. The first step is to devise the standards and then formulate the regulations and administrative rules. But often governments do not even reach this second point. The considerations in assigning the responsibilities are discussed later, in addition to the other considerations, including organizational structure.

Rules for Administering Water Rights

Even when countries have detailed water-rights legislation, the regulations and rules for administering the rights may be absent or cause undue delays. In these cases, the means to obtain information from the user to facilitate monitoring are not defined, the triggering values signifying noncompliance with regulations under various conditions are not specified and the enforcement actions are not promulgated.

Recommendation

Borrowers who do not have adequate water-rights administration rules and regulations in place should prepare comprehensive rules and procedures for administering the adopted forms of rights. This will require a range of measures, including clarifying legislation, preparing manuals and educating and equipping the staff of concerned entities to carry out this regulatory function.

Rules for Administering Land-use Rights

A system of land-use rights is inherent in the land-use zoning used to control development in larger urban centers in many countries. The administration of this land-use control system normally falls under the municipal government and is part of the programs for construction and property evaluation. However, in most developing countries, the issuance and administration of land-use rights for purposes of water resources management is a vague concept. Yet, it is necessary for controlling pollution, limiting flood damage risks and managing regional supply shortages. All responsibilities of water agencies and rules and regulations for administering such a system will have to be developed.

Recommendation

Borrowers who do not have an adequate system in place to administer land-use rights should prepare comprehensive rules and regulations for administering the adopted land-use rights. A proposal should be developed jointly by the agencies responsible for land-use management and

those responsible for water quality/pollution management. As in the case of water rights, this will require a range of actions that include clarifying legislation, preparing manuals and educating and equipping the staff of concerned agencies to carry out this regulatory function.

ENVIRONMENTAL QUALITY STANDARDS AND REGULATIONS AND RULES FOR THEIR ADMINISTRATION

Environmental quality management calls for the ability to measure existing conditions and compare them with stated objectives. Water quality standards for health objectives have been adopted in all countries, though they are often found to be incomplete for purposes of management. Standards for instream flow and for meeting other environmental management objectives are often lacking in developing countries, as are the regulations for administering the standards and applying enforcement measures.

Recommendation

Borrowers should prepare comprehensive standards for measuring compliance with environmental objectives, including public health and instream water quality and quantity conditions. Water-related environmental management objectives for natural and scenic conditions should be stated in measurable terms that are understood by the public, the planners and the operators. This should be followed with regulations and rules to administer the standards, including the range of actions from clarifying legislation to preparing manuals.

REGULATIONS AND RULES FOR ADMINISTRATION OF DAM SAFETY STANDARDS

The assurance of the safety of large government and nongovernment-owned dams is a traditional responsibility of government. Almost all countries have enacted legislation and have adopted the general principles put forth by the International Commission on Large Dams. However, few developing countries have a comprehensive dam safety assurance program in place. Regulations may cover technical aspects, but only minimal rules, if any, exist for administering the standards.

Recommendation

In response to this issue, borrowers should prepare regulations and rules for administering their dam safety standards, stating measurable conditions of acceptability, owner reporting requirements and agency monitoring and enforcement provisions. The owner's responsibilities for failures and penalties for noncompliance should be set forth and disseminated to all owners.

QUALITY OF SERVICE STANDARDS AND REGULATIONS AND RULES FOR THEIR ADMINISTRATION

The quality of a water service greatly influences the economic possibilities for the customer or, in the case of domestic use, the well-being of the consumers. It determines the customers' satisfaction and willingness to pay. Standards for water quality and service reliability can readily be set for community water supply, and most countries have adopted standards. Pollution-control standards are less frequently set forth in the detail required, and the rules for administering the standards often do not exist. The health problems found in many countries attest to the lack of administration rules to enforce the water-supply quality and pollution control standards and regulations. Standards for irrigation delivery are rarely set forth in the detail required for the administrative of an irrigation scheme. Illegal off-takes and the "head-ender" problems demonstrate the farmers' lack of discipline and the non-existence of regulations and rules

to administer most schemes. Standards for performance and the rules to enforce them are also necessary for drainage and flood control services.

Effective water-service standards and regulations, together with their fair and prompt administration, are essential if the investment benefits of physical facilities are to be realized. This applies equally to government-owned, user-group-owned and private utility operations.

Recommendation

Borrowers should establish appropriate standards and regulations for all services -- supply, waste collection and treatment, irrigation, drainage and flood control -- in the water sector, set rules for administering the service standards and regulations and provide organizations, staffing, equipment, and the legal means to carry out enforcement.

FINANCIAL AND MANAGEMENT STANDARDS AND REGULATIONS AND RULES FOR THEIR ADMINISTRATION

User-owned, for-profit private utilities and local government service entities have a responsibility to customers and to their financiers for efficient management and fiscal integrity. The customers must fund the operation of the entity by paying service charges, and the owners must secure financing by borrowing from customers, the government or commercial sources. All forms of service entities can be created under appropriate legislation that includes legal provisions to be met in the management and financing of the entity. Some countries have government regulatory units that oversee fiscal activities of local government units. Strong utilities commissions, independent of line agencies, have been created to provide this regulatory function for nongovernment entities in many countries. But in many developing countries, the rules for administering the regulations concerning management of public and private service entities are not in place, or the means are not provided for their enforcement.

Recommendation

Borrowers should prepare regulations for financial and administrative management of service entities and should tailor existing legislation and regulations to fit the anticipated service and ownership forms. The rules and regulations must assure independence, coupled with strong enforcement powers. And for-profit service entities should not be considered without these in place.

V. RESOURCES MONITORING AND DATA COMPILATION

With regard to water resources, data collection, analysis and dissemination should be a well-entrenched, smoothly functioning activity of every government. The availability, condition and use of each physical resource, together with the related history and future projections, are the foundation for decisions on major infrastructure expenditures and the country's economic policies and programs. Yet, these activities remain scattered and grossly underfunded. The mundane nature of the activities and ignorance of the true worth of sound information leaves them out of the budget allocations of finance and line ministries.

WATER RESOURCES INFORMATION

Most developing countries lack the information that is essential for the effective planning, development and management of water resources. Information on the quality and quantity of both surface water and groundwater resources is often not accurate enough to make sound allocation or operating decisions. Heavily polluted surface waters are not recognized as unusable for planned

purposes. Groundwater resource availability is often not known within plus or minus 50 percent accuracy. The groundwater contamination found in countries with comprehensive data collection causes concern about conditions in developing countries where chemical usage and disposal remain uncontrolled and unmonitored. Planning for management of shortages under drought conditions is ineffective without sufficient historical data. Without sufficient and reliable data, costly planning errors and mismanagement are unavoidable, as proved by too many examples in the field.

Recommendation

Borrowers should develop comprehensive water resources data collection, processing and dissemination programs together with their related support systems. Planning, regulatory and operating agencies should use a common format to define their needs. This should include both the traditional water agencies and others, such as transportation entities. A joint effort should establish the intensity of sites, communication system, standards for data quality, verification procedures, reports content and frequency. The respective responsibilities of the federal, state and project agencies should be clarified and data sharing should be spelled out. Information should be readily accessible to the public.

Climate and Weather Information

Water resources management under normal and emergency conditions requires comprehensive weather forecasting and real-time information. Relatively few developing countries have adequate systems for flood forecasting, though population increases on flood-prone lands place proportionately more people at risk. Day-to-day operation of large reservoirs and irrigation schemes during wet season require weather information. The four-month advance forecasting in the southeast Asia monsoon region now under trial offers significant opportunities for improved scheduling of irrigation crops in the affected areas. Newly developed procedures allow near-term drought conditions to be forecast through the use of weather forecasts, past and present regional soil moisture measurements and local stream flow information. This capability is particularly important as countries approach full development of their available water resources. Currently, a few individual schemes are investing in programs and equipment to provide forecasting information, but they are isolated and have little real-time coordination with others.

Recommendation

Borrowers should develop comprehensive programs to collect, process, and analyze weather and related information. Services for forecasting near-term climate, weather and stream flow should be considered. A central unit should have responsibility both for the scope and quality of the program and for its operation. The program should incorporate the existing data collection and forecasting efforts of operating agencies, though such agencies may continue to collect information to the extent dictated by their individual needs. In addition to federal and state agencies, linkages with neighbor countries' programs should be devised. The World Meteorology Organization offers considerable assistance in these matters.

Land Capability Information

Proper implementation of water resources investigation, planning and management activities requires reliable information on land capability, as opposed to that on present land use. Project performance reports repeatedly identify serious deficiencies in land capability decisions resulting from lack of information and from the substitution of poor assumptions for facts. Information on land capability and environmental restrictions on its use are needed to decide about long-term water commitments. Lacking detailed land capability information, water commitments and expenditures are made without sound evaluation of alternative water uses. Lands that can

produce under rainfed conditions may receive the basin's remaining supply for irrigation, while lands that require water for acceptable production levels are shorted.

Recommendation

Borrowers should complete a land capability assessment program with the least possible delay. This information should indicate possible alternative uses and limitations, without comment as to preferred use. Present land-capability programs should be consolidated under one central (or state) unit to take best advantage of current technology and trained staff. Broader Geographic Information Systems (GIS) capabilities and the need for information on economic development and environmental protection as they relate to water allocation and management should be reflected in the programs.

