

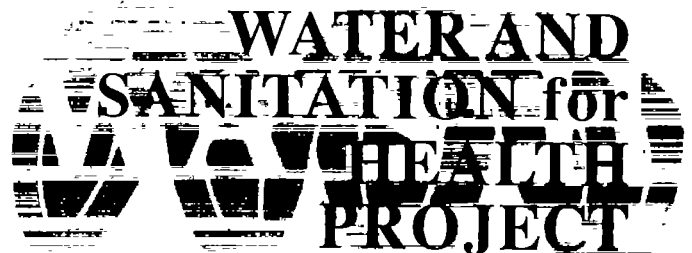
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MODELS OF MANAGEMENT SYSTEMS
FOR THE OPERATION AND MAINTENANCE OF
RURAL WATER SUPPLY AND SANITATION FACILITIES

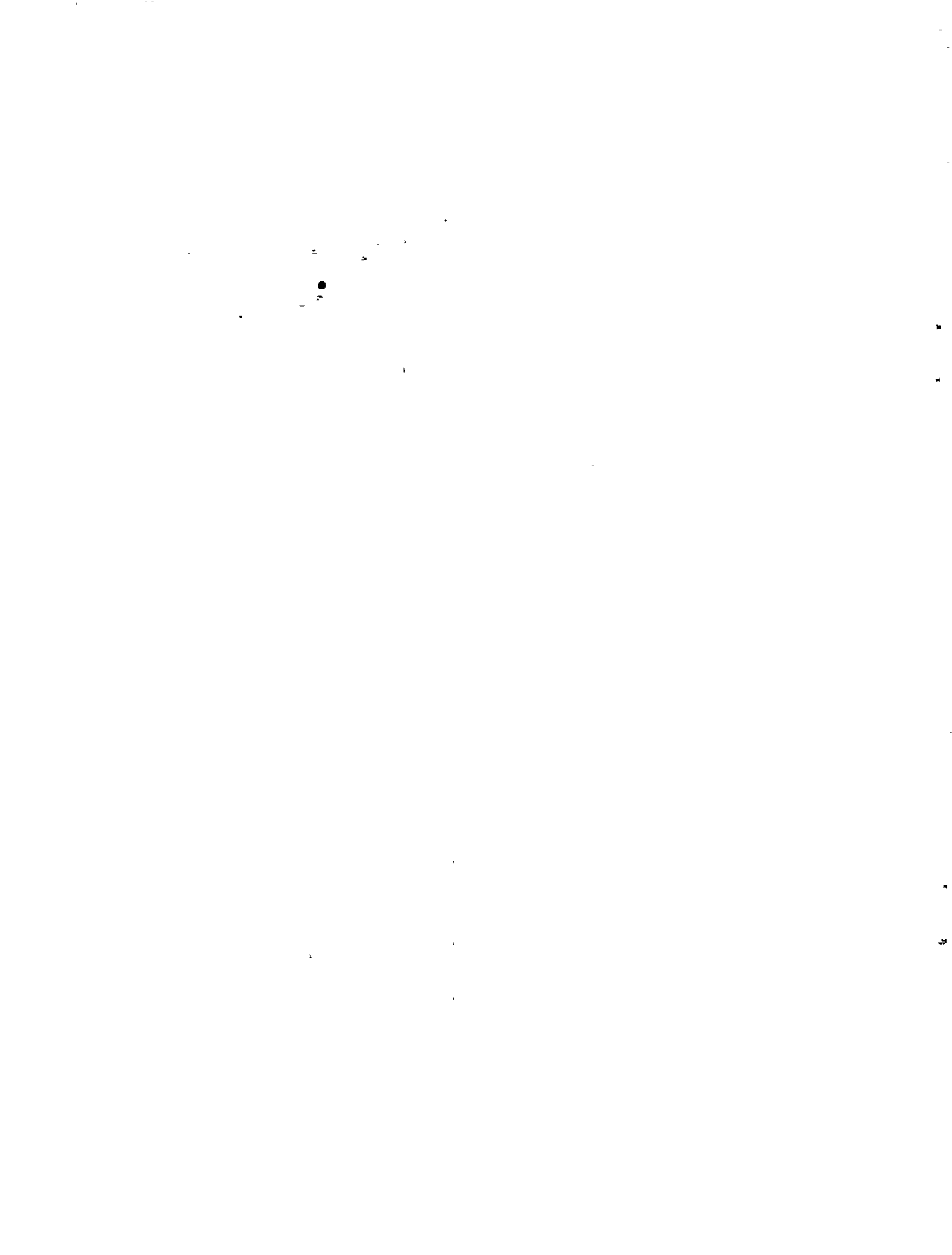
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WASH Technical Report No. 71

**MODELS OF MANAGEMENT SYSTEMS
FOR THE OPERATION AND MAINTENANCE OF
RURAL WATER SUPPLY AND SANITATION FACILITIES**

Prepared for the Bureau for Research and Development,
Office of Health, U.S. Agency for International Development
under WASH Task 162

by

Philip Roark
Jonathan Hodgkin
Alan Wyatt

February 1993

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RELATED WASH REPORTS

Estimating Operations and Maintenance Costs for Water Supply Systems in Developing Countries. January 1989. Prepared by James K. Jordan and Alan Wyatt.

Assessment of the Operations and Maintenance Component of Water Supply Projects. June 1986. Prepared by James K. Jordan, Peter Buijs, and Alan S. Wyatt.

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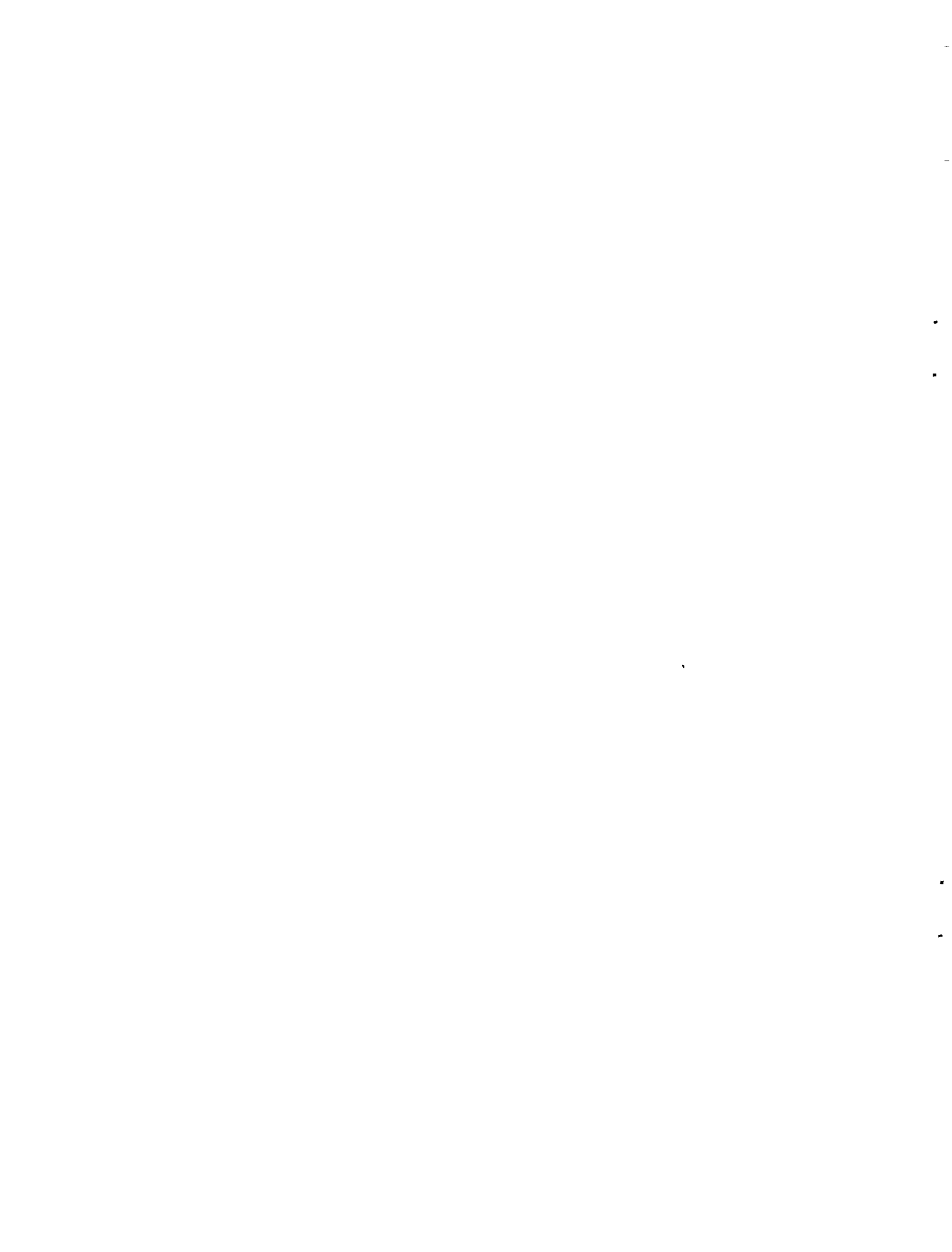
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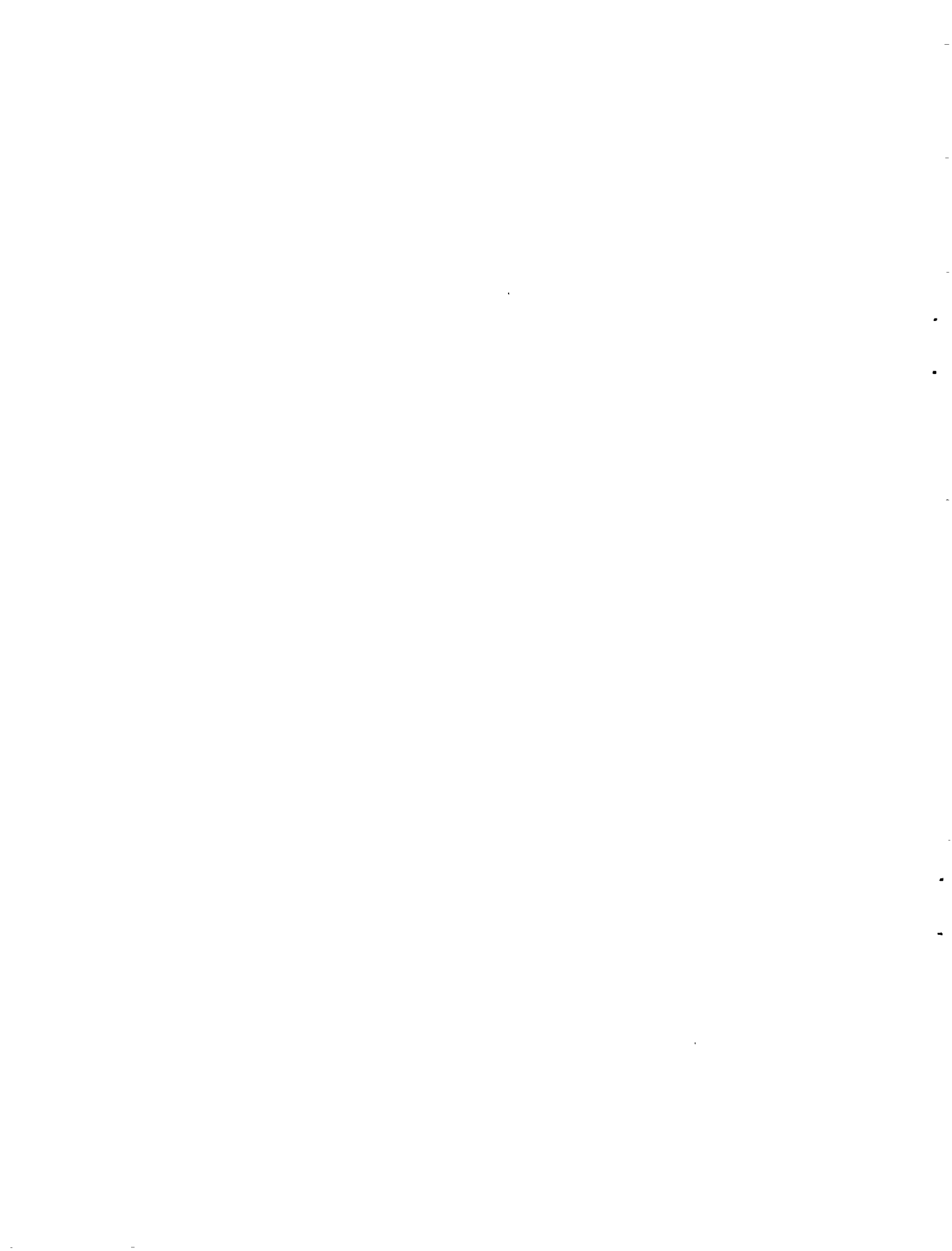


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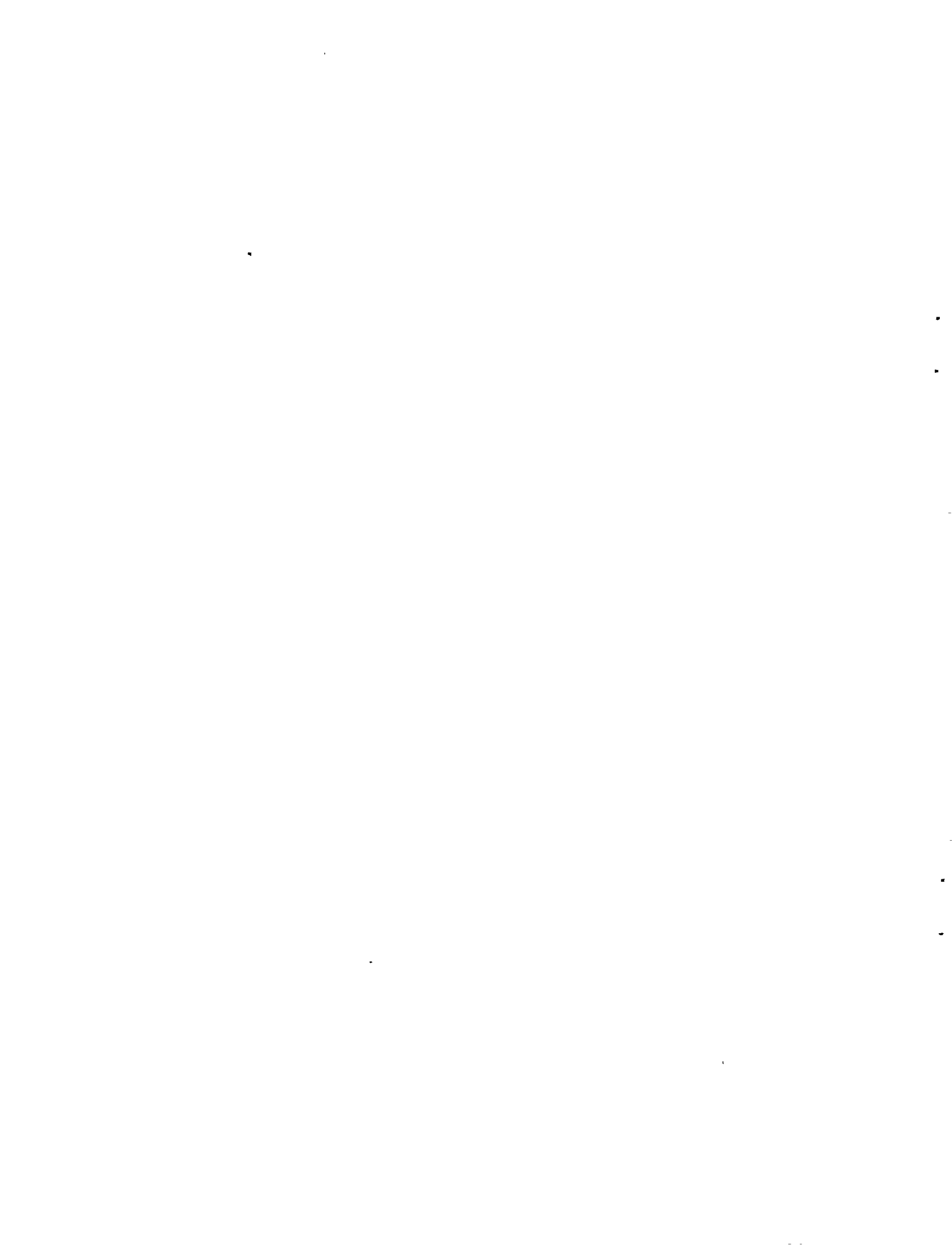