Land-use Information

Land use is a primary determinant of water use and water quality. The activities in every area of a basin (including the lands in natural vegetation, the agricultural lands, the urban areas and the mines) must be described in terms of the basin plans to make timely land-use and water management decisions. This is of obvious importance in environmental monitoring programs. Pollution of surface water supplies and groundwater resources can only be addressed with knowledge of present use and land-use trends, coupled with water quality measurements. Yet, many borrowers lack land-use information and their databases are inadequate to monitor changes in use or to enforce land-use regulations for pollution control purposes.

Recommendation

Borrowers should establish land-use monitoring programs tailored to their planning, monitoring and management programs. Although actual land use should be presented without interpretation as to preferred use or potential use, it would be helpful to display any current land-use zoning for reference. Present monitoring programs should be consolidated under one central (or state) unit to take best advantage of current GIS technology. The program should not collect information specifically for the purposes of land tax assessment or similar activities, though this recommended data collection program may serve as sources of basic information to these and other agencies.

VI. Issues Relating to Government/Public Water Management Responsibilities and Organization

Several issues arise when discussing government and public responsibilities and the organizational structure to carry out the responsibilities. Such discussion requires consideration of the linkages among the various physical factors to be managed, appreciation of basic principles for assigning responsibilities, and consideration of proven structures that are most suitable for given forms of government and the magnitude of the assignments.

Linkage Between Water and Land-use Management

Water and land-use interrelationships are inherent in resources development and management. Urban and industrial developments depend on assured water supplies of defined quality. Irrigation requires both land and water with suitable characteristics. Essentially all economic activities require certain quantities of both resources. The water-quality impacts of urban, industrial and intensive agricultural land use are now becoming a dominant concern in managing surface water and groundwater resources. Land-use controls are an essential means to control pollution and to protect scenic and ecological resources, all inevitably entailing water

commitments. Yet, governments continue to address these two resources in an uncoordinated manner under separate programs. Water-use issues are addressed without consideration of the impacts of land use, and much of the water allocation debate ignores the objectives of land use. Some agencies intentionally use water allocation to affect local land use as they judge wise, instead of addressing both land and water use together in considering the broader ramifications of the proposed action. The severe restrictions placed on drought management that result when all water available under normal conditions is used for high-priority purposes is not recognized. Without the flexibility to divert water from low-priority land uses (such as field crop irrigation) to critical uses in periods of drought, large urban areas face dire choices, as has been mentioned. And without farm land set aside near urban areas, waste water reuse may be infeasible. The physical configuration and location of wastewater collection and disposal system when designed in isolation often preclude the use of recycled wastewater for irrigation.

Recommendation

Borrowers should fully integrate all water use and land use in their planning and regulatory functions and, as appropriate, in their management and operations functions. This would entail defining water and land-use objectives jointly; preparing local and regional plans that reflect the defined water needs (consumptive, nonconsumptive and quality) of the land uses, the waste generation by the land use and the available means for managing the wastes; and identifying the regulatory controls and enforcement requirements of the water and land-use plans. The government should hold operating entities -- government and nongovernment -- responsible for complying with both resource plans and standards.

Linkage Between Quantity and Quality in Water Management

Effective water management requires that water quality and quantity be dealt with conjunctively. The options for use of a given water source depend on its quality and the maintenance of that quality. In turn, the specific use of a water source determines the quality of return flows, and, hence, the potential for subsequent use. The quantity of instream flow required to meet quality objectives is dictated in large part by the waste discharges that must be diluted. If water management does not focus on this aspect, the potential for toxic waste entering prime water supplies arises. Yet, governments commonly assign responsibilities for planning, management and operations affecting water quantity to units separate from those responsible for the water-quality management (not regulatory) functions. The cost tradeoffs between pollution control and water-supply treatment in the same watershed are not evaluated. National investment policies and programs do not reflect the interrelationship between water quality and quantity.

Recommendation

Borrowers should be encouraged to consolidate responsibilities for water quality and quantity management within the same functional units in the areas of planning, operations/services and regulation, particularly in the case of water supply and waste-treatment services. Specifically, planning should provide for allocating water sources and identifying the beneficial uses of returns. The operating functions should be combined in the local "utility" and in any governmental agency that provides wholesale services to local entities. Enforcement of supply allocations should be linked to compliance with the quality requirements of return flows.

Linkage Between Surface and Groundwater Management

Conjunctive planning, management and regulation of surface water and groundwater is rarely undertaken. The common separation of responsibilities for these two water resources gives rise to overly optimistic estimates of resource availability, conflicting exploitation projects, ineffective control of groundwater buildup and inefficient investments. Groundwater reserves can

be extracted to meet annual demands or managed for drought needs. Some water service agencies have active programs for water recharge, now of greater interest as suitable dam sites are lost. Through proper management, irrigation entities save money and add operational flexibility by recovering percolation losses rather than by funding costly preventative measures that yield less water. Nevertheless, countries continue to ignore the large operational benefits from conjunctive management of these resources.

Recommendation

Borrowers should consolidate responsibilities for surface-water and groundwater development and management in the same functional units in the areas of planning, operations/services for supply and regulation, with emphasis on the principle of conjunctively managing these resources at all levels. Though treated briefly here, this important principle can yield large benefits.

Linkage of Service Agency Jurisdiction and Civil Administrative Boundaries

Political and hydrologic boundary inconsistencies present few obstacles to broad planning, data collection and regulatory functions, though this may not be the case at the local level where more detailed attention and actions are involved. However, if service agency jurisdiction violates the hydrologic boundaries at the operational levels of water distribution, drainage and flood protection schemes, substantial difficulties can arise. This most commonly happens when irrigation services from one system are the responsibility of several local civil governments with jurisdictional boundaries different from the water systems. When this occurs, the most fundamental function for ensuring sustainability, O&M, suffers. Sound O&M, with the essential participation of farmers, dictates that customers and service beneficiaries of a given scheme should be included within one unit covering the involved hydrologic area

Recommendation

Borrowers should reorganize service entities as necessary to match the hydrologic bounds of the scheme. Where schemes overlap into two jurisdictions, and thus reorganization is precluded, single-purpose service utilities jointly directed by the two jurisdictions will prove best. Otherwise, uniformity in O&M will be difficult to attain. This would apply to all water supply, distribution, drainage and flood control projects.

Separation of Line Agency Functions

Planning, design, construction and O&M are the four primary line agency functions in the water sector. Comprehensive data collection and dissemination may be separately managed as a fifth function, but if it is not independent, this function is usually attached to a planning or resources regulatory entity. The most effective governments are organized with specialized units in each functional area in order to attain specialization and performance accountability. The level of government expertise and the quality of governmental programs depends on this principle and the associated personnel policies of staff selection, performance review, retention and promotion. However, some governments still have all-purpose units that handle several different functions and, shift staff between assignments as work demands dictate. Under this system, a central body of expertise is not developed, and program continuity, currency with evolving technology, maintenance of performance quality and agency accountability are sacrificed.

Recommendation

Borrowers should assure functional focus in the organizational structure of their government line agencies to attain high technical capability, quality control of work and accountability for results. Comprehensive, formal review and transfer procedures should be followed with documentation as programs pass from planning, to design, to construction, and finally to O&M. Staff tenure, training, performance, promotion and compensation policies should encourage retention of capable, experienced personnel in the respective functional units.

SEPARATION OF SERVICE OPERATIONS FROM REGULATORY FUNCTIONS

Many government organizational structures do not separate responsibilities for providing services from responsibilities for regulating actions pertaining to the services. In these cases, because government water-service agencies independently determine the allocation of water among their projects, overcommitments and overconstruction result. Some water-supply agencies have responsibilities for enforcing water-quality standards for their own supply services. Some industrial ministries that have power to promote industrial development, regulate industrial land use and sometimes even industrial waste disposal. Owners of major water facilities are often the sole judges of the safety and adequacy of the maintenance of their facilities. No one monitors the business and financial performance of governmental service units. And regulatory environmental protection activities are sometimes incorporated into the functions of water using agencies.

Recommendation

Borrowers should clearly separate responsibilities for the service functions from those for regulatory functions. This is one of the most important principles of effective management and quality assurance. It applies to all areas: Water rights, safety of structures, water quality, water use, business and financial integrity and customer participation. Regulatory units should report to the senior levels independently of the service units that they regulate and should be directed at the national or state level by an independent central office that reports directly to a minister.

DEFINITION OF FUNCTIONS AND RESPONSIBILITIES IN THE ENVIRONMENTAL AREA

Regulatory and operational responsibilities are frequently intermixed in the environmental area. One serious institutional complication in effectively addressing environmental problems and issues lies in the definitions used today for environmental activities. Population growth is the major cause of environmental degradation, yet it is not placed under the jurisdiction of environmental units. Similarly, activities such as urban waste treatment, land drainage, watershed protection and groundwater management are better called by their original descriptive terms than classified as environmental activities. Activities relating to relocating people from lands required for major works should not be linked with environmental activities. They are separate problems and should be treated as such in organizing government agencies and assigning expertise. The institutional arrangements and responsibilities to set criteria and standards, monitor conditions, introduce improved operational procedures, enforce regulations and execute remedial programs that affect, and always have affected, the environment can then be set forth in these terms. The assignments can follow the principle of separating the execution from the regulatory functions. The government's directly labeled "environmental" functions should constitute Recommendations on standards (enacted by legislation), and the associated regulatory, monitoring and enforcement actions. The importance of sound environmental management in the water field, together with effective institutional development of water resources, dictates the need for care in defining areas of responsibility for achieving these aims.

Recommendation

Borrowers should clearly separate responsibilities for the service/operations functions from those for the regulatory functions in the environmental area. They should exercise particular care to define and assign actions in the traditional fields to the line agencies that have the involved expertise and means. The environmental regulatory functions should reside in regulatory units directed by a central office at the national or state level that reports to the ministerial level. Line service agencies, private entities and individuals directly concerned must be responsible for physical actions that affect the environment, including utilization, protection, mitigation and enhancement programs. These parties should be held accountable for complying with the environmental standards and regulations in their routine work, and the environmental regulatory units should be responsible for monitoring government and private-sector activities and the enforcement of the established regulations and standards.

PUBLIC PARTICIPATION IN ADVICE AND OVERSIGHT

In many developed countries, individuals outside government traditionally have advice and oversight roles in the water resources sector. Beneficiaries who serve on agency boards, experts who serve on technical committees and public figures who serve on policy and oversight commissions provide timely inputs to decisions from an outside perspective. Such participation is particularly effective with regard to environmental, regulatory and resources allocation issues. An important result is greater public understanding and support of all government actions. This is often essential for instituting major changes. For example, the public will more readily accept drastic measures inherent in drought plans if the need for such plans is overseen by a citizens' panel and fully understood by the public. This institutional principle is not followed in most developing countries. Political leaders may be wary of public participation and direct influence. Bureaucracies oppose sharing management decisions or being subject to oversight. The public may lack information. But the growing importance of public opinion and nongovernmental organizations activities must be recognized and accommodated, and direct participation in decisionmaking from those outside government will be productive for everyone.

Recommendation

Borrowers should institute actions to secure the participation of nongovernment individuals in appropriate advisory and oversight capacities on agency boards, technical committees and commissions in the policy areas. Material should be prepared that describes the typical use of such entities in water resources planning, management and regulation, including the environmental area. Agencies should make all staff aware of the purpose, nature and effectiveness of such programs. Support of public information programs and limited workshops is a beginning. The latter should include construction of permanent informational features in major facilities.

WATER SERVICES AS UTILITIES

The easily identified water services include community water supply and waste disposal. In many countries, these are operated as utilities that provide a well-defined service to the customer. They own assets, conduct O&M, procure new facilities and equipment, finance capital improvements and charge for services. Where the beneficiary organization owns the system, the management board is constituted of users. Where the utility is privately owned for profit, management has a corporate form. Where a unit of government (usually at the local level) functions as an independent service utility, management, staffing, budgeting and accounting are carefully isolated from the parent government organization. The "utilities form of organization" also is common in irrigation, drainage and flood control in developed countries. The utility form of service entity, when made properly accountable, assures greatest operational efficiency,

accountability for quality of services to the beneficiaries and through cost recovery from the beneficiaries, financial self-sufficiency.

The water services entities in the urban areas of many developing countries have, to a varying extent, the form of a utility, but budgeting and receipts often are not isolated from general government operations and subsidies cloud the financial situation. The organizational forms of irrigation services vary. Those directly funded and constructed by governments typically remain government operations, characterized by high subsidies and minimal accountability. Yet, those financed and constructed by farmers are operated under all the principles of an independent utility with no expense to government. Drainage and flood-control facilities are always managed as government operations (without cost recovery) in developing countries and, as a consequence, many are not satisfactorily operated or maintained.

Recommendation

Borrowers should structure all water service entities as independent, financially self-sufficient utilities with rigid management, programing, budgeting, financing and public accountability. This is another institutional principle that is key to effective, affordable water resources management. All government services should be performed by such units, managed and funded independently as a subunit of the parent agency. Local government entities should be responsible to the customers through their elected representatives or appropriate oversight bodies. Any subsidies to these entities should be transparent to the public. Government irrigation and drainage schemes should be turned over to farmer owned utilities under an ongoing program. However, no utilities should engage in other support or non-water service activities.

ASSIGNING LINE AGENCY FUNCTIONAL RESPONSIBILITIES

Governments' success in meeting their responsibilities depends on their matching the required technical capability to the tasks best carried out at each level -- central, state, local and scheme. This is not a simple structuring of government agencies. It requires carefully assessing ongoing work in the various functional areas, locating the capability at the level demanded by the tasks and participants and supporting the unit by appropriate procedures, personnel policies and communications capability.

As project complexity has grown, governments have replaced the early regional all-purpose public works units that covered all aspects of water development and management with specialized central agencies . The central public works agencies typically carried out planning and design and dispatched its staff to execute the works. The subsequent O&M (a permanent local effort) often became orphans of the agencies. Regulatory activities were limited to water diversions and elementary drinking water standards. In many countries, program evaluation, task assignment and agency structuring has progressed no further. Available individuals are rotated through positions in whatever functional area is open, precluding the attainment of a satisfactory level of management.

As discussed earlier, functional areas require specialization. Several different functions should not be lumped in one unit. In the same way, a functional unit's location within the governmental levels is a critical consideration when assigning the functional activity. It is recognized that certain technical skills can only be sustained in small central units, that sound quality control demands a central technical review and that balanced programming requires a central budget review. These points must be satisfied. But excessively centralized direction can frustrate local input and jeopardize tailoring the program to the conditions. Experience shows that the nearer the agencies' responsibilities are assigned to the beneficiaries, the greater the probability of success. This may be partially aided by active local participation with the agency, if possible. Today, transport and communications remove many past constraints, including that of technical

capacity, to assigning responsibilities at whatever location best suits the most advantageous of the available choices.

Recommendation

Borrowers should assign line responsibilities to units of government at the lowest level at which high quality work can be attained, balanced with the need to interact with the public. The policies and procedures to assure specialization and necessary capability should be spelled out in detail. But reporting lines and staffing must assure central/state review for quality assurance and central/state coordination for programing and budgeting. This is an iterative process that examines near-term and long-term workload, required expertise, proper utilization of consultants to augment permanent staff, location of work, role of beneficiaries and the communications network. External oversight mechanisms should be introduced where matters are of public concern.

ASSIGNING WATER RESOURCE'S PLANNING RESPONSIBILITIES

Water resources planning should be assigned to the level of government appropriate to the purpose of the plan and the decisions to be made. The degree of planning detail depends on the maturity of the resources development and the management mechanisms adopted by the government. Water and land-use framework planning should be conducted at the level at which resource ownership resides and allocation is made. And this should be reflected in national, state and basin plans. Line agencies and service entities must plan in the detail required for the long-term development and scheduling of their project-specific programs.

Unfortunately, many aspects of water resources planning are often scattered, with only minimal coordination, among government agencies. Too often, the planning is incomplete and narrowly focused. The relative powers of the agency doing the planning determine the priorities. Some countries have national plans, but these also often suffer from the dominant-agency syndrome. Some plans are one-time efforts by consultants and are often produced with limited budgets, inadequate dialog with government leaders and insufficient data. Consequently, they soon reside on a back shelf, are not updated and become of little use.

Recommendation

Borrowers should create small permanent national or state water and land-use planning units, preferably located within the economic planning or budgeting/financing agencies to help maintain impartiality. These units should have two roles: to maintain the document-reflecting decisions and to offer advice to the legislative body and policymakers on the consequences of proposed actions or lack thereof. Line agencies with development responsibilities should be assigned responsibility for detailed project planning in their respective geographical and subject areas of responsibility. Review/approval mechanisms must assure compliance with the framework plans.

ASSIGNING WATER SERVICE FUNCTIONS TO BENEFICIARY ENTITIES

Local government service units or nongovernmental entities can provide most water services more efficiently than can central or state government agencies. Three of the more common services to which this applies are municipal water supply, waste collection and treatment and irrigation distribution. Agricultural drainage has long been a responsibility of local entities in many countries. Flood control is often assigned to a local government agency with a user entity in charge of O&M. Yet, government agencies in many countries procrastinate about relinquishing control.

In most developing countries, the government assumes O&M responsibility for all government built irrigation and drainage facilities, in many cases down to the level of ten or twenty beneficiaries. Beneficiaries have come to expect that government also will maintain the facilities and that they need contribute little or nothing in service charges or labor. Since they have made no capital investment and pay little for O&M, the beneficiaries have no concern for the condition of the facilities. The result is vandalism and service interference. By contrast, on farmer-owned schemes, the systems perform well, customers are disciplined, and all costs are covered by the beneficiaries. Though arguments are made to the contrary, similar farmer behavior should be attained on government schemes. Because O&M on government schemes must be seen by the beneficiaries to be in their interest, beneficiaries should participate in construction and O&M decisions and funding.

Thus, line agencies should recognize that for several reasons they will have to relinquish O&M and financing responsibilities for services to beneficiaries as performance and financing advantages become evident. Indeed, government budget constraints will force transfers. And moving O&M to the beneficiary-owner will assure that these budgets receive priority from the immediate owners and do not have to compete with other government programs, many of which are subject to political whims. The transfer will usually require beneficiaries to organize as a public corporation which has adequate taxing and jurisdictional powers. Private for-profit water service entities are being promoted in a few countries. But as they require a strong, unbiased, independent government regulatory unit, their early consideration is precluded in most developing countries.

The government should actively engage beneficiaries in rehabilitation and O&M decisions that affect them on both turnover and government-retained facilities. Beneficiaries should pay at least 20 percent of rehabilitation costs on facilities turned over and full O&M costs on government facilities not transferred. A permanent program of internal staff orientation and beneficiary contact should support these efforts.