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ACRONYMS

A.I.D.	U.S. Agency for International Development (Washington, DC)
O&M	operation and maintenance
PM	preventive maintenance
PVO	Private Voluntary Organization
UNICEF	United Nations International Children's Emergency Fund
USAID	U.S. Agency for International Development (Country Mission)
WASH	Water and Sanitation for Health Project
WHO	World Health Organization
WSS	water supply and sanitation
<i>Botswana</i>	
BPMS	Borehole Preventive Maintenance Service
DWA	Department of Water Affairs
MLGL	Ministry of Local Government and Lands
MMRWA	Ministry of Mineral Resources and Water Affairs
SIDA	Swedish International Development Agency
WD	Water Department
WMU	Water Maintenance Unit
<i>Yemen</i>	
LDA	Local Development Agency
RWSD	Rural Water Supply Division
<i>Sudan</i>	
NCRWRD	National Corporation for Rural Water Resources Development

Belize

BOM	Board of Management
GOB	Government of Belize
MOH	Ministry of Health
RWSSP	Rural Water Supply and Sanitation Program
WASA	Water and Sewage Authority

Tunisia

CRDA	<i>Commissariats Régionaux de Développement Agricole</i>
GOT	Government of Tunisia
MOA	Ministry of Agriculture
VLOM	very low operation and maintenance
WUA	Water User Association

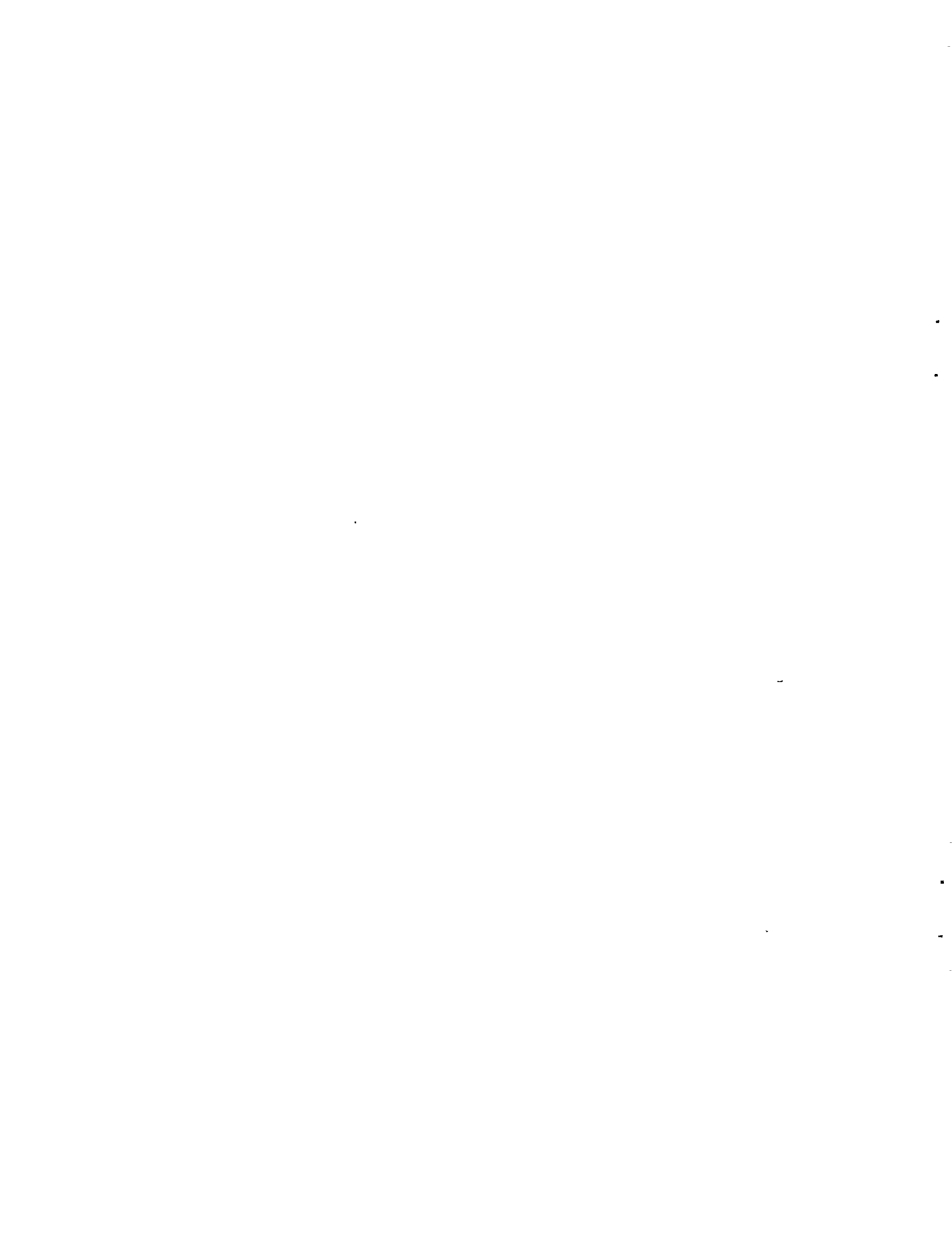
Indonesia

Repelita	National Development Plan
Cipta Karya	Ministry of Public Works, Directorate General of Human Settlements
BPAM	Regional Water Supply Organization
PDAM	Regional Government Water Enterprise
INPRES	Ministry of Home Affairs, National Subsidy for Local Development
HIPPAM/BPASB	Village Water Management Committee
CARE	US Private Voluntary Organization

Costa Rica

AYA	<i>Instituto Costarricense de Acueductos y Alcantarillados</i> (Costa Rican Water and Sewer System Bureau)
CAAR	<i>Comite Administrativo de Acueductos Rurales</i> (Rural Aqueducts Administrative Board)
MSP	<i>Ministerio de Salud Publica</i> (Ministry of Public Health)

PAC *Programa de Ayuda Comunal (Community Development Program)*
SNE *Servicio Nacional de Electricidad (National Electricity Service)*



EXECUTIVE SUMMARY

The actual number of people served by water supply and sanitation (WSS) facilities is often less than supposed because many facilities are either inoperative or operating at less than design capacity. In such cases, it is usually that management systems have failed to provide the necessary guidance and structure for effective operation and maintenance (O&M).

This report considers the many issues and actors that influence the development of O&M management systems for rural WSS facilities in developing countries. It describes models in eight representative countries and offers guidance to planners and designers in selecting the most appropriate one.

Models for rural WSS facilities range from highly centralized ones managed by government agencies to community systems owned and operated by local organizations. Between these extremes is a continuum of management models that includes participation by government agencies, communities, and private entities.

Management models often are characterized by the number of management tiers involved. The first tier is the government agency responsible for O&M at the national level. The second tier represents an intermediate body, either a regional government organization or a private group. The third tier is composed of local communities that operate and maintain their own facilities. The relative importance accorded to each tier defines the management model. Most countries use a two- or three-tier model, with responsibility varying from a strong central government role to a strong community role. Less common are single-tier models where either a government agency or the community has sole management responsibility.

Key issues that influence the choice of O&M management models are:

- Capacity of Traditional Community Organizations
- Key Community Skills
- Health Education and Community Participation
- Participation of Women
- Complexity of Technology
- Availability of Spare Parts
- Standardization and Local Manufacture of Equipment
- Requirements Shared with Other Sectors (e.g., Irrigation)
- Capacity of Private Sector
- Cost Recovery Mechanisms
- Ability and Willingness to Pay

- National and Regional Economies
- Logistics and Transportation
- Government Leadership
- Strength of Government Agencies and Staff
- Regional Autonomy
- Policies and Legislation
- Communication and Information Sharing

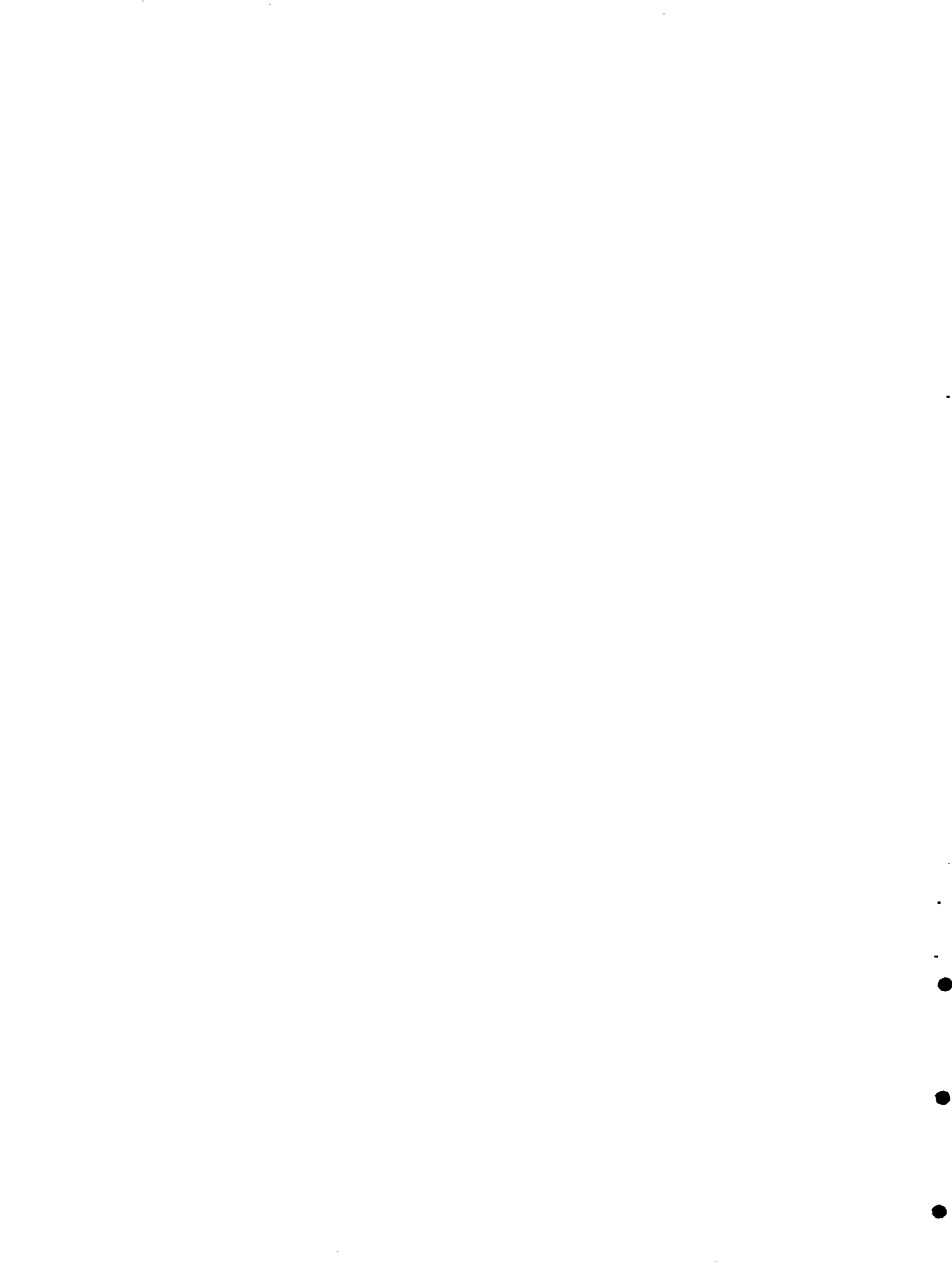
The role of O&M in the project cycle is critical to sustainability of project benefits; indeed, O&M may be considered synonymous with sustainability. The actors involved (national government agencies, regional government agencies, the private sector, and communities) have different contributions to make and each is a key component of project success. Case studies to illustrate these roles have been selected from eight representative countries: Botswana, Yemen, Sudan, Belize, Tunisia, Indonesia, Benin, and Costa Rica.

Botswana relies on a strong national government role because of a well-endowed national treasury. Yemen has a community approach that depends on capable local technical skills and an informal system of capital for repairs. Sudan is a poor country with centralized but ineffective leadership that has created a parallel management system at the local level. Belize has a dual management system determined by the two WSS technologies in use. Tunisia represents a system in transition from highly centralized to community management. Indonesia offers an example of community management that was facilitated by a nongovernment organization. Benin has established a three-tier system within a USAID project that depends on a strong private sector to provide spare parts and perform repairs. Costa Rica is a comparatively wealthy country with a strong central government dedicated to providing high levels of WSS coverage with increasing emphasis on community management.

From this variety of management models, there are several valuable conclusions that may guide planners in selecting the most suitable one for a particular situation.

- Involving the communities in project decisions is essential for effective O&M.
- The choice of technology must be congruent with local economic conditions.
- Training in management techniques is usually a necessary component of community-managed facilities.
- Willingness to pay for rural WSS facilities is complex and variable, but individuals usually will be eager to pay for water but reluctant to pay for sanitation.
- Spare parts supply rather than the availability of mechanical skills usually is a major problem in O&M.

- Despite the increasing emphasis on community control, decentralization, and private sector involvement, there always will be a role for government WSS agencies, at least to monitor and assess the effectiveness of management arrangements.
- Government extension agents are a critical communication link between the government and the communities.
- Strong national leadership is required to build popular confidence in the wisdom and equity of WSS and O&M policy.



1

INTRODUCTION

1.1 Overview

Management of rural water supply and sanitation (WSS) systems continues to be a major issue within the sector. Data on the numbers of people served by these facilities often are overly optimistic because many of them are inoperative or operating at reduced capacity. In most cases, management systems have failed to provide the necessary guidance and structure for effective operation and maintenance (O&M).

There are several management models, each appropriate for a particular country or situation. Models for rural or peri-urban WSS facilities range from highly centralized ones managed by government agencies to grassroots community systems owned and operated by local organizations. Between these extremes is a continuum of shared management models, including participation by government agencies, communities, and private entrepreneurs. Water supply facilities for rural and periurban areas may range from relatively simple gravity-fed pipelines and handpumps to more sophisticated pump and storage systems using diesel, electric, or solar power. Potable water may be supplied at a standpipe or well or piped into the home. Sanitation facilities range from pit latrines to flush toilets with leaching fields. Management models for urban WSS systems in developing countries tend to follow models established in developed countries and are not addressed in this report.

Management models often are characterized by the number of management tiers involved. The first tier is the government agency responsible for O&M at the national level. The second tier represents an intermediate body, either a government organization or a private group that has regional responsibilities. The third tier is composed of local communities that operate and maintain their own facilities. The relative importance accorded to each tier essentially defines the management model. Most countries use a two- or three-tier model, with responsibility varying from a strong central government role to a strong community role. Less common are single-tier models where either the government agency or the community has sole management responsibility. Figure 1 illustrates the tier concept and various management models.