Recommendation

To facilitate orderly turnover, borrowers should assist beneficiaries to form local government or nongovernment water service entities as part of a comprehensive program to turn over existing facilities, once they have been rehabilitated, and new facilities. Each entity should incorporate the principles of a utility with self-reliant management and financing without government intervention or assistance. Legislation that complicates creation of service entities in the water sector must be modified. The program would include the turnover of individual schemes to individual entities and of bulk supply facilities to a federation of user entities. The guiding policies and the implementation program measures should address scope of service, jurisdiction, facilities ownership, beneficiary contribution to facilities' costs, membership, administration, O&M, cost recovery, financing replacement and government oversight.

ASSIGNING REGULATORY FUNCTIONS

When the standards and regulations have been enacted, the assignment of the regulatory function and the capability of the regulatory units determine the regulatory contribution to meeting the resources management and environmental quality objectives. Typical areas for regulatory action are water quantity and quality, other environmental attributes affected by water, structural safety and fiscal accountability of service agencies. Central government, and state governments in federal systems, must issue explanatory materials on the standards and regulations for the activities related to the resources that they own. They must also assure compliance with the regulations. But the responsibilities for the enforcement of regulations must be separated from the user entities, while the responsibility for compliance with regulations is assigned to the operating entities. The

regulatory function is weak in most developing countries. Enforcement assignments are often given to the user agencies, and many regulatory actions are not established or are rarely and unevenly enforced.

Recommendation

Borrowers should assign the regulatory functions to the appropriate levels of government in accordance with the principle of separating user agencies from regulation enforcement responsibilities. The monitoring and enforcement of all water quantity and quality regulations and of environmental regulations should be assigned at the government level of resource ownership. (In federal countries, central government may have over-riding jurisdiction in some respects.) Administrative and financial monitoring should be assigned to the level of government responsible for entity formation and registration -- often the "interior" ministry. Where public health is involved, government public health or environmental protection agencies should administer standards. Standards for irrigation projects can be effectively administered through local operator/customer agreements, with oversight by a central O&M office in the case of government projects.

ASSIGNING DATA COLLECTION FUNCTIONS

The inadequacy of the available information for water planning and management stems in part from the dispersed assignment of responsibilities for data collection. Typically, the water development agencies collect only that amount of information necessary for formulating a project and terminate much of the data collection program upon completion of the study. The quality of information suffers because inexperienced personnel conduct such temporary efforts. Records are lost or are not processed for storage, and other entities, which may need the information, do not know of the records or have access to the files. Unless comprehensive information is collected, processed and made available promptly, sound resources management is impossible.

Recommendation

Borrowers should assign basic resources information collection, processing and dissemination, if not the actual execution of these activities, to a center or state unit with powers to set data collection standards and to review all data collection programs to assure the quality of the information. Users of the information should be free to stipulate the nature of the information they require. A central unit, in coordination with all line and regulatory units, should have responsibility for the scope and quality of the entire program. Although operating entities may augment the collection to meet their needs, the information they collect that is useful to others should be readily incorporated into the central system. Information should be made available promptly to all potential users, including resources planning agencies, water supply agencies, regulatory (including environmental) agencies and the public.

RESOURCES PLANNING AND LONG-TERM MANAGEMENT

I. PREAMBLE

The policies and principles for resources planning and long-term management guide the longer term programs and projects in each country's water sector. The issues and proposed policies and principles are presented under six groups: (i) Water Resources Development Goals, Objectives and Policies; (ii) Planning and Management Considerations; (iii) Framework for Long-Term Planning and Management; and (iv) Planning Criteria and Methodology.

II. WATER RESOURCES DEVELOPMENT GOALS, OBJECTIVES AND POLICIES

Many countries do not have well articulated goals, objectives and policies to guide long-term resources development and management. Aspects of this concerning water allocation were noted earlier. Local and regional programs and projects often have a single purpose, which may be inconsistent with national objectives. Many water resources programs of parallel line agencies at the same level of government have uncoordinated and even conflicting goals and objectives. Environmental objectives are not defined in the detail that is necessary to guide project planners. Overall resource allocations and commitments in support of investment decisions cannot be formulated with confidence.

RECOMMENDATION

Countries should develop a set of comprehensive goals, objectives and policies pertaining to long-term water resources development. These should be detailed in the fields of: (i) Social well-being, (ii) environmental quality, (iii) national economic development and (iv) regional economic development. The goals would define the broad aspirations, the objectives would describe in measurable terms what is to be accomplished, and the policies would guide actions to meet the objectives. This set of policies would not address organizational or physical aspects of management, but would focus entirely on meeting the objectives contained within the water management goals.

III. PLANNING AND MANAGEMENT CONSIDERATIONS

TIME HORIZON FOR PLANNING AND MANAGEMENT

Different time horizons are appropriate for different levels of water resources planning and management. The period required to formulate and execute a major resources development action dictates that increasingly longer time horizons be reflected in the decisions. The gestation period of major infrastructure developments and the impact of population growth on all decisions today warrant committing to a period of time at least equal to the useful life of the largest commitments. Many countries, even those with minimal population growth, use a fifty-year time horizon for national planning, long-term resources development and related major project formulation.

Unfortunately, many developing countries do not apply consistent criteria for selecting the time horizons used in configuring projects. The time horizons are rarely defined within a comprehensive forty- to fifty-year basin plan. Indeed, many projects are formulated with complete

indifference to existing commitments or to major future demands of a higher priority on the involved resources. Project justification may use a thirty-year payout, after completion, when even a cursory analysis demonstrates that the dedicated resources will have to be diverted to other purposes long before that time has passed. And such documents do not describe and estimate the costs of the actions necessary to meet conflicting demands fifty years ahead, or the social and economic consequences of failing to take such actions. Financing needs, demands on future government budgets and the role of the resource users are ignored in both long- and short-term programming and budgeting even though the sustainability of investments depends on large financial commitments.

Recommendation

Countries should formulate a comprehensive set of criteria defining time horizons and their specific application in water resources planning and management. A minimum fifty-year horizon should be used in all national planning and basin planning and in long-term government programing. The criteria also should set the time horizons to be applied when considering matters such as socioeconomic and demographic projections, economic activities affected by the plan, projects that are components of the plan, and financial considerations to be incorporated in the planning efforts.

RESOURCES ALLOWANCE FOR THE FUTURE

Water resources allocation for the future is not a pressing concern where the resources are ample for present and foreseeable future needs. However, it becomes a primary consideration as countries approach the limits of their resources, particularly when the magnitude of the resources are not accurately known. Moreover, the uncertainty of demand projections, the deteriorating quality of resources that limit their use, and the impossibility of forecasting the nature of droughts in terms of extents of shortfall and duration require a safety margin in committing the country's waters. The greater the uncertainty of these factors, the greater should be the resource allowance to cover the uncertainty, and the magnitude of the allowance will influence decisions on the nature of near-term commitments

Recommendation

Countries should provide a resources allowance for the future that is proportionate to the factors bearing on the possible variability of the supply and the potential demands on it, noting the consideration used for each factor and how they are cumulated in the allowance. Sound risk analysis and sensitivity analysis should be applied to all factors to provide guidance and information both to the political bodies and to the responsible agency officials. Absolute set aside and the schedule for conversion of lower priority uses to higher priority uses should be clearly defined in a document for use in planning and management.

MULTIPURPOSE PROJECTS AND PROGRAMS

Multipurpose projects and programs offer immense opportunities and are essential to efficient water management. Irrigation, power and community water supply projects, however, are too often formulated and operated by single purpose agencies under restricted charters (and would be a risk with for-profit entities). Some of these agencies are fearful of involving the other services because they may lose control of "their" project or have it altered. Nevertheless, increasing populations and tightening water situations in many areas force irrigation systems to function as water suppliers that also serve community and other priority customers. Energy demands and environmental objectives favor installation of hydropower facilities on all conveyance and storage facilities that have any significant head drops. Treated wastewater disposal, joined

with irrigation or groundwater recharge conserves resources. Such multipurpose uses of projects should be primary objectives in planning.

Recommendation

Borrowers should pursue national and basin planning to meet the national objectives from a truly comprehensive, multidisciplinary perspective that reflects cost-and-benefit allocations among purposes in selecting the most advantageous undertaking. Agency purposes should be satisfied within this broader framework.

COMBINED WATER AND LAND-USE PLANNING

Some countries are acting to combine aspects of water and land use in planning and management. As noted, the best use of each resource demands that it be viewed and treated as interdependent rather than in isolation or recognizing its dependency only in the obvious situations. There is no alternative to planning jointly with these resources, a principle that must be formally recognized in every functional agency and program in government. More narrowly, cost savings with less disruption to the area can be realized in locating facilities, particularly joint transportation and conveyance corridors in congested areas.

Recommendation

Borrowers should explicitly address water and land-use jointly in formulating plans for long-term management of water resources, and should specifically reflect this in the resulting programs and projects. Statements should describe the linkages between these two resources as reflected in individual policies and programs.

PROGRAM AND PROJECT FLEXIBILITY

Some project objectives may be met by alternative facilities and some facilities can be configured to allow flexibility in their later operation. Water-storage capacity is fixed by construction, but some facilities may be designed to leave expansion options for future decision-makers. Lowering outlets to drain reserves during emergencies, designing conveyance and storage features to accommodate hydropower equipment, assuring capacity to serve future community water demands from irrigation canals and establishing groundwater regulations that allow shifting uses are examples of conscious planning decisions that provide flexibility for future generations. Another sound long-term planning and management action is to set aside rights-of-way for future conveyance facilities, particularly for supply and drainage. In spite of the benefits of adopting site acquisitions and project configurations that allow flexibility to deal with future uncertainties, many agencies plan only for the immediate and often narrow purpose.

Recommendation

Borrowers should adopt formal policies and procedures to seek maximum flexibility in all plans. Cross-sectorial review among the economic and infrastructure agencies should become established procedures. These procedures should assure comprehensive examination of proposed programs and projects in order to identify measures that give options to future generations. In particular, the cost of precluding future options should be explicitly set forth.

LARGE VERSUS SMALL STORAGE PROJECT

Much has been written and many seemingly unyielding positions have evolved in the debate about large versus small storage projects for developing and managing water resources. However, long-term planning of water resources development must consider all means available to

best meet a country's development objectives. For flood control and significant seasonal and multiyear carry-over storage, large capacities are needed, and they must be where the water can be captured. Without doubt, enormous cost and land savings result from creating storage in a few large reservoirs rather than numerous small reservoirs. If large facilities are the best means to meet a future need, then they must be scheduled in the planning to be operational when the need arises. Delays in resolving this issue or arbitrary completion of all small projects before starting the large ones can seriously compromise future supplies and the related human and economic health of the nation.

Recommendation

Borrowers should fully examine all surface water storage options, both large and small, in their long-term planning process and should select the options that both best fit their goals and objectives in water resources development and meet long-term demands on the resources. This effort should include the necessary scheduling of works to deliver water in a timely manner to meet the needs of the population and projected economic growth.

IV. Framework for Long-Term Planning and Management

National or State Water and Land-Use Master Plans

Lack of a national or state level water plan is not a critical shortcoming when water is plentiful. But, as resource limits are approached and pollution control and other environmental objectives impose new demands, comprehensive national or state plans become essential. For the objectives of meeting water demands for domestic, industrial and agricultural purposes and for flood damage prevention, land-use zoning and budget allocations must be viewed from the national perspective and for extended periods into the future.

The national or state water plan should not be greatly detailed, but it should accurately forecast demographic, economic and social changes and relate these to projections of water quantity and quality needs. It should record the conditions of current resources and commitments against them, and should be updated as changes occur and new commitments are adopted. It should not be an advocacy document, but rather it should document the nation's decisions, and it should permit all to visualize present and future conditions and the impact of contemplated decisions. The plan should form the basis for assessing basic policy and reevaluating objectives.

Recommendation

Borrowers should prepare and maintain comprehensive national or state water and land-use plans to serve as the government's framework for its long-term planning and management. The status of these plans should be such that they guide enforcement of other actions. Changes should be incorporated as they occur and an updated document should be issued at least every five years.

Basin Plans

Basin plans form the basis for allocating the specific water and land resources and for verifying the compatibility of long-term programs and projects with conditions within a hydrologic system. Few developing countries prepare such plans in sufficient detail, and thus they undertake programs and projects with no guiding framework. Even such obvious benefits as use of return flows, conjunctive use of surface and groundwater and reuse of wastewater are forfeited. A basin plan should be a comprehensive document detailing the availability of water and the conditions for

its use by government and private entities. Real-time water quality and quantity management and operations can only be coordinated within an adopted framework for the hydrologic system.

Recommendation

Borrowers should prepare basin plans for long-term development and management of water and land resources. Each plan should document present and projected resources availability, water uses by category (consumptive or nonconsumptive, diverted or instream), class (domestic, industrial, agricultural), location under all conditions of flow and the location and description of the involved water control facilities. Allocation and uses should be defined in terms of seasonal, normal and drought conditions. Basin plans should conform to national/state plans, but should contain much greater detail.

PROJECT PLANS

Project planning proceeds from project identification through feasibility studies to final design and implementation. Plans for operation and maintenance (O&M) follow. Sound resource commitments demand that project planning is conducted in strict conformance with a basin plan. Feasibility plans should meet criteria for data adequacy, identification and study of alternatives, evaluation of the costs and benefits of the selected project and assessment of the environmental impact. Feasibility plans are then converted into final facilities plans for implementation and ultimately to "as-built" documents for use by O&M units and safety regulators. In reality, full feasibility planning requirements are not met on many projects. Physical alternatives are inadequately investigated, and costs and benefits left in doubt because of insufficient data from resources characteristics to site exploration. Construction concepts sometimes prove impractical, excessive and cost over-runs occur and construction schedules are often overambitious. O&M considerations are often inadequately addressed.

Recommendation

Borrowers should apply rigorous criteria in the preparation of feasibility plans and final project plans. The unquestioned adequacy of data, the multipurpose possibilities, the alternatives considered and the conformance with basin plans should be assured and fully documented. These criteria should override any scheduling objectives.

INTERNATIONAL BASIN PLANS

The resources of international bodies of water are important to all riparians. The best use of both the international and the national resources depends on knowing what is available and how it will be managed. Even security issues arise from uncertainty about management of the basin. Nevertheless, many international water bodies are being developed today without firm plans because there are no agreements on which to base such plans.

Recommendation

Borrowers should enter into active discussion that lead to joint planning and operation of their bordering international waters. They should be informed of use as appropriate the general and specific assistance offered by the international agencies. These have often proven to be the catalyst that helps resolve long-standing disputes.

V. PLANNING CRITERIA AND METHODOLOGY

ECONOMIC PLANNING CRITERIA

Standard and well-known techniques are available for the economic evaluation of multipurpose water development programs. These techniques normally seek to evaluate the costs and benefits of alternative scenarios with a view to advising the decisionmaker of the economic implications of different decisions. All values need to be expressed at shadow prices to reflect real resource implications, and all taxes and transfer payments should be excluded. Estimates of shadow prices and other assumptions to be used in a particular country are frequently prepared by the national planning commission or some similar agency. In evaluating alternative programs, it is essential to include all costs not only the direct costs associated with the physical investment but also all opportunity costs arising as a result of externalities and similar effects associated with the investments. If costs and/or benefits cannot be adequately quantified in an economic numeraire, then multiobjective planning techniques may need to be used. These seek to optimize total economic returns subject to specified (not quantifiable) constraints. They can, therefore, be used to inform the decision-maker about the economic costs of alternative lines of action.

ENGINEERING PLANNING CRITERIA

Consistent, sound planning requires that all government agencies within a country follow a common set of planning criteria and methodologies on water resources. These must not be overly restrictive or in minute detail, particularly with reference to standard engineering principles. However, in countries with well-managed resources, planning documents generally note the reference manuals used and state in greater detail any criteria specific to the plan. Unfortunately, such means to assure consistency with well-thought-out criteria are not applied in many developing countries. The resulting plans and subsequent projects exhibit serious oversights and conflicting principles.

Recommendation

Borrowers should establish and rigorously apply a comprehensive set of planning criteria (economic and engineering), including a mechanism for regular updating, for guiding water resources planning by agencies at all levels of government. Plans should formally note the criteria used to facilitate review and inclusion in subsequent project records for future reference. (Some common factors that seriously distort plans are discussed in the following paragraphs.)

ADEQUACY AND RELIABILITY OF RESOURCE DATA

Sound planning is impossible without adequate information on the resources to be developed. This is self-evident and should not be an issue. Nevertheless, irrigation projects and programs are proposed and implemented by some countries in which water resources, land capability and water demands are not known within 40 percent accuracy. Storages, flood control and river training works are designed and constructed with inadequate hydrological data. Even urban water supply facilities are designed with inadequate data to forecast the extent and recurrence periods of supply shortages and, therefore, the means to meet such events. Despite these data deficiencies, "feasibility" reports for projects purport to estimate their economic rates of return with levels of accuracy to the third significant figure.

Recommendation

Borrowers should secure data on water and land resources and on water commitments and demands at the project and basin levels. These data should be reliable and extensive enough to conform with the planning at the designated level of accuracy. The accuracy of data used and the

governing planning criteria should be referenced and compliance stated in the project planning document.

WATER-USE EFFICIENCY AND EFFECTIVENESS

Many papers and lengthy debates focus on water-use efficiency and huge sums are spent on improving system efficiencies. Modifications to irrigation, a favorite target of such programs, has the objective of freeing up large amounts of "new" water for use within the scheme or for other purposes. Unfortunately, when it is related to water management, the term "efficiency" is often completely misunderstood. Efficiency, the ratio of the quantity of water consumptively used to the quantity diverted, does not in itself indicate whether water is used effectively and wisely. Most of the water diverted for an irrigation project in the upper areas of a basin, but not consumed by the plants, returns to the surface water or groundwater systems and is subsequently put to other downstream uses (irrigation, aquaculture, urban or rural supply and/or instream uses). It is not lost. Indeed, increased efficiencies, coupled with increased use on an upstream project, reduces resources available to downstream users, that may have consequent detrimental effects. Additional investments on the upstream project render earlier downstream investments less productive and equate to spending money to lose money.

The important water quantity question relating to efficiency is whether water is lost from an area and flows to the sea or to a polluted sink from which it cannot be recovered. The measure to use when considering total resource use is basin efficiency, not farm or project efficiency. If upstream water "losses" are available to and used by downstream users, there is no quantity gain by changing individual project efficiencies. If there is wastage to the sea at a time when possible users exist within the basin or in an adjacent basin, there is potential for a gain in water quantity from efficiency measures.1/

Recommendation

Borrowers, when considering reduction in project water "losses," should analyze water use in terms of effectiveness in meeting allocation and other objectives within the basin and in terms of efficiency on a basin-wide basis. All proposals to improve efficiency should be measured against all objectives and the cost-effectiveness of the proposals in meeting these objectives. Costs or damages that result from raising groundwater levels or from increased pumping should be analyzed and all measures, not just "loss" reduction efforts, should be assessed in selecting actions.