There have been some recent notable trends in the development of management models as governments strive to improve their O&M capabilities. Many governments are considering or implementing a decentralized policy, giving greater authority and responsibility to tiers below the national level. Another trend is to bestow full ownership and management responsibility on community organizations, with only marginal oversight by government agencies. A third trend is the increasing reliance on the private sector to maintain and repair WSS facilities. In some countries a particular model may work quite well, while in others the same model is less

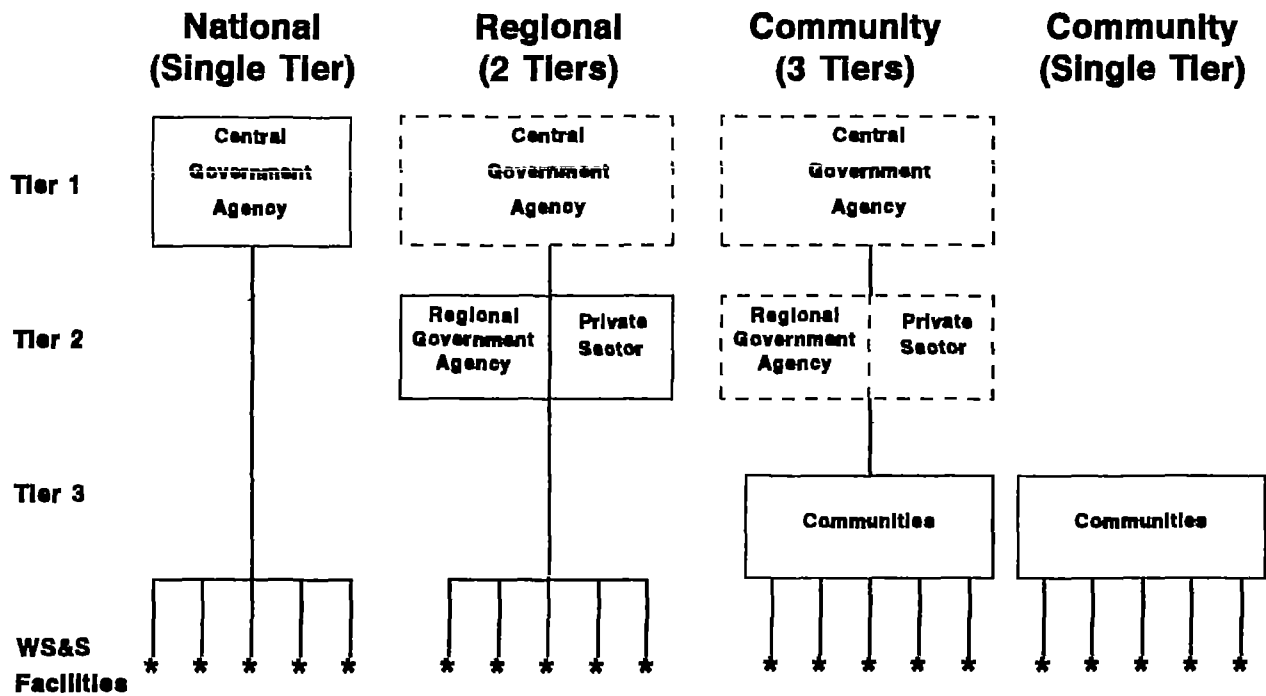


Figure 1

Management Models and Tiers of Responsibility

effective or meets with failure. Selecting the right model for a particular country requires consideration of many interrelated factors.

1.2 Objective

This report discusses the issues that influence the choice of a particular management model and provides examples of countries where various models are in effect. It offers planners and designers of projects recommendations for the most effective operation and maintenance of WSS facilities and emphasizes the importance of management responsibility. Key questions to be considered are:

- What responsibilities should communities have in O&M management?
- What are the optimum roles of government and the private sector in management?
- How does the local economy affect the choice of technologies?
- What role do leadership and policy play in O&M management?

The choice of a particular management system requires a review of the actors and activities, as well as the prevailing issues and influencing factors. This is shown schematically in Figure 2. The actors, in collaboration with one another, propose a set of activities that are passed through a filter of issues to determine whether the activities are acceptable, need to be modified, or perhaps rejected. It can, of course, be presumed that these same issues are an omnipresent backdrop influencing the original determination of activities and the thinking of the actors as the project develops. During the course of the project, information is reprocessed through the monitoring of successes and failures of these activities, and again filtered through the same set of key issues. The successful implementation of WSS activities ultimately produces not only health benefits but also benefits to society, the economy, women, and the environment. It is the various combinations of actors, issues, and activities that produce the management models of interest in this report.

Management in this report is defined as the marshaling of resources to plan, direct, monitor, and evaluate the operation and maintenance of WSS systems. A prerequisite is that all actors understand their roles and responsibilities and have the resources to carry them out. Project designers must consider this from three perspectives: the technical requirements of O&M; an organizational setup that clearly assigns management responsibility to various actors; and an institutional process that ensures long-term stability. This report addresses only the last two elements, as the technical requirements of O&M are straightforward and are not a significant problem within the sector.

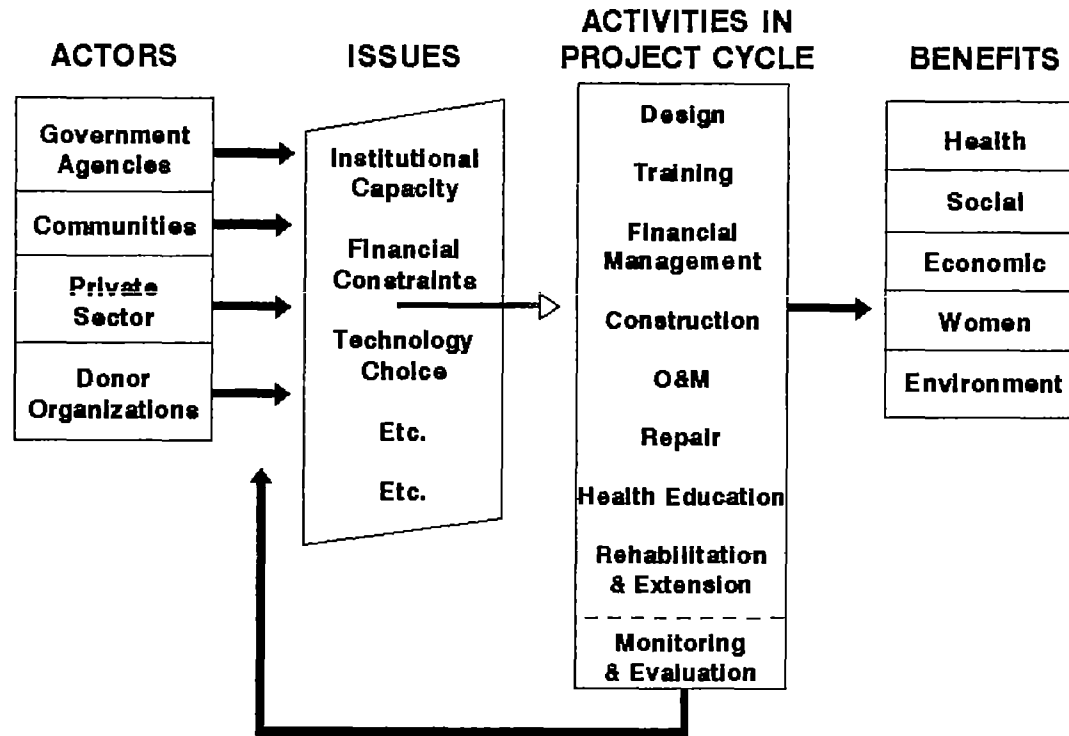


Figure 2

Flow Chart of Actors, Issues, and Activities Involved in Water Supply and Sanitation Projects

1.3 Water and Sanitation Management Differences

The report focuses on water systems, while recognizing that in many situations water and sanitation facilities are developed as part of a package. The intention is not to diminish the importance of sanitation, which often contributes as much or more to improving health, but to concentrate on water systems because they tend to be more complex in rural areas and therefore require a wider variety of management approaches.

Rural water systems are always shared and sometimes owned by the community at large, while sanitation systems, in the form of latrines, are generally privately owned and used and are the responsibility of the owners and thus not a management issue. Examples of shared latrines are schools, markets, and sometimes several families who join together to cut costs. In the case of schools, the students typically are required to carry out cleaning and minor maintenance. Market centers may have a merchants' organization that pays for cleaning and repairs, but successful examples are few. Families work out some time-sharing arrangements for cleaning and repair before they agree to build the latrine.

Management of latrines is a minor problem compared with the larger issue in the sanitation sector of expanding coverage in rural zones. Rural dwellers must be persuaded to accept the need for proper sanitation and convinced of the risks that poor sanitation poses to their health.

1.4 Organization of Report

Following this introduction, the report discusses the role of O&M in the project cycle (Chapter 2), provides an overview of the many issues affecting the management of WSS systems (Chapter 3), presents case studies from eight countries that exemplify the wide range of management models in practice (Chapter 4), and ends with some conclusions (Chapter 5).

2

ROLE OF O&M IN THE PROJECT CYCLE

2.1 Goal of WSS Projects

The primary goal of WSS projects is to improve or safeguard the health and well-being of targeted beneficiaries. This will be achieved only if the facilities function and are used as they are intended. A management model must include operation and maintenance to sustain long-term benefits.

The project cycle is an ordered progression of activities designed to produce benefits over time (Figure 3). At the start, organizational matters take precedence and there are no project benefits before construction begins. A properly planned project will incorporate the O&M management system at the design stage. As each facility is completed, O&M activities begin and benefits start to accrue. When the project ends, it should leave in place an O&M system that will maintain or even increase benefits. Such a project is said to be sustainable, a state that is primarily dependent upon achieving a proper O&M management system.

2.2 Actors in Project Cycle

The principal actors in the project cycle are:

- the national government WSS agency
- the regional government WSS agency
- the private sector
- community organizations

Each of these has different attributes related to potential management capabilities. National and regional government agencies have constitutional authority, widespread power, and the ultimate responsibility to safeguard the health of citizens. These agencies usually have some of the best managerial talent, although their responsiveness to citizens' concerns and needs may be less than desirable. A key individual actor is the extension agent, who provides the liaison between the community and the WSS agency and serves as the conduit through whom information flows to and from the community both during construction and especially after the project has been completed. As such, the agent is critical to the management system.

The private sector consists of entrepreneurs, whose primary objective is profit-making, and nonprofit voluntary organizations, whose funding sources are not the targeted population but outside donors or government agencies. Nonprofit organizations tend to undertake riskier

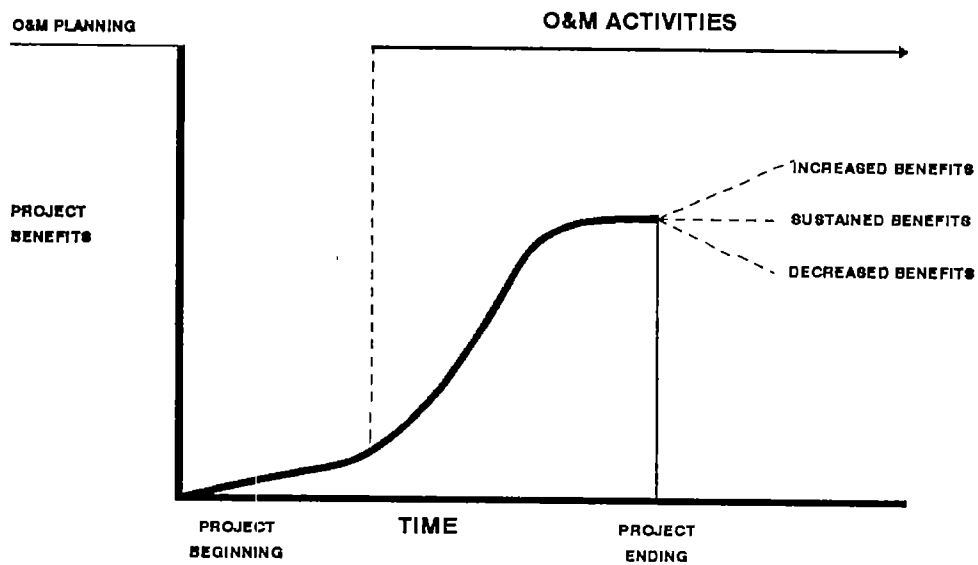


Figure 3

Benefits of Water Supply and Sanitation and Role of O&M over Project Cycle

projects in economically marginally areas. Some of the best managerial talent typically is found in profit-making organizations. Communities have the biggest single stake in proper management as the direct beneficiaries of smoothly run WSS facilities, but typically have the fewest resources and multiple limitations in managing them. Training is often required to bring community management skills up to the level needed.

Donor organizations may also play an important role in O&M activities, although generally they prefer to provide assistance during the design and construction phase and to leave O&M management to local institutions. The idea is to discourage long-term dependency on outside assistance. However, unless key management issues are adequately addressed in the design stage and management systems have been firmly established during the project cycle, local institutions are unlikely to be in a position to assume responsibility at the end of the project. Donors who do not plan for adequate O&M management jeopardize their investments because the WSS facilities to which they have contributed are at risk of long-term failure.

2.3 Activities in Project Cycle

The activities in the project cycle are listed below in order of occurrence. Some reordering and overlap may occur under specific circumstances (see Figure 2).

- Design of WSS System
- Training to Impart Needed Skills
- Financial Management
- Construction
- Operation and Maintenance
- Health Education
- Repair
- Rehabilitation and Extension
- Monitoring and Evaluation

Design covers the detailed planning of not only the physical plant but also the institutional structure and management arrangements. Government agencies design the facilities, with input from the community, and give due consideration to management at this stage.

Training is provided to equip the community with the skills to support the activities specified in the project design. Specialized agencies must design training according to community needs. Training may include such subjects as leadership, accounting, pump repair, and hygiene.

Financial management is the control of O&M funds and should be entrusted to the community if it is given the responsibility for meeting O&M costs.

Construction covers the building of the facilities and, depending on the technology, may be a joint effort by a government agency, private entrepreneurs, and the community. The technology must be compatible with the manager's ability to control and utilize the facilities.

Operation and maintenance covers the efficient day-to-day working of the facilities, regular preventive maintenance, and the assurance of proper use. The communities are the logical choice but other actors have a potential role depending on the situation.

Health education is intended to promote hygienic use of the facilities and tends to be an ongoing activity to reinforce positive user attitudes and practices, which in turn will facilitate O&M management. Specialized government agencies, usually within the Ministry of Health, normally are responsible.

Repair, as opposed to preventive maintenance, covers the replacement of damaged parts and typically is a joint effort between the government, the private sector, and the community.

Monitoring and evaluation is the formal assessment of the effectiveness of the system and its benefits to the community. The community itself is the logical evaluator but government extension agents also should closely monitor the evaluation to ensure the public good. An

essential purpose of monitoring and evaluation is to use the results to modify activities, if needed, to better achieve project goals (see Figure 2).

Rehabilitation and extension completes the cycle by replacing worn-out segments of the facility or extending it to accommodate changed needs. This should not be necessary for several years after the project has been completed and will depend on the effectiveness of the O&M system. The community plays a prime role in this process but may need assistance from government agencies and the private sector.

Figure 4 shows the actors and activities in a typical water and sanitation project during the three stages of the project cycle: pre-project, project, and post-project.

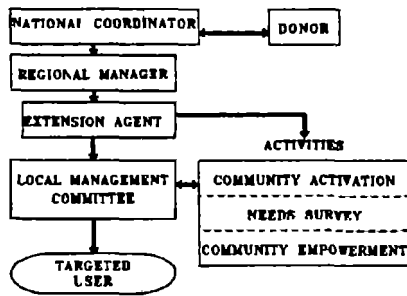
In the project stage, the emphasis is on the construction of facilities and on training to strengthen human resources. The establishment of local management committees to plan and oversee construction is essential. Hygiene education makes the user population aware of the role that water and sanitation play in health care. Social, economic, and other benefits follow as the project proceeds. As it nears completion, inputs are gradually removed and the designated actors take over full responsibility. Most important is the responsibility for operation and maintenance, which includes provisions for financial autonomy and spare parts procurement.

The trend is towards making users fully responsible for financing, although some governments choose to provide partial subsidies. Spare parts generally must be imported, although many countries are encouraging the local manufacture of needed components. The distribution of equipment and parts usually is in the hands of private dealers, who are needed at locations convenient to the users.