STRUCTURAL VERSUS NONSTRUCTURAL FLOOD PROTECTION

Many countries control flood damages only through the use of levees and storage reservoirs. The concepts of excluding high-value activities from flood-prone lands through

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1/ The reality of the situation and the water saving opportunities may be clarified by examining some examples. The average irrigation project efficiency in the United States is 43 percent. By comparison, U.S. urban supply schemes have an average efficiency of 19 percent and water-use efficiency on industrial/mining operations averages 16 percent, far below those of irrigation. Of greater consequence, the majority of urbanized areas lie near the sea, where there is no opportunity for downstream use of the return flows. By contrast, the overall irrigation sector efficiency in the United States is 87 percent, with only 13 percent of the water diverted for irrigation lost to the sea or otherwise unavailable to other users. This is due to the typical upper basin locations of irrigation schemes in the United States. Thus, contrary to popular thinking, the irrigation sector has the highest efficiency among the major water users, at both scheme and basin levels. (See World Bank Technical Paper No. 185, "Drought Planning and Water Efficiency Implications in Water Resources Management.")

floodplain zoning and nominal flood proofing of structures generally are not applied. Rarely are flood-prone areas permanently set aside for agriculture or the construction of any structures in the area or obstructions in drainageways prohibited. Inevitably, without such controls, the high-value developments pressure government to provide costly, yet not fully reliable, protective works.

Recommendation

Borrowers should consider nonstructural measures (floodplain zoning and floodproofing) for flood damage reduction in equal detail with their consideration of dams and levees, and incorporate such measures where suitable into their long-term planning and management. These concepts should be incorporated into both basin water plans and local land-use planning and management.

APPLICATIONS OF COMPUTER MODELING TO PLANNING AND MANAGEMENT

Computer applications that are useful, if not essential, in project analysis are available from a range of sources. Multiyear simulation of weather and runoff permits close evaluation both of crop water demands and supply and of project yields. Similarly, future urban demands and alternative facilities can be examined. Planning the operation of several reservoirs within a basin to meet multipurpose objectives requires the use of an interrelated set of models, and these are even more necessary for planning the operation of multibasin systems. Though many developing countries have adopted computer technology, their water resource agencies still do not use appropriate models to the extent possible in their long-term planning and management activities.

Recommendation

Borrowers should systematically review the agencies' needs and use of modeling and establish a library of proven models with a procedure for regular updating. A collection of models already in the public domain can serve most purposes with little investment by the agencies. Further, countries should have a formal verification procedure to assure that staff utilize appropriate, proven models for all evaluations, such as simulation of weather and water systems; conjunctive operation of surface water and groundwater systems and all project, basin and interbasin operations.

ENVIRONMENTAL ASSESSMENT CONSIDERATIONS

Most governments have or are preparing guidelines for evaluating the environmental impact of programs and projects. However, as with all guidelines, the user must apply a sound interpretation. Some consider only negative environmental impacts thus implying that only the economic benefits can be listed as positive project results. This stems from past project evaluation procedures that did not explicitly recognize either negative or positive environmental affects. For example, positive and negative effects of projects on wildlife, recreation, public health, instream and reservoir fisheries and stabilized streamflow were cited, but not defined as environmental. And they were usually treated only in subjective terms, though cost and benefit allocations and related funding were assigned to some. Now that many of these elements have been incorporated under the environmental category, care must be taken that environmental accounts present both the positive and the negative impacts in each of the environmental classes so that evaluators (and the public) can readily assess the net environmental impact of a project or program. The environmental benefits of clean hydro replacing nuclear or fossil fuel alternatives is an obvious example. Safe drinking and wash water for urban and rural poor is a second. Also, the costs of siltation and seismic possibilities should not be counted twice. Reservoir siltation is always reflected in the project life. Potential seismic affects are accommodated in the design and related costs.

Recommendation

Borrowers should conduct comprehensive environmental assessments for programs and projects in accordance with sound guidelines. They should present both the positive and negative impacts in all classes so that the net environmental impact of programs and projects can be evaluated. Indeed, the wide range of environmental impacts of not constructing a project should be set out as a basic reference for use in evaluating alternatives. These impacts should be fully explained in terms that the public can readily understand and evaluate.

REAL-TIME MANAGEMENT OF WATER RESOURCES

I. PREAMBLE

Primary activities in real-time water resources management include planning for operations and maintenance (O&M) of the services, management of related programs at all levels and administration of rules and regulations. The issues and proposed policies and practices are presented here under five groups: (i) Administration and Support Activities; (ii) Plans for Real-Time Operations; (iii) Water Operations; (iv) Maintenance and (v) Regulatory Functions.

II. ADMINISTRATION AND SUPPORT ACTIVITIES

PROGRAMING AND BUDGETING OF ACTIVITIES

Sound programing and budgeting are essential to efficient and cost-effective government operations and services. If these basic actions are not carried out in a timely manner, all other project planning is of little use. Though the issue is not peculiar to water resources activities, it is introduced here because most underfunding and inaction in the regulatory, planning, data collection and O&M areas is caused by inadequacies in the related programing and budgeting. Unless this issue is treated equally with other issues, sound water resources management is impossible.

Recommendation

Borrowers should apply sound, realistic and supportable programing and budgeting procedures for all government activities in the water sector. The programs and budgets should be presented by line item and organizational unit with complete cross-references, thus allowing verification of staff and funding that is linked to the tasks decided upon to meet the year's goals. The program and budget for each project should be detailed and the activities displayed, ideally on a critical path method type diagram presenting both applied resources and activity status.

PERSONNEL POLICIES

Civil service regulations differ from country to country. Many were formulated under circumstances far different from today's in terms of type and level of activities, required skills, communications and compensation. To complicate matters, social objectives govern staff selection in some countries. Overall, most existing personnel policies seriously constrain the modernization of organizations and operational systems. Though it is difficult to change civil service regulations, aspects can be modified within the existing policy framework; for example, staff rotation. The technology of modern water management requires staff skills and unit organizations to match the task. Wise laws and soundly devised project concepts are meaningless deceptions without the means to execute them. Legislating modern environmental monitoring is useless without the technical equipment and permanent skilled staff to collect and analyze the data. New technological aids, from models to remote sensing lose value without staff continuity. And massive training programs are a waste when those trained are transferred to other tasks.

Recommendation

Borrowers should modify personnel regulations with the objective of developing a highly skilled capability in each functional area. Following their policy framework, they should tailor

position descriptions, compensation, staff selection and staff promotions to the specialized units. Rules should provide for rigid enforcement of position qualifications, select training and service continuity within the specialized area.

III. Plans for Real-time Operation

Basin and Scheme Operations Plans Under Normal, Flood, Drought and Emergency Conditions

Many basins, particularly those in Asia, are now developed to the level that carefully prepared plans for real-time basin operating plans are necessary to make maximum use of the resource and to take full advantage of all facilities to manage both water supply and flood conditions. The reliability and equity of the individual scheme services would be greatly improved by one master system that monitors weather and flow conditions in a basin to serve all projects and one central office that coordinates and makes real-time decisions for operating the principal facilities. Plans to guide operations during floods, droughts and pollution emergencies should state the priorities, the actions to be taken, the triggering conditions and the public notification requirements.

Recommendation

Borrowers should prepare real-time operating plans and establish organizational arrangements for each river basin covering all water quantity and quality aspects of water management under normal, flood, drought and pollution emergencies conditions.

Plans for Operation and Maintenance of Scheme Facilities

Many agencies do not address the O&M of individual water systems sufficiently during all phases of implementation to assure the planned service to the beneficiaries and sustainability of the facilities. The agencies do not reach agreement with the customers or customer entities on the services or the responsibilities, service rules and penalties for violation. Designers do not consider O&M impacts of adopted designs. Frequently, O&M buildings, equipment and supplies are not included in the project plans, nor are they procured and available at start-up. Few prepare project-specific comprehensive O&M manuals. The construction organization hands over the incomplete facilities to people that may have inadequate O&M training and experience. The consequences, in terms of deteriorating systems, poor service and vandalized facilities, are evident in too many countries.

Recommendations

The preparation of the plan for operation and maintenance (POM), should be initiated as part of the early project configuration studies and defined in great detail in the final design phase. A clear description of the operational concept and O&M program avoids many of the design inadequacies and service shortcomings that are often encountered. Permanent O&M facilities can be constructed for use during the construction phase with a cost savings to both functions. The guidelines for preparing POMs that have been developed by various international groups provide an excellent basis for agencies when they prepare their project-specific POMs.

Borrowers should prepare detailed POMs for every water development project and any subschemes from the basin level to the customer. Each plan should set forth organization, staffing and equipment and incorporate all relevant documents from the field investigations, planning, design and construction phases. It should state operating objectives and policies; rules and criteria on such matters as water allocation, water quality, conjunctive use of surface water and

groundwater, conservation of water and reuse of water; beneficiary responsibilities and service charges. It should specify maintenance and replacement procedures in manuals, both routine and scheduled. It should stipulate customer conduct and penalties for violating rules or abusing facilities. It should include comprehensive project documentation to facilitate operation, maintenance and regulatory actions and any subsequent facilities modifications. Basic documents should include basin and project plans (by reference), the design criteria and analysis reports, as-built drawings, geological reports and construction reports.

IV. WATER OPERATIONS

BASIN VERSUS SCHEME FOCUS

Even the best of operating plans are useless without an organizational structure that can effectively implement the plan. The level of overall basin authority and the extent of direct physical control of facilities will vary, but one office should have jurisdiction over the key structures. This office may in turn be under one organization or it may be the representative of joint operating entities in the basin. Given the limited extent of the actual tasks, the operating unit will be quite small, and will have no responsibilities other than those necessary to meet the objective of coordinated operation of the principal structures. Though a small operations unit following agreed-upon operating rules can coordinate and direct basic operations, the debate on creating powerful all-purpose basin authorities sidetracks efforts to introduce a simple means to meet this fundamental principle.

Recommendation

Borrowers should institute coordinated basin operations of primary storage and diversion features of all water operations and services and provide an operations unit with the necessary monitoring, communications and analytical capability to carry out this function. The basin operations unit mandate should be limited to projecting conditions, coordinating major storages and diversions and monitoring results. It should not engage in any activities in the schemes of the individual diverters.

WATER SUPPLY SERVICE MEASUREMENT AND ACCOUNTING

Flow measurement at key points is essential to operating a basin or a scheme. Ideally, all water supply services should be measured volumetrically for purposes of administering a system of charges. Many countries meter urban deliveries, particularly deliveries to industry. In the case of irrigation, facilities and operation costs preclude direct measurement of deliveries to very small farms. Indeed, most deliveries are to a service area within which the farmers distribute. Nevertheless, the measured area service permits service costs to be charged to that area and in turn to the farmers in proportion to land area served. Long established farmer-owned schemes and some low-lift pumping systems in developing countries use this method to assess members. Drainage services may be similarly measured. Land area within calculated zones of benefit in the protected area is the best basis for assessing flood control and drainage services. However, observations of depth and duration at selected points will indicate the actual service and allow the facility to be corrected or charges, usually property taxes, to be adjusted. Waste collection and treatment, and, more broadly, pollution control measures, are complex, and both the service measurement and the charge mechanism can be addressed in ways that necessitate special consideration of the concept to be adopted.

Regardless of the nature of the water service, it is important to establish the concept of service measurement and to institute regular measurement of the services rendered by each system.

If this is done, the O&M entity will become accountable and seek operational improvement, the benefits will become explicit and a rational basis for charging beneficiaries will be created.

Recommendation

Borrowers should install water meters as possible for industrial and urban residential services. They should also install service measuring devices at the head of service areas within irrigation schemes. In all cases the intended service should be public knowledge. Waste effluent measurements should relate to the charges for collection and disposal services. For irrigation, the actual service provided should be publicly posted at biweekly or monthly intervals at each scheme diversion and at key points within delivery areas. Similarly, flood control and drainage system performance at key locations could be defined in specific terms and publicly posted. Waste management results in terms of measured quality of receiving waters should be publicly posted.

WATER CONSERVATION MEASURES

Water conservation receives attention in every discussion about how to satisfy expanding water demands and water-related environmental concerns. However, "habit modification," low water-use plumbing and desert landscaping of residential areas, have little practical application in developing countries. The urban and industrial metering of water supply services offers conservation opportunities and are being promoted. (They may have a marginal impact in many large Asian cities where residential use is already limited to essential needs.) Demand management through pricing should be considered, but the consumption patterns, physical restrictions on supply and difficulties in collecting even cost-recovery charges will determine its applicability. Water price levels can have an impact and some water service entities have adopted tiered or escalating service charge rates. Water deliveries to meet basic needs for domestic, industrial or crop production are charged at a base rate, with increasing rates for amounts above that. This charge structure may not generate significant funds, but it causes users to improve operations, whereas the combination of water and pollution charges to urban and industrial customers has a double effect on reducing water demand. Some users seek improved industrial processes and modified cooling systems for electric generation that offer significant reductions in water use.

The opportunities to conserve irrigation water vary considerably. Usually the full reuse of return flows from upstream irrigation or the recovery of seepage through groundwater pumping limits the amount of water that can be conserved by additional measures. Reduced conveyance losses and improved application offer considerable opportunities in situations where irrigation runoff or seepage are otherwise lost to saline aquifers or to the ocean. Better practices, including sprinkler and drip equipment, should be introduced in those situations. Equally important, delivery stream size and scheduling can greatly affect the uniformity of application and directly affecting the efficiency of soil-moisture management possible by the farmer.

As is noted previously, repairing urban pipe systems, lining conveyance canals and improving user efficiencies may conserve little water at the basin level, though the reduction in diversions may be important enough to justify expending the necessary effort. The impact on overall supplies of such efforts depends on the location of use and the level in the hydrologic unit at which the savings are made. Overall supplies will be affected by improving "efficiencies" of all users near the sea or where return flows cannot be readily recovered for productive use.

Recommendation

Borrowers should adopt effective conservation measures in the operation of urban and industrial systems. These should include: Service metering with an appropriate service charge structure, combined billing of water supply and waste service charges, and distribution system improvements for metropolitan systems with priority given to regions located near the sea. Local

government should zone sufficient areas near urban centers for waste water irrigation (or groundwater recharge) if quality can be assured and should promote user operations that minimize water quality degradation of return flows to permit reuse. Borrowers should promote both as much water conservation in irrigation and urban systems as possible through service water charges and advanced low-water use in industrial processes and cooling.

V. Maintenance Issues

Maintenance Priorities

In developing countries, the maintenance of facilities suffers from funding shortages. This is often exacerbated by the low priority accorded to this activity by the responsible agencies. Commonly, routine maintenance is inadequate and facilities deteriorate until total project rehabilitation is necessary. The "replacement" category is rarely found in O&M plans, schedules or budgets and project sustainability is sacrificed. As deficiencies grow, countries face huge funding demands, and the hoped-for transfer of O&M responsibilities to users becomes impossible. This situation holds equally in flood control, drainage, irrigation and in components of urban water supply and wastewater collection and treatment systems.

Recommendation

Borrowers should ensure that all categories of maintenance on existing water facilities are fully funded and that capable staff and equipment are provided in a timely manner so that the facilities can continue to operate as designed into the future. This objective should have the highest priority on funds, ahead of new construction, as sustainability was explicitly assured in the original project evaluation and investment decision.

Acceptance, Transfer and Guarantee of Facilities

Project sustainability and services depend directly on the completeness and soundness of the facilities' construction at the time of transfer from construction to O&M status, and on the timeliness of the transfer. Some projects linger under the construction unit's jurisdiction for years without O&M budget, equipment or knowledgeable staff to maintain the works. In other cases, projects lack facilities and incomplete site work is transferred to O&M units. The receiving O&M units lack construction capability and budget to complete the works.

Formal transfer procedures, incorporating clear assignment of responsibilities with accountability for quality and completeness of works, can overcome much of the problem. The construction unit must assure completeness of all work, guarantee the quality and promptly correct deficiencies found within a warranty period using capital construction funds. Before acceptance, the O&M unit must be satisfied in all respects and receive all manuals, as-built drawings and start-up results on equipment and facilities.

Recommendation

Borrowers should institute formal facility transfer procedures, which should include conditional acceptance by O&M units upon satisfactory completion of the facilities and site clean-up. Provisions should also be included for the construction unit's warranty to correct deficiencies encountered within the first three years after conditional transfer. The final transfer should be made when such work has been completed and its quality proved.

METHODS OF EXECUTING MAINTENANCE

In most governments, the O&M entity's staff execute all maintenance on public irrigation schemes. Where there are fluctuating budgets and shifting surplus agency staff, gross inefficiencies result and personnel costs can approach 90 percent of the total O&M budget. Equipment shortages, inappropriate means and ill-trained operators are prevalent constraints to effective O&M. Some governments contract maintenance to the private sector, offering flexibility in scheduling as well as competition to control costs. In these instances, multiyear maintenance contracts allow contractors to secure efficient equipment and retain capable staff. Local conditions dictate the most suitable approach, but regular review of maintenance costs and results by senior officials or oversight units should have the objective of adopting the most cost-effective approach.

Recommendation

Borrowers should evaluate their methods for conducting irrigation facilities maintenance and carefully consider the use of maintenance contractors for routine as well as special maintenance. Trial routine maintenance contracts should be undertaken at intervals to serve as a comparison for existing means for maintenance used by the agency.

The regulatory functions and their necessity for overall resources management were discused under Institutions, Section IV. But effective real-time resources management is impossible without the rigorous administration of the regulatory legislation. This is a key principle or the physical operation and services will have no bounds and individuals will ignore the laws whenever they find it in their interest.

Recommendation

Borrowers should establish staff and equip units at the central, state, basin and local levels as appropriate to actively perform the regulatory functions necessary to manage their resources. The regulatory areas include surface/grounded rights; land-use rights; water quality and dam safety.

ADMINISTRATIVE AND FINANCIAL INTEGRITY OF SERVICE ENTITIES

Though governments have auditing procedures for agencies' fiscal performance and oversee some administrative activities, the water service sector is largely unsupervised. There are no administrative or fiscal performance reports that can be examined. However, efficient, real-time services in the water sector will never be realized until agency performance is thoroughly and regularly evaluated.