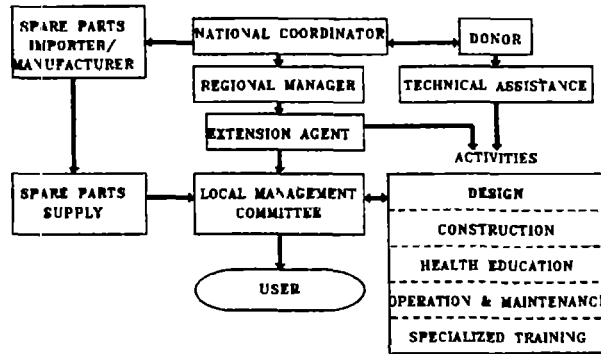
At the post-project stage, donor inputs have ceased and designated host country actors have assumed full responsibility. Chief among these are the users, who have the biggest stake in ensuring the survival of the facilities. In some cases full ownership is ceded to the community, but the government continues to observe developments and provide assistance if required. The extension agent offers solutions to any problems that occur and monitors O&M practices, conducts periodic health education sessions, and works with local management committees. At this stage of a typical WSS project that is expected to be sustainable, all the actors and activities described must be in place.

Yet, important as these are in the project cycle, even more essential for an effective O&M management system are several key issues that vary in importance from one country to another. The actors involved must be considered because of their considerable impact. These issues are discussed in the following chapter.

PRE-PROJECT STAGE



PROJECT STAGE



POST-PROJECT STAGE

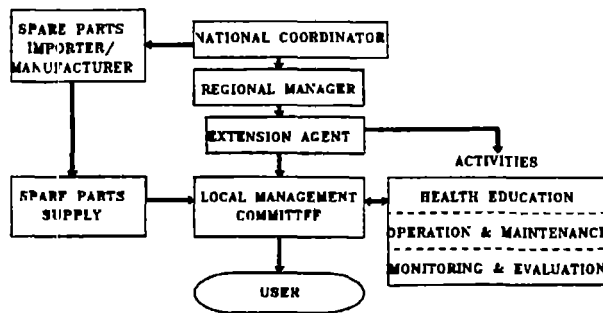
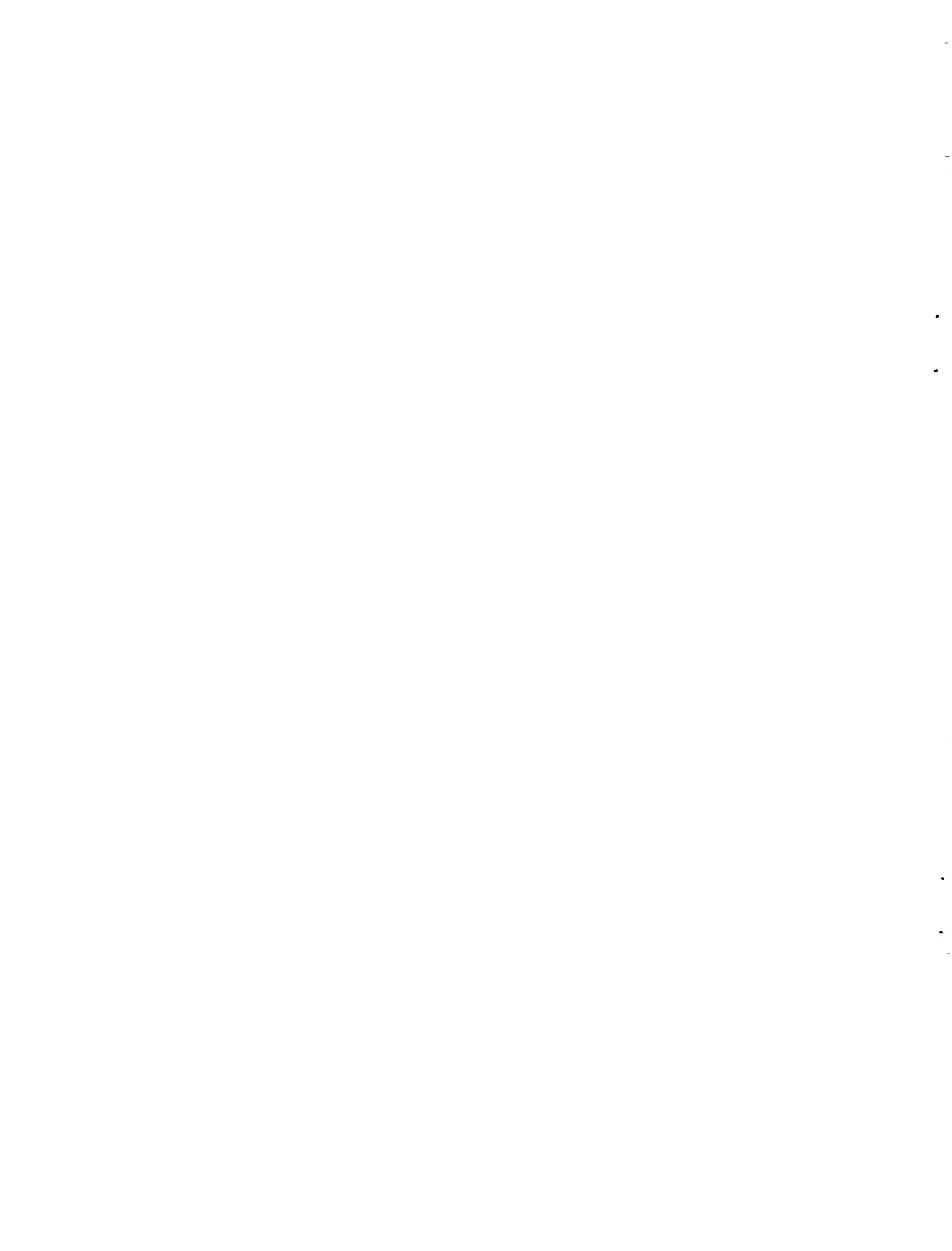


Figure 4

Actors and Activities During the Project Cycle



3

ISSUES AFFECTING THE MANAGEMENT OF WSS SYSTEMS

The choice of an O&M management model is influenced by several key issues that are listed below and are discussed in detail

- Capacity of Traditional Community Organizations
- Key Community Skills
- Health Education and Community Participation
- Participation of Women
- Complexity of Technology
- Availability of Spare Parts
- Standardization and Local Manufacture of Equipment
- Requirements Shared with Other Sectors
- Capacity of Private Sector
- Cost Recovery Mechanisms
- Ability and Willingness to Pay
- National and Regional Economies
- Logistics and Transportation
- Government Leadership
- Strength of Government Agencies and Staff
- Regional Autonomy
- Policies and Legislation
- Communication and Information Sharing

3.1 Capacity of Traditional Community Organizations

The community is a focal point in the management of rural WSS systems because it has a vested interest in efficient operation and maintenance. By their very nature, communities are structured to provide leadership, conduct social and religious activities, and attend to legal,

property, and economic matters affecting their members. The control of traditional water supply sources and waste disposal sites is part of this structure, since all communities have some type of WSS facilities, however primitive these might be.

Some communities have a highly sophisticated set of rules and responsibilities for managing their WSS facilities. For instance, communities located near rivers may not have a rigorous management system, since water is readily available. But communities in arid regions with precarious water supplies usually have strict rules governing individual rights and responsibilities and impose penalties for violations. Similarly, densely populated communities usually have a tighter management system for sanitation facilities than those more sparsely settled.

While the physical environment dictates the need for certain levels of management, so does the character of the society. There are significant differences between societies and their view of management needs for WSS. Some societies have a strong communal approach to meeting their needs; others prefer an individualistic approach. Some are hierarchical while others are more diffuse in structure. These differences must be considered, and, whenever possible, the traditional management system should be empowered. However, certain technologies may require skills that the traditional management system does not have, and new management models may need to be introduced.

3.2 Key Community Skills

Among key community skills that must be considered in assessing local management capacities are leadership, accounting, and mechanical aptitude. Leadership is required to organize, motivate, and educate the community. Many decisions require a consensus after the issues and alternatives have been clearly explained. For example, the siting of a well or standpipe could be controversial, since one location will be more convenient for some users than for others. The level of service and fee structures are questions that deserve wide discussion. Many WSS projects rely upon community participation for the construction of facilities. To marshal this work force requires leadership skills. Often communities will have transferable experience in sectors unrelated to WSS, such as building a school.

Accounting and recordkeeping skills are necessary for the proper collection and disbursement of funds. Typically, families in a community pay a flat fee or one that is based on service received. In some cases fund-raisers, such as the sale of crops from a communal field, are organized for the WSS facility. Community confidence must be ensured by public disclosure of collections and spending and scrupulous accounting. Further, decisions reached at meetings should be placed on record. In some developing countries where literacy levels in rural areas are low, this is not always possible.

Some mechanical skills within the community are necessary. Depending upon the technology involved, these can range from simple caretaker skills to repair skills for sophisticated machinery. Deep wells, for example, may be the only option for supplying potable water to a community, but the pumping requirements may be beyond local repair capability. In such

cases, the community will provide only caretaker and operational labor and call upon outside assistance for repairs.

Training is one way of upgrading community skills. Of course, there are limits to training adults with a low level of literacy, but for most areas of community need instruction can be held to these limits and still achieve adequacy. Many projects provide WSS management committee members with training in the maintenance and repair of pumping equipment.

3.3 Health Education and Community Participation

In addition to technical and management training, community understanding of health, hygiene, and community participation is important. This understanding may vary considerably from region to region. For a WSS facility to be effective it must not only be functional but also be used. Many properly designed WSS facilities have not been utilized sufficiently or correctly through ignorance of their health benefits. When poor quality water is more easily available, good quality facilities often are allowed to fall into disrepair. Sometimes clean water at the distribution point is polluted by the user through improper transportation and storage.

Other areas of health awareness, particularly child survival activities, also are important. Widely disseminated information on the benefits of immunization, oral rehydration therapy, breast feeding, and nutrition will reinforce understanding of the cause and effect of disease and lead to effective use of WSS facilities. Female literacy is a particularly important determinant of community health, since women are the key implementors of health practices. Since WSS projects usually are cited as a priority need among potential beneficiaries, they often serve as a catalyst for the introduction of other health interventions.

3.4 Participation of Women

Women are primarily responsible for obtaining and using water, but generally have not been given much say in decision making. The result has been facility designs and management structures that hamper effective use. Women deserve a significant voice in the design, construction, management, and utilization of WSS systems.

Increasingly, they are being given more responsibility. Some projects have stipulated the number of women to serve on WSS committees. Others have assigned them specific roles, including non-traditional ones such as that of pump operator.

The role of women as decision makers varies among societies. While there is general progress in increasing their participation, some societies maintain barriers that must be respected in designing management systems.

3.5 Complexity of Technology

Technologies for rural or periurban water systems range from capped springs that feed gravity distribution systems, to deep wells equipped with electric powered pumps and a distribution system consisting of a storage tank and pipelines, to household connections. Sanitation systems in rural or periurban areas range from simple latrines to flush toilets with cesspools. Many of these technologies have been in use for decades with only minor changes. However, research has produced many new improvements adapted to the needs of developing countries. For example, handpumps are now designed to be more robust and more easily repaired. Drilling rigs for shallow wells have been reduced in size and cost. Pumping systems relying on wind and solar energy have been developed. Low-cost latrines that are sanitary and well ventilated are now easily available.

Given this range of technological choice, the fundamental maxim is that the technology should be compatible with the beneficiaries' ability to handle it. If repairs are too complex for them, the next tier up must assume this responsibility. Some communities may be able to repair part of a system, such as a pipeline, but not an electrical generator. In this case the responsibility would have to be shared. Generally, it is preferable for the beneficiaries to be primarily responsible for managing the system even if they require outside mechanical assistance.

3.6 Availability of Spare Parts

The availability of spare parts has been a recurring problem for many WSS projects. Some have installed hundreds of handpumps and presumed that market mechanisms would impel local hardware dealers to provide needed parts. In certain countries government agencies retain this responsibility, in others they import spare parts and rely upon a commercial system for distribution. In any case, the laws of supply and demand do not always work as expected. Too often systems fail because spare parts are simply inaccessible.

3.7 Standardization and Local Manufacture of Equipment

The problem of the availability of equipment and spare parts can be overcome by standardization and/or domestic manufacture. The installation of pumps made by several foreign manufacturers has led to a chaotic situation in many countries. Spare parts often are not available and repairmen are not familiar with certain pump designs. This situation is largely the result of bilateral aid that restricts procurement to pumps manufactured in the donor country. Some developing countries, in response, have insisted on specifying which pumps they will accept.

Many of these countries are now developing an indigenous capacity for the manufacture of plastics for pipe and well casing. Locally manufactured equipment and policies that standardize equipment are the best answers to technological choice. Local manufacture also eliminates the need for hard currency, which is always in short supply.

3.8 Requirements Shared with Other Sectors

Procurement problems often can be eased by considering the requirements that the WSS sector shares with other sectors. The irrigation sector, for example, uses considerable quantities of pumping equipment, pipe, and related materials. The housing sector uses faucets, toilets, pipes, and building materials. The market for equipment in one sector can influence decisions in another sector. Thus, a new irrigation project could determine the type of pump the WSS sector would select for a project in the same region.

3.9 Capacity of Private Sector

The private sector may have a role in the design, construction, maintenance, and repair of WSS facilities. In urban areas there is seldom a question of its capacity; in rural areas its presence may be limited or nonexistent. Some projects have trained repairmen to maintain several facilities in a region. Others have presumed that a sufficiently large market will of itself attract repairmen to the target area. This generally is true of WSS facilities near urban centers.

If the profits to be made are reasonable, private sector participation usually is assured. Some projects have established prices for services and parts to protect the communities from price gouging. But prices must be fixed with due regard for adequate financial returns in the context of the local economy. Tasks such as well drilling and the construction of storage reservoirs are best contracted to the private sector. Many projects arrange franchised regional repairmen for the equipment installed.

3.10 Cost Recovery Mechanisms

Government policies requiring cost recovery in WSS projects have two objectives: to make the beneficiaries pay for the benefits they enjoy; and to ensure that the beneficiaries gain a sense of ownership and thereby a concern for preserving the facilities. The costs of many rural WSS projects are beyond the means of the communities they serve, and the government or a donor subsidizes all or part of these costs. The philosophy behind this is that state revenues are to be distributed for the national good, and that rural health and living standards are entitled to special attention if this goal is pursued. However, if a project is to be sustainable, the beneficiaries must be able to fully cover all operation and maintenance and replacement costs.

Among the cost recovery mechanisms employed in WSS projects, perhaps the most common is a flat monthly fee levied on each family or household. In arid zones, where water is at a premium and conservation is essential, water typically is sold by the unit volume. When water is pumped by a fuel driven engine, volume sales are the norm. In areas where cash is not in general use, communal sales of agricultural products are earmarked for the WSS system. Some communities insist on payment from every consumer, while others may provide free

water to the very poor. In notable instances, some communities receive funds from presumed richer members who have moved to the city or to foreign countries.

3.11 Ability and Willingness to Pay

The ability to pay is a function of disposable income and depends on the absolute wealth of the wage earners in a household. WSS interventions must be scaled to a level compatible with the ability to pay.

Willingness to pay is a different matter, influencing all expenditures including that for WSS service. Where there is no alternative water choice, the willingness to pay may be quite high, resulting in vastly inflated prices. Thus, water vendors in periurban areas often charge several times the price that is paid in the adjacent urban zone. In contrast, improved water supplies may not be used if there are streams nearby and the cost of water from the improved source is considered high. Water quality often is ignored if water can be obtained free from an unimproved source. In societies where women control money, they often are more willing to pay for water than men are, realizing the benefit of a clean and convenient source. For sanitation facilities, convenience and privacy are paramount. Dwellers in dense housing neighborhoods appear more willing than their rural counterparts to pay for latrines or toilets.

Because of difficulties with payment, many projects require funds to be collected in advance for O&M, and sometimes for construction, as evidence of the community's willingness to participate. In other cases, potential participants are surveyed to determine their willingness to pay. These surveys require the use of appropriate sampling techniques to ensure accurate answers to delicate questions related to personal financial preferences.