Recommendation

Borrowers should implement regular administrative and fiscal audits of government service entities and issue regular reports of their findings. Staff, equipment and offices should be provided to a unit reporting to the ministerial level. The actions of management and the service rendered should be included in the review and discussions.

FINANCIAL ASPECTS OF WATER RESOURCES ACTIVITIES

Financing water resources activities is not entirely an institutional subject. In discussion, however, it is often linked to the institutional issues of allocation mechanisms, pricing services and organizational responsibilities. Principles have evolved for calculating and allocating project costs; financing project investment, operation and maintenance (O&M) and subsidies; cost recovery; and service pricing.

I. PROJECT COST AND ALLOCATION AMONG PURPOSES

Several countries successfully apply standard principles for project cost allocation among project purposes. These identify categories of uses and direct and indirect benefits and assign associated costs -- capital, interest, operation, replacement and maintenance being typical. Yet, many borrowers do not apply consistent cost allocation rules to their projects, and some have no rules. This prevents proper analysis of potential benefits during project formulation and the correct costing for subsequent use in setting service prices.

Recommendation

Borrowers should adopt formal cost allocation procedures and apply them consistently in their planning and management. Allocation categories should include all services -- municipal, industry and irrigation supply, waste collection and treatment, flood control, drainage, navigation and hydro and the nonservice purposes such as recreation and any environmental enhancement, but not mitigation. Allocation should be made in full to all purposes, and any subsidies should be identified and applied during the subsequent pricing/funding decisions.

II. SERVICE COST COMPONENTS

There is debate over what should be included in costing services in the water sector. Typically, developed countries apply the principle that service costs comprise all costs to constrict, operate and maintain the single-purpose service facilities and the same categories of costs allocated from multipurpose projects serving the scheme. These costs are measurable, easily examined and can be judged to be fair by beneficiaries and the public alike. Differing from system to system, they match what the beneficiaries receive in each situation. No approximation or outside rationalization is involved. Recovery of most of these costs would allow governments to continue future undertakings without sacrificing other obligations.

Recently, some countries have charged water quality degradation as an operating cost, since downstream users will incur direct expenses by the polluters' action. This most obviously applies to urban and industrial dischargers. Theoretically it could apply to agricultural discharges when they are caused by chemicals or livestock operations rather than by natural runoff.

It has been suggested that "opportunity costs" should be used as the basis for charging customers of water supply services, even where the water use, and hence the water allocated, is authorized under legislative action. The concept would replace the use of the cost of facilities as the basis. But the mechanics of calculating opportunity costs, the rate of change in this component as it affects investor plans, its application to environmental uses and how to free it of political and worse influence are not resolved. Of course, as "free market" pricing, this would function as an

allocation mechanism, overriding any other water allocation objectives such as social, environmental and security.

Foregone opportunities are one of a great many "costs" of a society's decisions in allocating its land, water and other resources. Since opportunity cost pricing is not yet applied in the developed countries, it should remain under study for application in the developing countries. Even if a practical application method is devised, this can only be considered after a country's society has set its allocation objectives and undertakes to select its allocation mechanisms.

Recommendation

Borrowers should calculate costs for all water related services -- supply, waste collection and treatment, flood control, drainage, navigation and hydropower -- using the cost allocation principles described. The calculation of service costs should be kept independent of the subsequent decisions on setting service charges, subsidies and general cost recovery mechanisms.

III. Cost Recovery

One cause of deteriorating systems is governments' unwillingness or inability to budget to meet their clear obligations to maintain the facilities. The linkage of O&M funding to cost recovery has served to justify this underfunding. (The excessive level of maintenance sometimes required is often caused by construction deficiencies.) The first principles relating to cost recovery are that government should fully budget system O&M and separate that from the effort to institute cost recovery. This is discussed further under O&M Funding.

The full costs of government-provided water services is seldom recovered from the beneficiaries, though some countries are moving aggressively in that direction. Flood control, navigation, drainage, most irrigation, most large water supply systems and essentially all waste treatment are subsidized. The primary exception is the hydropower sector, where subsidies are minimal. Yet, private and farmer-owned irrigation systems in these same countries are financially self-sufficient. These unsubsidized schemes serve the majority of irrigated lands in some countries. Often municipal and local government water-supply schemes are essentially self-sufficient. In a few countries, small government-built irrigation systems are turned over to the farmers to operate and maintain, but usually no capital costs are recovered.

Private and water-user-owned systems that have existed for decades and even centuries prove that water supply and irrigation schemes can be physically and financially self-sustaining. They follow common principles that are important to their success. The system is designed as an affordable facility consistent with the benefits; the construction is of a type and quality that results in affordable maintenance, the beneficiaries invested in the facilities, the government does not guarantee rehabilitation when deficiencies or failures occur, the service is reliable as measured by the rules, and a disciplined operation is supported by strong beneficiary enforcement of rules. As may be seen, cultural and economic conditions in most developing countries justify beneficiaries paying for services, unless government has undertaken costly or unsuitable projects or is not providing a reliable service.

Recommendation

Borrowers should institute a system of direct and indirect charges to beneficiaries to recover the costs of most services in the water sector including municipal and industrial (M&I) supply and waste removal; irrigation and drainage for agriculture; flood control (to the extent it is not a national benefit on major rivers); hydropower and navigation (again to the extent it is not a national benefit such as with rural ports for fishing and transport). Project investment subsidies

may be justified so a country can meet adopted objectives through construction of expensive schemes. (This helped nations to settle new lands, and it is now used to control urban and industrial pollution.) Flood control for major urban areas commonly receives such subsidies. However, no O&M subsidies should be warranted, except for delayed collection during a brief start-up period. The only exception would be where abnormally high O&M costs occur as the result of poor construction. However, government should never force an O&M agency to assess charges below full cost recovery unless it directly and fully augments the O&M agency budget as required to sustain the system.

IV. Service Charge Mechanisms

Several direct and indirect factors influence the selection of service charge mechanisms. These include the service, conservation incentives, subsidies, poverty alleviation, equity and the ability to pay. Every advocate of the various mechanism can find a cause in its resolution. However, the recovery of costs is not only a question of paying for a service, but a necessity as government budgets tighten.

A variety of customer service charges are used. Examples are delivery charges for M&I and irrigation; stand-by charges for a service that enhances the property value or for fire protection; and zoned property tax assessments to beneficiaries and, at different tax rates, to the adjacent public that reflects the level of flood control and drainage protection. Usually, a mix of mechanisms best suit irrigation O&M financing. A component property tax will carry a water supply service through low-delivery years of drought, while delivery charges will reflect actual benefits derived by the customer. A tiered or escalating rate structure will encourage water conservation in municipal and irrigation systems. Minimal rates will apply to the system's low-income group. Experience shows that drainage and flood control costs are most effectively and equitably charged through zoned property taxes. Several countries are experimenting with new waste-charge mechanisms. These should be viewed from the standpoint of adequacy of recovery, equity and effectiveness if they serve as a pollution management tool.

Recommendation

Borrowers should establish a clear, detailed policy document that includes procedures to determine service charge mechanisms. Further, borrowers should calculate service charges on each specific system to reflect the system's peculiarities, the level of services by the beneficiaries and the basic principle of no cross-subsidizing by beneficiaries among different systems. All should be applied in an open, easily monitored manner. The collected funds should be rigorously accounted for, assigned in total to the entity providing the service and dedicated to the purpose and isolated from other funds.

V. Funding Capital Expenditures

The funding of capital expenditures concerns countries at every stage of development, but particularly those with limited means. Their growing development demands exceed outside funding assistance, thus forcing attention to other sources for funds for future undertakings. The most obvious method of funding is substantial or full payment of all capital costs by the beneficiaries. This both provides replenishments to fund future reports and improves agency performance through customer pressures.

Recommendation

Borrowers should finance, at fair interest rates, local governments' and user entities' needs as a condition for pursing new projects. In many instances, government loans should replace grants for rehabilitation and emergency repairs. Service entities use a variety of charge mechanisms for reimbursing government. They should establish the goal of financing local works through revenue or obligation bonds on the financial market. Hydropower and M&I systems offer particular opportunities for using such means, as do larger irrigation schemes when they are backed by government.

VI. Funding Operation and Maintenance Expenditures

Government Guarantee of Full Operation and Maintenance Funding

Borrower governments long have assumed responsibility for water development. They have allocated the resources, planned the developments and executed the work without considering options. Indeed, even the beneficiaries have not been engaged in devising the program, though they had demonstrated capabilities by prior development. With development and construction of infrastructure goes the responsibility to maintain the facilities. Though not necessarily stated, this is as obvious an obligation as any component of the program. There can be no question that governments know their inherent responsibilities and that they must meet them. Unfortunately, the O&M situation today demonstrates some borrowers' continuing neglect.

Recommendation

Borrowers should guarantee O&M funding of government-owned facilities at a level to sustain the facilities in a condition to fully provide the designed services on into the future. This should override all other agency budget demands. The principle followed in bond financing of such facilities should be rigorously applied by the government and by any lending agencies supporting construction of such facilities. The principle is that the first call on any revenues (government budget) produced by the scheme is to fund O&M fully at the level necessary to permanently sustain the facilities. The adequacy of the O&M effort must be verified by an outside review unit. Any revenues surplus to O&M may be applied to other budget items. Any shortfall should be made up by the owner. This principle should never be violated, even in the short term. In no other way can a country reconcile its wishes with its means. Neither is there any other action that is as effective in assuring sound, affordable investment in resources development.

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