3.12 National and Regional Economies

Many developing countries have high rates of inflation, costs of living, and unemployment, all of which have a significant effect on O & M management. High inflation requires careful attention to budget planning. Many meticulous plans have crumbled because of the loss of buying power by local currencies. Several countries, notably in the Middle East, depend a great deal on funds sent home by workers who have found higher paying jobs abroad.

Rapidly rising prices of basic commodities also plague certain countries. Fuel prices are often critical for WSS projects that use engines for well drilling or pumping.

Unemployment can create a large labor pool for labor intensive tasks such as the digging of a pipeline. This lessens the need for expensive machinery and places responsibility in the hands of the beneficiaries. Some communities carry out such tasks without remuneration as their contribution to the project. These tasks should be arranged to coincide with seasonal levels of unemployment, so that they do not interfere with the regular agricultural cycles, for planting and harvesting, when everyone is busy.

Some countries have regional pockets with distinctive characteristics that set them apart from the national economy. These may be areas of high poverty that lack natural resources, or they may border a country that has a more developed economy and thus be in a more favorable position to support development projects.

3.13 Logistics and Transportation

Isolated areas difficult to reach because of long distances or bad roads will add to project costs and increase uncertainties in planning. They will require special attention to the logistics of communication and transportation of supplies.

3.14 Government Leadership

The strength of government leadership in the WSS sector is an important factor in selecting a management model. Governments that take the lead in formulating policies and plans are likely to maintain control over all aspects of WSS development. When the WSS sector is singled out for centralized control, the government may be emphasizing the importance of the sector. Indicators of leadership include public pronouncements of the value of WSS by prominent officials, social marketing campaigns to influence public behavior, significant investments in the sector, and the existence of agencies to respond to public requests for information and services.

Some prudence is necessary, however, in evaluating public pronouncements. It is not uncommon for politicians to develop platforms that call for improvements in the WSS sector. Some governments take a paternalistic attitude to providing for the people's welfare. Campaign promises and professed support for the sector must be judged by actual accomplishments.

Visible and active leadership is needed to bring issues relating to WSS to the forefront. Where government leadership is lacking, more emphasis must necessarily be placed on management approaches molded to fit local conditions.

3.15 Strength of Government Agencies and Staff

Institutional effectiveness is a critical factor in the sector and is influenced particularly by the organizational framework and the quality of the staff. The organizational framework should encompass all the components of the sector from planning and design to operation and maintenance, with support for programs of health education and community participation. There should be clear lines of authority and responsibility, and when several government agencies or ministries are involved, coordinating mechanisms are essential. Often the Ministry of Public Works and the Ministry of Health are each assigned specialized tasks. Public Works is responsible for constructing the systems, while Health is responsible for health education and

community surveys. Coordination is crucial but difficult unless there is a formal organizational agreement and framework.

Ultimately, the key to agency success is the quality of the staff, from the top to the lowest echelons. Successful agencies have leaders who are good managers, technically competent in the WSS sector, and able to articulate the objectives of the agency. Staff must clearly understand their role and have the technical expertise to carry it out.

Extension agents are the vital link between the agency and the community. There must be enough of them to cover vast rural areas, and they must have adequate transportation and be skilled in community outreach techniques.

Another important requirement for a successful agency is a budget large enough to carry out the mandate, including line items for staff salaries, administration, equipment, transportation, and training. Attractive salaries and benefits are necessary for retaining competent workers since the private sector often competes for their talents.

3.16 Regional Autonomy

Many countries have wide regional differences in climate, topography, land use, social and religious customs, economy, and access to services and materials. Climates may range from tropical to arid, requiring significant differences in the approach to WSS projects. Mountainous regions may offer abundant spring development, while arid flatlands may require deep drilling. Local cultures can differ considerably and can be separated by philosophies and geographic distance. Some regions may have a relative abundance of natural resources. In large countries travel to outlying areas may be arduous. All these differences are conducive to the creation or strengthening of regional administrations. Decentralization brings power nearer to the beneficiaries. Central control of the WSS sector in countries with significant regional autonomy can be detrimental to development.

3.17 Policies and Legislation

Without sound policies and legislation, there is little chance of significant WSS development. Policies must express government goals and objectives, and issues must be clearly defined. Policies governing the following issues are particularly important:

- the responsibilities of the communities and their ownership of the WSS systems;
- technology choices affecting equipment standardization and the procurement of spare parts;
- the role of the private sector;
- cost recovery mechanisms and fee structures; and

- the role of government agencies and the scope of their support.

The application and enforcement of government policies and legislation must be judged by results. Comparisons between stated goals and actual outputs offer useful insights.

3.18 Communication and Information Sharing

Communication and information sharing spring from a commitment to the process. Objectives can be met only if adequate information is available at all levels from the communities to the central government. All players within the sector should be abreast of policies, legislation, decrees, administrative decisions, and any other pertinent matters. While the lack of technological hardware sometimes impedes communication with distant points, more often it is a lack of will that is the cause.

Mass communication techniques such as radio messages in local languages have been successfully used to inform dispersed populations in rural areas. Frequent visits by extension agents to the communities are also an important means of communication, as are audiovisual aids such as posters, bulletins, and videos.

3.19 Summary of Issues

Some of the issues discussed are not static but vary over time, often in response to the influence of the actors involved, but occasionally for reasons entirely outside their control. Therefore, a dynamic management system is needed that can adapt to change and confront problems as they develop.

Given the many issues affecting the development of an O & M management system, it is not surprising that there are many management models in use. The following chapter presents eight case studies that exemplify these different models. They were selected from countries that represent a range of economic conditions, political organization, cultural identities, and climates. The countries are Botswana, Yemen, Sudan, Belize, Tunisia, Indonesia, Benin, and Costa Rica. The case studies provide

- a description of each O & M management system,
- a discussion of issues relating to the system,
- an evaluation of the effectiveness of the system, and
- a discussion of future problems and trends.

3.20 Star Diagram

A useful means to delineate the differences between O & M management models is to show the relative importance of the various actors involved in managing the systems. A star diagram (Figure 5) presents this graphically for the national government WSS agency, the regional government WSS agency, the private sector, and the community organizations in each country.

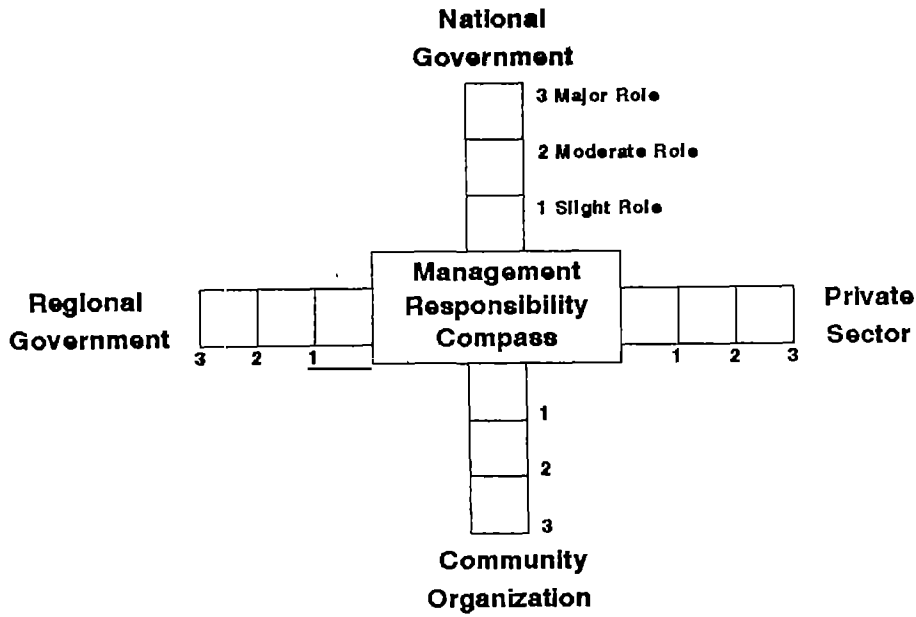


Figure 5

Star Diagram: Responsibility of Actors in O&M Management

4

CASE STUDIES

4.1 Botswana

4.1.1 Description of O&M Management System

Background

Botswana was one of the poorest countries in the world until the discovery of diamonds in the 1970s brought about a dramatic change. At first, the effects of this new wealth did not reach beyond the diamond-producing towns. But the Government of Botswana drew up a series of National Development Plans to spread the benefits of mineral exploitation throughout the country. The goals for employment and rural development included the construction and maintenance of water supply facilities in the villages.

Basic Principles

The policy has been designed to:

- provide safe piped water to urban and rural dwellers,
- retain government responsibility for operation and maintenance,
- collect user fees in urban areas, and
- subsidize both construction and O&M costs in rural areas.

It has resulted from a realistic assessment of economic conditions in the country, which, with neighboring South Africa, offers employment opportunities for those with technical skills. Few people with good technical training remain in the rural areas. The government's desire to encourage people to stay and the prevailing lower income levels justify the subsidies to rural water users. The high cost of pumping water and of collecting user fees in these areas has led to increased funding for training, staff, and equipment from national sources.

In the large urban areas, a parastatal (the Water Utilities Corporation) develops water sources, installs water systems, and collects user fees to offset all costs.

Roles and Responsibilities of Parties Involved in Maintenance

Prior to independence in 1966, the few public water supply facilities were operated by District Councils. During the next 15 years, several new facilities (using diesel-driven Mono pumps) were added, initially with donor funds and technical assistance, and later with contributions from diamond-generated revenues. The government, believing that the District Councils would not be able to operate and maintain these new water systems, established the Borehole

Preventive Maintenance Service (BPMS) at 11 depots around the country to provide both preventive and corrective maintenance and repairs for public and private water systems. Although this service was subsidized, bad roads, long distances, and the increasing number of rural water systems (both public and private) conspired to render it ineffective. Planners became convinced that the District Councils would have to develop the capacity to operate and maintain rural water systems themselves.

In 1979-1980, District Council Water Maintenance Units (WMUs) were established as part of the Works Department in each district. By the late 1980s, several of the WMUs were upgraded to full department status within the District Council infrastructure. The WMUs and Water Departments (WDs) have primary responsibility for O&M, work in coordination with other government entities, and are empowered to contract with the private sector for purchase of equipment, supplies, and services. Village organizations have little or no responsibility for their water systems, except to appoint a pump operator who is paid by the District Council.

There are thirteen WMUs and WDs throughout Botswana, one in each district except for the largest district, where five subdistrict WMUs have been created. Several districts have also created subdepots to service water systems in remote areas. The WMUs and WDs have received considerable training and funding support (from both international donors and internal sources) since the mid-1980s, and are providing major and minor repair as well as maintenance services. All District Councils have trained mechanics, vehicles, and spare part inventories. In several of the better organized districts, a regular schedule of preventive maintenance is followed.

There are other agencies engaged in the operation and maintenance of rural water supplies. The water engineer and his staff at the Ministry of Local Government and Lands (MLGL) and the Department of Water Affairs (DWA) within the Ministry of Mineral Resources and Water Affairs (MMRWA) support the WMUs and WDs. The water engineer makes field visits and provides advice, and his office also oversees the budget process, establishing budgets and distributing funds for special projects (such as Drought Relief and Water Supply Rehabilitation), and acts as a liaison with the Department of Water Affairs at the national level.

DWA is responsible for the design and installation of facilities which, once completed, are turned over to the District Councils. The councils, through the MLGL water engineer's office, are given assistance in water system rehabilitation and upgrading when this becomes necessary because of population increases, drought, and aging equipment. Since the District Councils do not have borehole drilling or cleaning capability, DWA provides emergency services when borehole yields decline due to aquifer depletion, borehole collapse, or any other well-related problem. The services of the Borehole Repair Service—the renamed and reconfigured BPMS—are also available but are rarely used.

The District Councils have budgetary discretion to contract for private sector services. Yearly contracts with oil companies for the delivery of fuel and lubricants are typical in Botswana. Council departments also maintain accounts at various equipment and spare parts suppliers. In addition, several specialty repair shops rebuild fuel pumps or provide machine shop services.

Responsible Actors

In Botswana, a few national government employees have sole responsibility for all O&M activities. The responsibilities of these actors are shown in Figure 6.

Their duties are described below:

- *Pump Operators*: complete daily O&M checks including tightening drive belts, cleaning the engine and pump house, changing oil, and making entries in the pumping logbook. (Pumping logbooks have not yet been introduced at all sites.) Report all problems to the senior operator or, in case of emergency or breakdown, directly to the chief technician of the WMU or WD.
- *Senior Operator from the WMU or WD*: supervises all pump operators and reports O&M problems to the chief technician for action.
- *Chief Technician of the WMU or WD*: oversees all O&M operations at the council level. This includes scheduling work crews, procuring spare parts and equipment, prioritizing maintenance and repair work, developing and implementing budgets, maintaining borehole and village water system records at the District Council offices, and maintaining liaison with DWA and MLGL's water engineer at the national level.
- *Water Engineer at MLGL*: oversees the disbursement of funds to the WMUs and WDs for special projects. Oversees the work of the DWA in support of rehabilitation and drought programs.

WMU technicians are responsible to superiors at the District Council level and the water engineer to superiors at the Ministry level. These superiors have final budgetary authority and occasionally bring pressure to bear on O&M issues. While this has not been a significant problem, it has affected decisions.

4.1.2 Issues Relating to O&M Management System

The issues relating to O&M of rural water systems considered in Chapter 2 are briefly discussed as they apply in Botswana.

Capacity of Traditional Community Organizations

Since the construction, operation, and maintenance of rural water facilities in Botswana are the responsibility of the central and regional governments, community organizations have no

BOTSWANA
Two-Tier Regional Government Focus

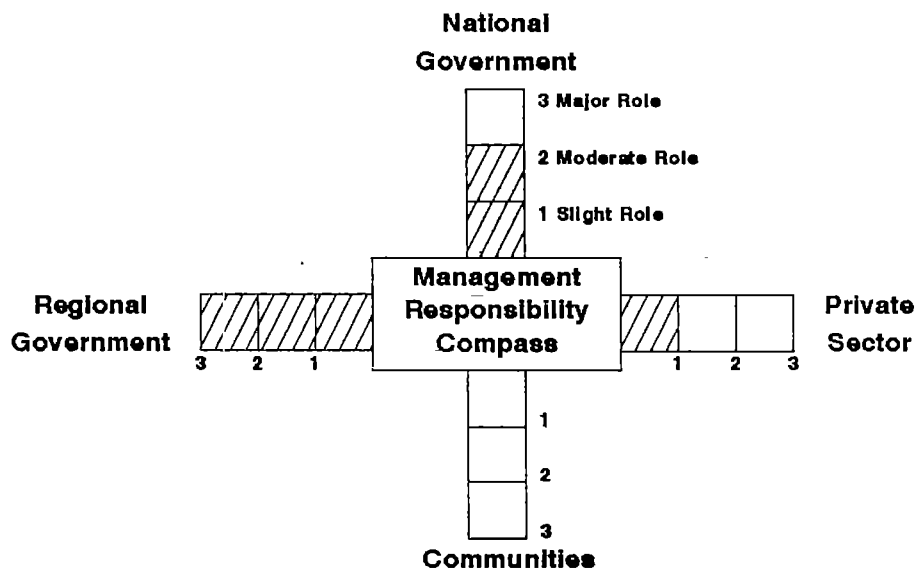


Figure 6

Botswana: Responsibility of Actors in O&M Management

formal role in operation and maintenance. However, each village has a Village Development Committee and a Village Health Committee which, through the District Council and elected members of the National Assembly, can lobby for improved service from the WMU or WD or petition for rehabilitation, system extension, etc. The functioning democracy in Botswana ensures that these petitions cannot easily be ignored.

Key Community Skills

Basic mechanical and bookkeeping skills can be found in most communities. Many men have worked in South African mines, and often pump operators are among these. Most villages have one or more small shops whose owners or operators have basic bookkeeping and accounting skills. Village leadership can be dynamic or relatively lethargic, depending upon the social position, education, vision, and personality of the headman.

Health Education and Community Participation

Health education activities are conducted by Ministry of Health extension agents working through the Village Health Committees. They are reasonably well trained but often are not highly motivated. Water quality, cleanliness, water storage, nutrition, family planning, and sanitation are among the subjects they cover. There is little coordination of these efforts with O&M, in which the community takes almost no part. Community participation in O&M activities at the village level is nearly nonexistent.

Participation of Women

Because the men of the village are often away as expatriate workers, women have established themselves as forces within many communities. They serve on village committees and are community decision makers, and in some villages work as regular or relief pump operators.

Complexity of Technology

Diesel pumping systems are widely used in Botswana. There are no gravity-fed systems and very few handpumps as the water table is generally deep. Several villages have solar pumps. Water sources outside the range of possible contamination by village pit latrines are difficult to find. This, combined with efforts to limit the distance to a water tap, has led to relatively complex water systems that require a deep-well pump driven by a diesel engine often located several kilometers from the village.

Availability of Spare Parts

Spare parts are readily available for all models of engines and Mono pumps used in rural water systems. WMUs and WDs maintain stocks of drive belts, pipes, and pipe fittings, and most have spare engines for replacement. Any parts not available at the WMUs and WDs usually can be obtained within several days from suppliers in major towns. Since Botswana is a member of the Southern Africa Customs Union and its currency is freely convertible, spare parts are readily obtained from manufacturers or suppliers in South Africa.

Standardization of Equipment

The DWA has standardized all new equipment to include Lister/Petter diesel engines and Mono positive displacement progressive cavity pumps. This standardization has greatly

simplified O&M by reducing the spare parts inventory and limiting the training of mechanics to the makes and models in use.

Requirements Shared with Other Sectors

The government and private agricultural sectors are the other two principal users of water pumps. There are a few large irrigation systems confined to areas in the eastern part of the country and a network of several thousand privately owned and equipped boreholes used for stock watering. The government owns and operates over 250 boreholes at border posts, police stations, and research farms. Most private farms and all government boreholes are equipped with Lister/Petter engines using Mono pumps, although older reciprocating pumps are still in use. More recently, some private farmers have begun to use Yanmar and Kubota diesel engines because they are cheaper to purchase. Again, this standardization has led to improvements in both the availability of spare parts and the skill levels of mechanics.

Cost Recovery Mechanisms

There is no attempt at cost recovery for water supply in rural Botswana, since the cost of collecting fees on the scale for urban users would exceed the fees collected. To charge more than the prevailing rate for urban water users would go against government policies of equity for rural dwellers. Mineral revenues and a large current and capital account surplus allow the government to fully subsidize rural water supplies.

Ability and Willingness to Pay

Since rural water users pay no fees, there is no need to determine ability or willingness to pay. Private connections in larger towns are charged for water delivered, but users do not pay the full cost of water consumed. In a survey of several of these towns, fee collection rates were considered very good, ranging from 80 to 90 percent of fees charged. Should national fee policies change, the lack of a fee structure at the village level would make the introduction of fees difficult.

National and Regional Economies

The strength of the national and regional economies has had a significant impact on the success of O&M systems. The government has the resources to provide a high level of service and to finance technician training, the procurement of spares and equipment, and the rehabilitation of older or inadequate systems. Since the local currency is freely convertible, external procurement of equipment and supplies poses no problem.

Logistics and Transportation

Logistics and transportation are a constant difficulty. Rural water systems are often 100 kilometers or more from service centers. When spares are not available in service center stores, long trips are necessary to procure them from major urban centers. Recent improvements of the rural road network and the vehicle fleet have helped, but transportation and logistics continue to be a time-consuming nuisance.

Government Leadership

The democratically elected government of Botswana is strong, and a vocal opposition helps keep priorities in line with the needs of the people. A five-year planning process outlines government policies and goals as well as specific projects. The government funds many of these projects and seeks donor assistance for others. This process provides a consistent basis for development.

Strength of Government Agencies and Staff

The population of Botswana is just over one million, which does not provide a large pool of educated and talented civil servants. A number of expatriates are employed in line positions in various ministries, but a gradual nationalization is being attempted without compromising the strength of these agencies. Leadership and guidance at the upper levels of the ministries managing water resources and water supplies are strong. Unfortunately, it is difficult to retain high quality staff at the lower levels. Competition from the private sector is strong, offering opportunities for professional growth, higher compensation, and the chance to live in the major towns.

Regional Autonomy

Most rural water system construction is planned at the national level and all operational decisions are made at the District Council or regional level, where O&M management systems are developed and implemented. Certain procedures must be standardized to facilitate WMU and WD links to the water engineering office of the MLGL and the rehabilitation and emergency support provided by the DWA. In general, there is a high degree of regional autonomy for setting priorities and work schedules according to regional technical needs and political pressures.

Policies and Legislation

Policies and legislation affecting the water sector are clearly spelled out in the National Development Plan and the laws of the country, but there are concerns about the continued

development of new water systems. Limited water resources and the cost of constructing and operating systems in ever smaller villages pose significant challenges. Villages of even a few hundred are currently slated for diesel-driven pumps and piped water delivery.

Communication and Information Sharing

Communication and information sharing are very good, largely because of the MLGL water engineering office. Data from monthly status reports provide the basis for national plans and funding. Most of the WMU technicians trained together and have remained in contact. Telephone communication takes place between the WMUs and WDs and the water engineer and the offices of the DWA. An annual week-long seminar for WMU technicians brings them together to share problems and solutions.

4.1.3 Effectiveness of O&M Management System

In general, the O&M management system in Botswana is very effective. No more than 10 percent of the water systems are out of service at any one time, and response to breakdowns is on the order of two to four days. With a reserve of several days of elevated water storage, some villages continue to have water during breakdowns. Given differences in technician skill and district size, some districts provide more efficient service than others. On average, the number of breakdowns per borehole per year is 3.5. However, in districts with preventive maintenance schemes, the rate has fallen to one per borehole per year.

This success has been gained at considerable expense. In 1987, the recurring cost was \$2,500 to \$3,500 per borehole, which included salaries, building maintenance, tools and equipment, spares, and fuel. The per borehole cost for spares alone was between \$450 to \$650. These costs are considerably more than most governments are willing or able to meet to assure reliable water supplies for rural communities. The single most important factor in the success of the O&M program in Botswana is that the government can afford to bear these costs from the national treasury and does so. Other significant factors include equipment standardization, availability of spare parts, and good communication among District Council technical personnel, the MLGL's water engineer, and the DWA.

4.1.4 Future Problems and Trends

The current phase of rural water supply construction is drawing to a close with the completion of the Swedish International Development Agency (SIDA) supported Village Water Supply Program. The focus is on the rehabilitation of systems constructed early in the program (late 70s), which were not built to today's standards and may not serve today's populations. The completion of this program also will mean the scaling down of donor assistance in the sector.

Over the past several years, donor support has largely been in the form of technical assistance, with all capital and recurrent costs being met by the Government of Botswana. The change will have implications for sector capability. In the past, the government has contracted with the private sector for services it has difficulty providing, particularly in the design of water systems. The private sector may be used even more in the future.

Given the success of the rural water supply program in Botswana, there appear to be few problems. However, difficulties could arise from the government's assumption of complete responsibility. Rural dwellers have gained high expectations of service at no cost, and elected officials eager to keep constituents happy could pressure government agencies and District Councils to expand services to ever smaller communities. Already, some villages of less than 300 are scheduled to have their own systems. If the government can no longer finance the construction and O&M of rural water supply facilities, it will be difficult to introduce a fee structure, even for only partial cost recovery.

At present, there is no serious consideration of introducing water user fees in the villages. The emphasis is on completing the construction of systems in progress and rehabilitating existing systems. There also is a growing effort to upgrade training programs, provide career opportunities for skilled individuals at the WMU and WD level, and institute countrywide recordkeeping and preventive maintenance programs. This may be difficult with the withdrawal of technical support from donors (due in large part to the success of programs and the decreasing financial need of the country). Although many Botswanans are very capable, the program has been significantly aided by expatriate skills.

Finally, there are efforts to more closely link the water supply programs to health education and health awareness. The separation of DWA in MMRWA and health workers in the Ministry of Health, as well as the emphasis on the construction and O&M of water systems, have caused this aspect to be neglected. Botswana has a well-focused, well-organized, and well-functioning O&M management system that depends in large part on adequate funding, standardization of equipment, and ease of procurement. This is quite unique in the developing world and highlights the wide range of factors that must come together to make O&M work smoothly.

4.2 Yemen (Former Yemen Arab Republic)

4.2.1 Description of O&M Management System

Background

Rural water services and O&M management have evolved out of Yemen's civil war from 1962-1970. During this period, local organizations developed in many rural areas, creating and maintaining services (including water supply) with local resources. After the war, the government gave these organizations the status of Local Development Agencies (LDAs), and they continued to operate projects with funding from *zakat*, (the Islamic tax), special local

taxes, and other sources. The LDA structure has changed over the years, becoming more centralized and government controlled. However, the self-help attitude that gave rise to the original groups continues to prevail in rural water projects and O&M management.

Basic Principles

The policy in Yemen has been to make users responsible for all recurrent O&M costs. The LDAs, through the village water project committees and the District Councils, contribute to the upgrading of some of the older water systems. The Rural Water Supply Division (RWSD) of the Ministry of Public Works provides technical assistance and funds for new construction and trains pump operators in O&M. Upon system completion, all O&M responsibility is transferred to the LDAs. If problems arise, such as when water sources dry up, the District Council or the RWSD can be approached for help. Petitions for assistance are granted if the case presented is convincing.

Maintenance Management, Roles, and Responsibilities

Maintenance systems in Yemen differ according to geographic and financial conditions. But, in general, management is shared by the village, the District Council, and the private sector. The responsibilities of these actors are shown in Figure 7. The village, through the pump operator, the village water project committee, and the village representative on the District Council, organizes operation and maintenance, collects fees, and decides on minor repairs. The District Council either lends or grants money for major repairs and is the link with agencies of the central government when technical and financial assistance is needed for such problems as major upgrading, dry boreholes, or major breakdowns. In some cases, informal contacts with national government organizations prove more effective. The private sector provides almost all construction and repair services. The larger towns have a well-developed network of equipment and parts suppliers for the major engine and pump brands, along with well-trained technicians. Competent mechanics provide much of the first-line repair service in the smaller towns and villages.

4.2.2 Issues Relating to O&M Management System

Capacity of Community Organizations and Key Community Skills

O&M management in Yemen depends heavily on dynamic village leaders to encourage the people to participate, to lobby for local projects, and to win the support of the District Councils, national representatives, and donors. There are enough technically capable operators and mechanics, often with experience gained in the Gulf oil fields, who can offer guidance when engines and pumps need repairs, even if they do not do the work themselves. Where village water project committees are well organized, the members are trusted, fees are

collected regularly, and funds are saved for the purchase of equipment. The orderly functioning of these committees is particularly important where multiple pumping stations, large pipe networks, and many hundreds of users are involved.

Complexity of Technology and Standardization of Equipment

In the lowland areas, water supply systems consist of a 15-20 hp Japanese engine driving a vertical turbine pump. Water is delivered to an elevated tank and then to distribution points within the village, or in some cases to a ground tank directly accessible to users. These systems generally serve several hundred people. The equipment is similar to that used for irrigation and spares are usually available. In mountainous areas, the systems consist of several boreholes equipped with 100-150 hp engines and pumps that deliver water to booster stations which lift it to the villages being served. In some cases, several villages are served by one system with 1,000 metered connections. The wide range of equipment used, often because of special technical requirements, causes some difficulty in obtaining spare parts not readily available from local or regional suppliers.

Cost Recovery Mechanisms and Ability and Willingness to Pay

Government policy requires the villagers to meet all O&M expenses, so fees are collected from each household. If the villagers are too poor to pay, as in the lowland

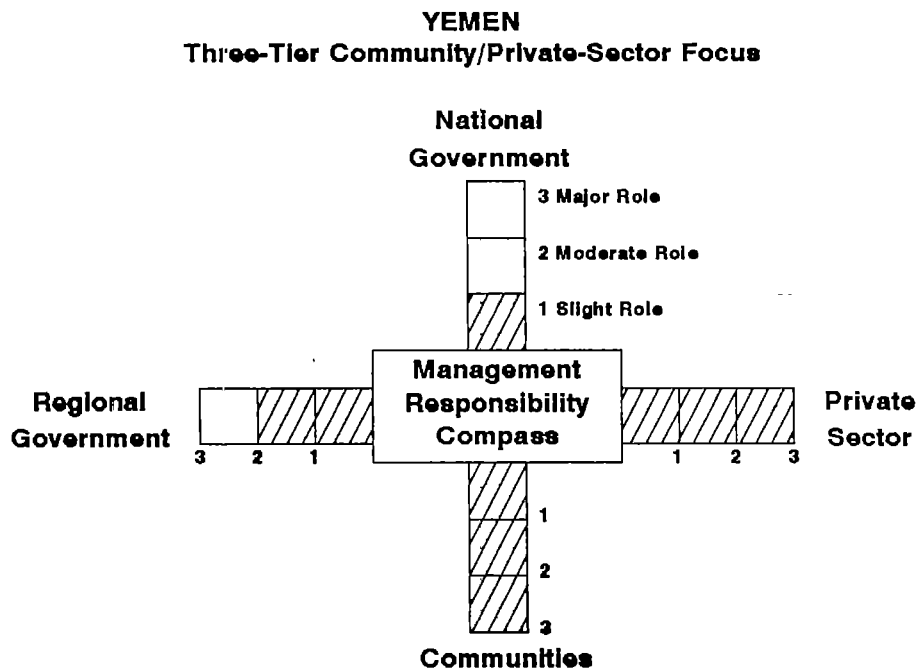


Figure 7

Yemen: Responsibility of Actors in O&M Management

areas, they can petition the District Council for discretionary funds to assist with repairs. In at least one case, the District Council pays for fuel and lubricants. In the mountain towns, water systems are metered and equipped with locking taps. Fees cover all costs, including the wages of the pump operator and a full-time mechanic, the operation of a vehicle, and payments to a support staff of meter readers and bookkeepers. Although there are complaints from the staff that the work is long and hard and the pay is low, the services provided are satisfactory.

National Economy, Availability of Spare Parts, and Transportation

Although the Democratic Republic of Yemen is under some financial stress, it has maintained a relatively open import policy that facilitates the offshore procurement of materials. The prices are high by local standards, but new equipment and spares are available in major urban centers. The country has a good road network connecting major towns with the rural areas, so that most villages are within a day's round trip.

4.2.3 Effectiveness of O&M Management System

There has been concern lately about the breakdown of rural water supply systems, as many as 30 percent of which have been out of order at any one time. The reasons have been poor O&M, depleted water sources, and village conflicts. Many of the O&M related outages are brief. Most villages have an efficient response system for minor breakdowns, but, when major breakdowns occur, must collect the money to pay for spares and a skilled mechanic from a nearby town. The villages do not have the resources or skills to cope with depletion of the water source, frequently the result of poor initial well siting. Village conflicts are often long-standing and predate the introduction of the water supply systems. The resolution of these conflicts points to the need for strong and enlightened village leadership.

4.2.4 Future Problems and Trends

The effects of the merger of the Yemen Arab Republic and the People's Democratic Republic of Yemen are not yet clear at the local level, where the implications of changes in the national and regional administrations are uncertain. It appears that the national policy will continue to give the villages responsibility for O&M, but that some of the larger systems serving several villages may be operated directly by the LDAs. The District Council structure, originally designed to help people meet their own needs with local control of funds, has become progressively more centralized and bureaucratic, a trend that does not foster self-reliance.

4.3 Sudan

4.3.1 Description of O&M Management System

Background

The rural water supply in Sudan has been affected significantly by the economic decline, administrative restructuring, and political instability prevailing in the country. Equipment, funding mechanisms, and O&M methods, vary by geographical area. In the northern part of the country along the Nile, the rural areas are quite prosperous and traditionally have met their water needs with their own resources. In the western desert region, government assistance has been necessary. The areas in the south, the east, and between the Blue and White Niles have their own characteristics. This case study confines itself to the northern and western parts of the country.

Basic Approaches

The government believes that rural water supply systems should be self-financing over the long term. For political and practical reasons, the western provinces of Kordofan and Darfur have received most attention, and the region is the focus of the National Corporation for Rural Water Resources Development (NCRWRD), which is responsible for the construction of boreholes and for all O&M tasks. In this area deep boreholes are required. A government employee operates and maintains the water source (called a wateryard), and a clerk collects user fees that ostensibly cover the cost of operating the wateryard and making necessary repairs.

The NCRWRD also has offices in the north but mainly provides design assistance and some construction management, because water is close to the surface here and villagers are affluent enough to fund most, if not all, of the cost for construction. The NCRWRD is not involved in O&M management to nearly the same degree as in the western provinces. The regional offices are sometimes called upon for service, but the villages are free to use private sector sources for spares and technical help.

The slow but steady economic decline in Sudan has deprived the NCRWRD of the resources to provide adequate O&M service for the rural systems. In addition, charges of favoritism and the misuse of funds, the rising cost of the national infrastructure, and evidence of corruption have made many villagers cynical and untrusting of the NCRWRD. Today, little or no O&M service is provided even though fees are collected, fuel allocations from the government are minimal, and little foreign exchange is available to buy equipment or spares.

In the western region, which has depended heavily on government support for O&M, the villagers have developed their own O&M management systems to keep water flowing. Many have set up water committees to collect fees in addition to those collected by the government wateryard clerks, and are using the money to purchase fuel, lubricants, and spare parts from

the black market if necessary. The NCRWRD does not recognize these village organizations but is willing to accept the help they provide. NCRWRD mechanics perform maintenance and repairs but often require the villages to supply transportation and even tools.

Roles and Responsibilities of Parties Involved

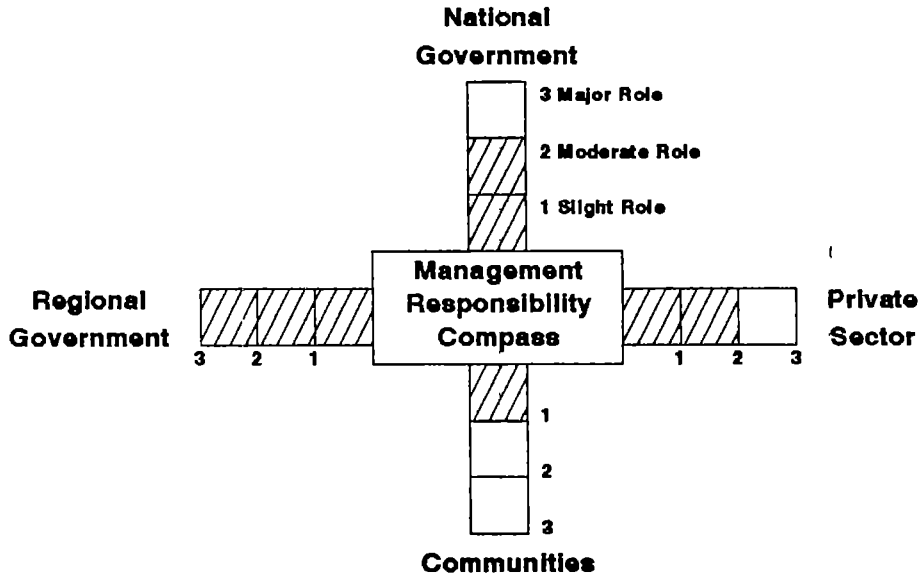
The responsibilities of actors in O&M management are shown in Figure 8. The NCRWRD, now largely unresponsive to village needs, has formal responsibility and claims that with adequate funding it would be more effective. The various duties and responsibilities are as follows:

- *Pump Operators*: attend to daily operation and maintenance, lubrication, and minor repairs; preventive maintenance does not appear to be part of the task.
- *District Workshops*: responsible for maintenance and repair including light machining, and engine and pump overhauls; maintain an adequate stock of spare parts; perform field repairs.
- *Regional and Provincial Offices—O&M Section*: perform heavier machine shop work on engines and pumps as well as on vehicles and drilling rigs; maintain a larger stock of spare parts and arrange procurement from national stores as necessary; make fuel and lubricant deliveries when supplies are available. These offices perform field repairs where District Workshops have not yet been established, and collect fees through a circuit schedule of visits to villages.
- *National Headquarters—O&M Section*: remits O&M funds collected to the Ministry of Finance and Economic Planning; organizes fuel and lubricant deliveries to regional offices; makes off-shore purchases of supplies and spare parts when funding is available.

This structure has resulted in a large centralized bureaucracy no longer responsive to local needs, and has spawned an informal alternative whose effectiveness is a function of the local NCRWRD representative's attitude and village skills in financial management and politics. The elements of this organization at the village level are as follows:

- *Pump Operator*: attends to daily operation and maintenance, lubrication, and minor repairs.
- *Village Committee*: monitors the operation and maintenance of the wateryard and collects additional fees, either regularly or as needed;

SUDAN
Formal: Three-Tier Regional Government Focus



SUDAN
Informal: Three-Tier Community Focus

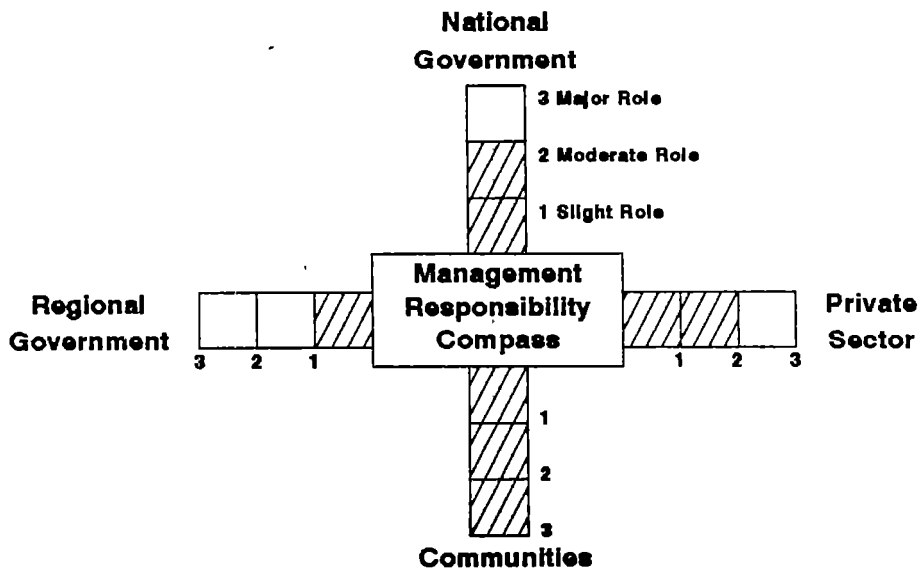


Figure 8

Sudan: Responsibility of Actors in O&M Management

purchases fuel, lubricants, and spare parts; may also provide transportation for mechanics to come out and investigate breakdowns and make repairs.

- *Private Sector Suppliers*: sell fuel and lubricants, usually at black market prices; procure spare parts, often available only at some distance from the village, perhaps as far away as Khartoum.
- *NCRWRD District or Regional Offices*: provide mechanics for most repairs, particularly in the western region. Transportation, parts, and consumable items are provided through the village committee. The arrangement works reasonably well if the villagers are well connected. Otherwise, the water supply system is often in very poor repair or not operating at all.

This description applies largely to western areas. In the north, the fact that construction costs have not been met by the NCRWRD and ownership is retained by the villages gives these villages much more autonomy in managing O&M.

4.3.2 Issues Relating to O&M Management System

Community Organizations and Key Community Skills

The NCRWRD does not formally recognize community participation in its O&M structure. Yet the operation of wateryards is carrying on mainly because community members are willing to pay additional fees, while continuing to tolerate the delays and frustrations of an economy in disarray. Some relationship must be maintained with the NCRWRD, in spite of its failure to perform its O&M duties. But the complete breakdown of water supply systems in some villages is evidence that a reliance on community organization and leadership is wiser. In the north, as surveys indicate, water systems operate well because of their community-based O&M management.

Cost Recovery Mechanisms and Ability and Willingness to Pay

In the western region, there is an adversarial relationship between the villagers and the NCRWRD. The NCRWRD claims the villagers do not pay enough and abuse their water systems, and the villagers claim the NCRWRD collects fees but provides no service. The fees that the village committees collect over and above the NCRWRD tariff enable the purchase of spare parts and fuel that the NCRWRD is no longer providing.

National Economy

The weak national economy affects the management of rural water supplies like every other activity in the country. Currency controls and commodity shortages have created a flourishing

black market. Fuel and spare parts are in short supply, as are sugar, flour, tea, and all consumer goods, but most items are available at inflated black market prices. Little is imported legally, and more suppliers of foreign equipment have no spare parts on the shelf. Some reconditioned or smuggled parts are available in the marketplace, but government agencies are forbidden to purchase them. The use of many makes and models of engines and pumps complicates parts procurement. Shortages of fuel and spare parts also make transportation undependable and expensive.

Villages in the northern part of the country have somewhat less difficulty operating and maintaining their water systems. Many of the workers who have gone abroad come from there and family connections are strong. Spare parts bought overseas can be sent directly to villages in the north through family and village connections in Khartoum. Also, the fact that the water systems in these areas are locally owned means that they are less dependent on the NCRWRD for O&M.

Strength of Government Leadership and Government Agencies

The many changes in the administration and in the leadership of government agencies in recent years have weakened them to the point where they are no longer effective. In addition, the economic climate has led many capable managers and technicians to seek employment abroad. Unfortunately, those in decision-making positions are unwilling to recognize this decline. A restructuring to give villagers in the western region a more active role in O&M management would greatly strengthen water supply services.

4.3.3 Effectiveness of O&M Management System

Maintenance systems in Sudan generally are very weak, largely because of the faltering economy. Shortages of fuel, spare parts, and replacement equipment plague all areas. If water supply facilities continue to operate, it is because of the resourcefulness of many Sudanese and the fact that villagers have taken O&M management into their own hands. In the northern region, the villagers own their equipment and the NCRWRD role is limited to design, construction, and servicing assistance. In the western region, where donors and the government provide a much larger share of the initial costs, the NCRWRD retains ownership and formal responsibility for O&M, which is unsatisfactory because of poor service, the adversarial relationship between the village and the government, and the unwillingness of the NCRWRD to formally recognize village contributions to O&M.

4.3.4 Future Problems and Trends

It is difficult to tell what the future holds for rural water supply in Sudan. The absence of hard currency funds and total dependence on donor support place the NCRWRD in a vulnerable position. There are those in this agency who recognize the need for improving O&M management systems, including the encouragement of more structured village participation, but there are few indications of real change. Perhaps change will come about as the situation becomes even more desperate.

4.4 Belize

4.4.1 Description of O&M Management System

Background

There are two types of rural water supply systems in Belize, which differ greatly in level of service, community involvement, maintenance responsibilities, engineering, and cost. The first are the piped water systems consisting of a water source (drilled well or spring), electric or diesel pump sets, storage tanks, and house-to-house connections. Families install outdoor yard taps or full indoor plumbing according to their means.

Currently, there are 19 such systems in the country, typically serving 500-1500 people through 75 to 200 connections. They have been designed by the urban Water and Sewerage Authority (WASA), constructed by private contractors, and are operated by community water boards with support from the Rural Water Supply and Sanitation Program (RWSSP) in the Ministry of Natural Resources. Much of the funding has come from USAID. The responsibilities of actors in O&M management, for which WASA has prepared a manual, are shown in Figure 9.

The second type of rural water supply uses handpumps, approximately 600 of which have been installed in shallow drilled wells. Many of the larger communities have several handpumps, each serving two to 10 families. The first model of choice was the U.S.-made cast iron Dempster, but more recently the Indian-made steel Mark II model has been favored for its reliability. Prior to 1985, pumps were installed and maintained by the Ministry of Health, but they are now installed by the RWSSP and maintained jointly by the communities and RWSSP regional maintenance crews.

The RWSSP has a central office near Belize City (shared with the main WASA depot) that includes a large store for handpump parts, a vehicle and well rig repair shop, and administrative offices. It also has regional offices in three of the six districts in the country, with each regional crew responsible for two districts. The regional facilities are smaller, but include an office, a depot for vehicles and supplies, and, in some districts, stores with parts and tools.

The responsibilities of actors in O&M management for the handpump systems are shown in Figure 10.

CARE has installed several piped water and handpump systems with support from USAID and UNICEF and follows the same approach as RWSSP. However, CARE has more personnel and resources to support its projects.

While considerable progress has been made in extending coverage, there are still many communities without improved water supplies where families use hand-dug wells, surface water sources, and, most commonly, simple rainwater catchment devices. Recent projections estimate the need for approximately 30 more handpumps to reach full rural water supply coverage, operated by local families themselves. Recent projections estimate the need for approximately 30 more piped water systems and 700 more handpumps to reach full rural water supply coverage.

Piped Water Systems

The three-tier O&M management of piped water systems places primary responsibility in the hands of community Boards of Management (BOMs). Regional government offices at the second level provide technical and managerial support and training, and the central government at the top oversees regional government operations and sets water and sanitation policies. The communities can use private mechanics.

The BOMs have a manager, treasurer, secretary, several representatives from the community, and a paid staff. These elected bodies set budgets and tariffs, collect and manage funds, and decide on system expansions. The typical system has an operator to run the pump, do minor repairs, keep logs, and perform other basic O&M tasks, a billing clerk, and, in some cases, someone to keep the books and handle cash.

The BOMs essentially are independent of the government, and operate and maintain the systems with their own resources. If the operator has a problem, the BOM will call upon private mechanics or equipment and parts suppliers and solicit the advice of the regional government office. There have been few breakdowns or maintenance problems because the systems are still quite new and most use reliable electric pumps. In the beginning, the regional and even the central government would provide money or equipment to fix a breakdown or other serious problem, but this practice has been discontinued, except when a community has a legitimate need.

Communities with piped water systems benefit from considerable training, technical support, and monitoring in all aspects of system operation, including O&M, budgeting, financial management, administration, community involvement, and health and hygiene education.

The O&M budgeting and cost recovery system is an important element of the piped water management system. The regional offices (or CARE) work with communities to establish budgets in the first year or two, with ample provision for all O&M costs, including electricity

BELIZE
Piped System: Three-Tier Community Focus

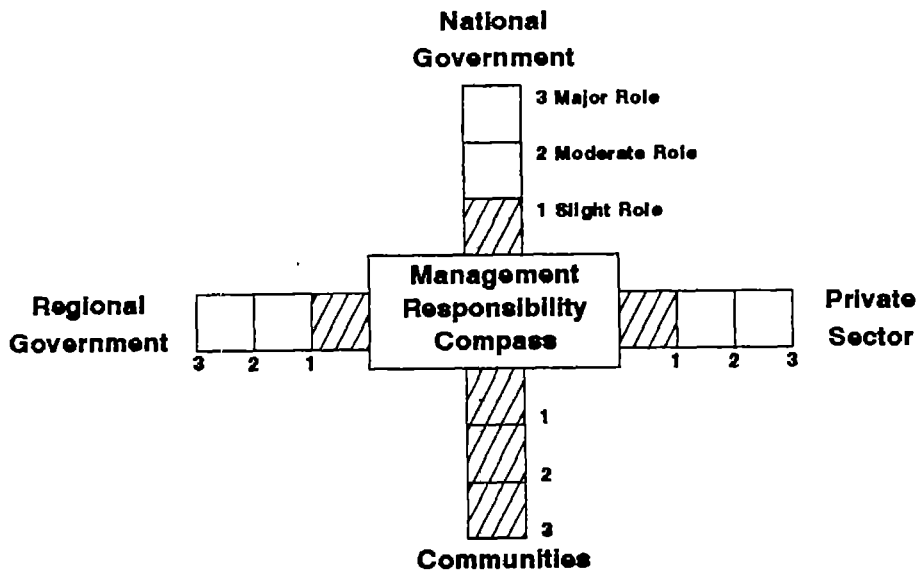


Figure 9

Belize: Responsibility of Actors in O&M Management

BELIZE
Handpumps: Three-Tier Regional Government Focus

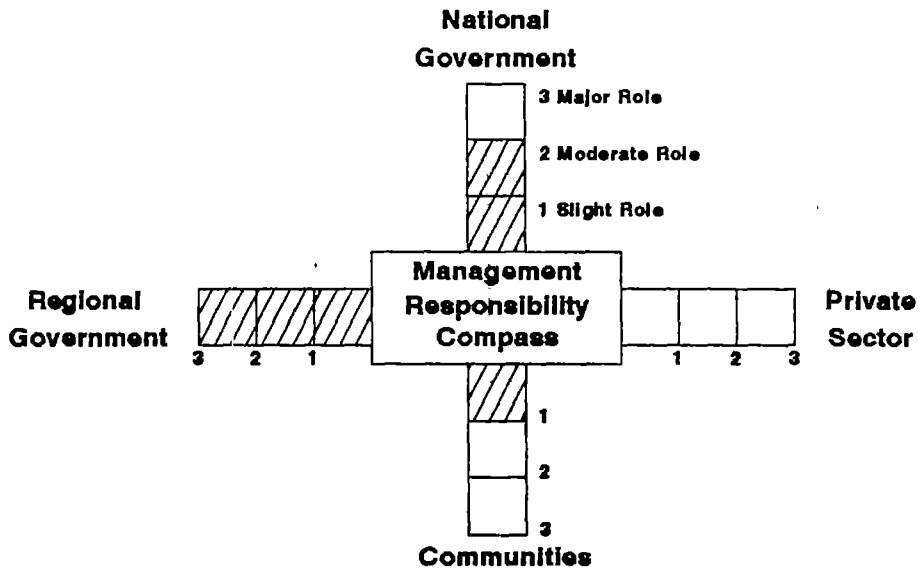


Figure 10

Belize: Responsibility of Actors in O&M Management

or fuel for engine/pumps, chlorine, staff (operator and clerks) wages, maintenance and repair costs, as well as a sinking fund for future replacement of the engine/pump. Communities establish flat rate tariffs in accordance with these budgets and do not hesitate to cut off households that do not pay. Monthly tariffs typically are US\$3.50 for basic service, with additional charges if sinks, showers, or toilets are used. The connection fee is US \$12.50. These rates are well established and well accepted. Many of the piped systems have been able to build up a reserve of US\$1,500-\$3,000 in the sinking fund for future outlays.

Handpumps

The O&M management of handpump systems is very different. Communities have nominal responsibility, but regional government crews do most of the O&M work. The central government is obliged to import parts and the role of the private sector is negligible.

In theory, village councils are supposed to organize volunteers for minor above-ground maintenance such as lubrication of handle pivots and other wear points, and cleaning and upkeep of the pump apron or surface drainage/soakaway system. In practice, council members do some of these tasks themselves, or they are not done at all. No fees are collected, there are few tools, and no parts are available locally.

District maintenance crews keep busy chlorinating the wells and performing the more complex down-hole repairs on broken pumps and also spend a considerable amount of time installing new pumps.

Government of Belize (GOB) policy calls for the establishment of "safe water groups" to conduct minor maintenance and ensure cleanliness around handpump wells, but these have yet to be formed in most areas of the country. The policy also calls for an appointed village pump mechanic (with tools) to perform preventive maintenance and minor repairs with the support of the district maintenance team. This three-tier maintenance system operates only sporadically and has not yet been fully developed or formalized.

Fortunately, the handpumps have proved generally reliable to date. The Indian Mark II, installed in the deeper wells, has had an excellent record, while the Dempsters have required somewhat more frequent repairs.

While the extent of community involvement in handpump O&M may seem inadequate, it is a considerable improvement over what prevailed in the early 1980s. At that time, the systems were regarded as the property and full responsibility of the Ministry of Health (MOH), and the people were afraid to touch them.

A significant increase in community involvement in O&M is unlikely. Training and equipping villagers to conduct down-hole repairs would not be cost effective. Given the long period of GOB control of the handpumps, people have never paid for service or repairs. In some locations, the villagers prefer alternative water sources (hand-dug wells or rain water). They do not like the high mineral content of the groundwater that handpumps provide and are not

willing to pay anything. Once piped water systems arrive, handpumps may disappear as second-rate technology.

The potential for private sector involvement in handpump O&M is limited. Because the pumps generally have been reliable, the demand for spare parts is low and there is no market for private sector participation in maintenance or repairs.

4.4.2 Issues Relating to O&M Management System

Community Organization/Skills

The BOMs for piped systems are the outgrowth of a tradition of village council involvement in local development. Several communities have individuals who have worked abroad and acquired managerial, community organization, and accounting skills. But there is less evidence of these skills being marshaled for handpump maintenance.

Standardization and Local Manufacture of Equipment and Availability of Spare Parts

Because the tiny market makes local production impractical, all pumps are imported and a reliable supply of parts is important. The RWSSP has striven to standardize equipment to simplify procurement and facilitate maintenance and repair.

Capacity of the Private Sector/Requirements Shared with Other Sectors

Most piped water systems use the same type of electric pumps as the housing, industrial, and agricultural sectors, so there is an adequate private sector provision of equipment and repair services. However, there are few users of handpumps besides the village wells, so the procurement and supply of parts and equipment must be managed by the government.

Budgeting/Cost Recovery

The piped systems have a very strong system of budgeting and cost recovery, the basis for good maintenance, because users are willing to pay. There is no user cost recovery for handpumps, and government maintenance is only moderately effective.

Willingness to Pay

Users of piped water systems readily pay a tariff not much less than the basic urban water tariff. However, villagers using handpumps show no willingness to pay, perhaps because the

pumps are shared by families, access to water is much less convenient, and the government has set a precedent by managing these pumps.

Government Leadership/Policy

The GOB's policy statement defining the institutional relationships and responsibilities within the sector places strong emphasis on the community management of rural water and O&M. This policy has been implemented effectively for piped water systems but not for handpumps, where more training and community organizing clearly are necessary.

Strength of Government Agencies and Staff

The RWSSP is effective but could do better with the human, material, and financial resources it lacks. For example, it would like to place a maintenance crew in each of the six districts, with its own vehicle and store for down-hole handpump maintenance and repairs. It has only half this number, with little hope that cost recovery from users will add more resources. It also needs a better management support system (e.g., a computer for cost accounting, work orders, inventory management, etc.) and vehicle maintenance.

System Ownership

Users of piped water systems feel a strong sense of ownership and responsibility and the government recognizes this. By contrast, the sense of ownership of handpumps is weak and there is no feeling of community responsibility. Many users think of the handpump as the government's or as belonging to the family living closest to it.

Water System Politics

Electoral politics is an important element in community level development projects. Local representatives in Belize's two-party parliamentary system are eager to support community water supply projects, and use their power to direct government resources into maintenance to win the favor of their constituents. Interestingly, even in this political climate, Belizean politicians support community autonomy. The influence of politics on handpump maintenance is unclear.

4.4.3 Future Problems and Trends

O&M management in Belize needs strong community participation in handpump maintenance, which will require more effective extension, training, and community organization. The GOB

does have clear policies in this regard but they have not been successfully implemented. Further study can determine how these policies should be applied or whether they need modification.

Maintenance management at the central and district levels also needs to be improved through better planning, preventive maintenance schedules, work order procedures, cost accounting, and system records. The vehicle pool, supplies and parts storage, and distribution facilities could profit from an immediate infusion of resources that would be cost effective in the long run.

There has been considerable discussion about the merger of the RWSSP (which is part of the Ministry of Natural Resources) into the WASA (the semi-autonomous urban water authority overseen by the Ministry). The merger probably will take place soon and will undoubtedly involve some transfer of personnel and disruption of activities. There is a feeling in the RWSSP that this administrative change will adversely affect the RWSSP's field orientation.

4.5 Tunisia

4.5.1 Description of O&M Management System

Background

The current policy in Tunisia is to maximize community responsibility for O&M management through a strong training program to build up local technical, financial, and management capabilities. This policy, launched in pilot programs in the Kasserine and Kairouan regions in 1986 and formalized in a Presidential Decree in 1988, is steadily being implemented. Community management of irrigation systems has operated in the oases in southern Tunisia since the 1930s. However, its application to rural potable water supplies is new.

Prior to the current strategy, the regional and central governments paid all costs of rural potable water supply, including construction, fuel and electricity for pump operation, and labor and parts for repairs and replacements. But thousands of community water associations set up from 1986-91 now operate and maintain rural water systems with some technical, financial and managerial assistance from the government, which plans a gradual withdrawal of subsidies.

Under the old arrangement, where regional governments were responsible for even the simplest maintenance, crews were poorly organized and managed, breakdown rates were high, and systems were often out of service for long periods. Water users contributed nothing to the O&M of their systems. The change in policy recognized that the beneficiaries could do a better job with assistance from the government. Figure 11 shows the responsibilities of actors in O&M management under the past, present, and future systems.

This case study considers the present system, not yet fully implemented, and what remains to be done.

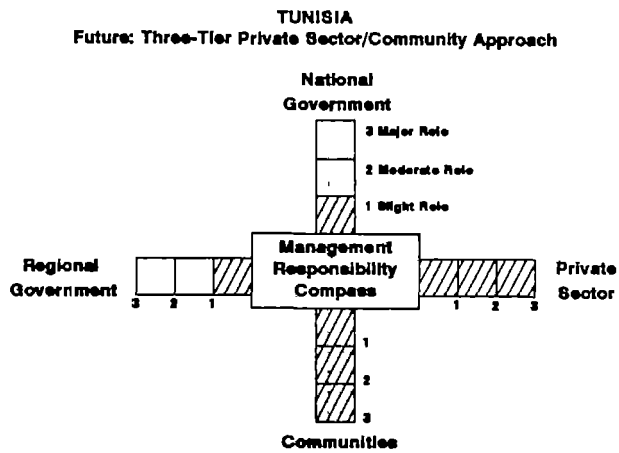
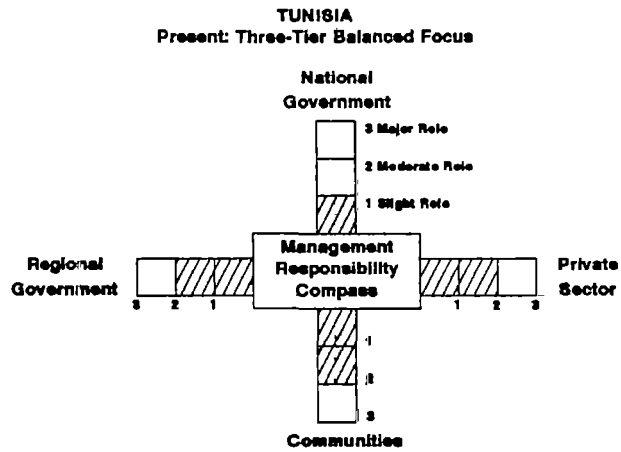
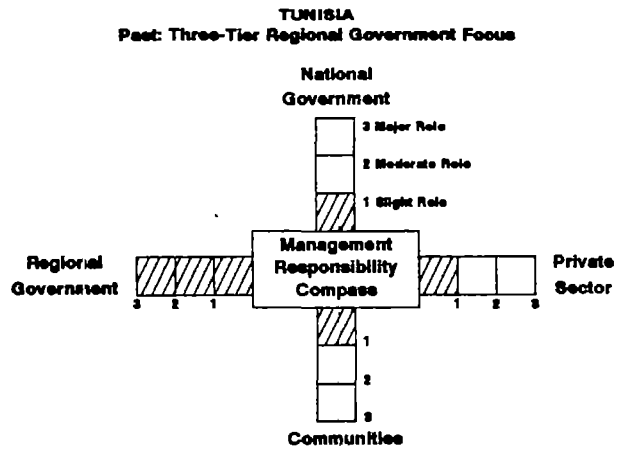


Figure 11

Tunisia: Responsibility of Actors in O&M Management

Basic Principles

The principles guiding rural water supply operation and maintenance management follow.

- The beneficiaries should have primary responsibility.
- Good organization and planning are essential.
- Preventive maintenance is the most effective and least costly in the long term.
- All tasks and responsibilities must be negotiated and clearly defined.
- The private sector must be involved at all levels for greater efficiency.
- Training must be strongly emphasized.

Roles and Responsibilities of Parties Involved

The basic three-tier system has actors at the central, regional, and local levels. In some parts of the country, a fourth level called the delegation (in between regional and local) has been added. Table 1. lists the roles and responsibilities of all parties and the degree of their involvement in past, present, and future O&M.

The term *involvement in maintenance* must be interpreted broadly. For example, the Ministry of Health only supplies chlorine bleach to the communities for disinfection and conducts hygiene education programs. Similarly, the Ministry of Finance supervises the financial management of water user associations (WUAs) and controls all maintenance expenditures. These activities are not strictly O&M but do affect project benefits.

O&M Management

The responsibilities of those actually involved in O&M management are:

- *Pump Operators*: complete daily logs of O&M tasks performed (in many but not all regions) and plan accordingly.
- *Community Water User Association Boards*: oversee all O&M activities, collect fees, hire and supervise operator, arrange for repairs, negotiate responsibilities and establish budgets with the *Commissariats Régionaux de Développement Agricole* (CRDA), attend and plan training, manage funds.
- *Regional Maintenance Units (Ministry of Agriculture)*: negotiate O&M budgets and responsibilities with communities, train and assist communities, conduct major repairs and rehabilitation, develop and execute preventive maintenance programs in collaboration with the communities and private sector crews.

- *Regional Water User Association Support Units*: assist the Regional Maintenance Units and the community Water User Associations to conduct training programs, negotiate O&M budgets and responsibilities with communities, and monitor the effectiveness of the Water User Associations.
- *Ministry of Agriculture*: establish O&M policies and procedures, provide technical assistance and training to regional MOA maintenance offices, assist in procurement and standardization of equipment.

The private sector is not yet involved extensively in maintenance management. Suppliers of parts and equipment, and repair and maintenance technicians are managed by the communities or by government offices. The only exception to this is engineering or consulting firms working at the national or regional level in policy or planning relating to O&M.

4.5.2 Issues Relating to O&M Management System

Traditional Community Organizations

Rural Tunisians have some experience in the collective management of irrigation and grazing, initiated by the communities themselves in some cases and with considerable government assistance in others. However, collective management experience is not widespread and community-based O&M will require the government to provide ongoing support, monitoring, and conflict resolution.

Community Skills and Training

Most villages do not have the leadership, accounting, financial management, conflict resolution, health education, and technical skills to conduct community O&M. An extensive training program must be planned.

Participation of Women

Women are the principal transporters and users of water, but cultural practice has denied them a voice in the planning and operation of water systems. The men decide where standposts are placed and how the system is run, often contrary to the needs of the real users and with detriment to the anticipated health benefits.

Policymakers see the greater involvement of women as the key to effective O&M. As a result, some regional MOA offices now are partly staffed by women, and women are working as extension agents in communities. In several regions, women's interest groups meet at the community level to discuss their concerns and raise questions for the water user association boards. In a few locations, women even serve as pump operators or caretakers, but for the

Table 1

Tunisia Rural Water Supply Maintenance System

Sectoral Level	Organization	Primary Role or Activity (Currently or in near future)	Degree of Organization's Involvement		
			Past	Present	Future
Central	■ International Bilateral Donor Agencies	■ Provide funding for technical assistance & training.	Medium	Medium	Med/Low?
	■ Ministry of Agriculture	■ Establish O&M policies and procedures; provide technical assistance and training to regional MOA maintenance offices; assist in equipment procurement and efforts to standardize equipment.	Low	Medium	Low
	■ Ministry of Health	■ Establish and supervise programs at regional level for hygiene education, and water disinfection.	Low	Low	Low
	■ Ministry of Finance	■ Establish and supervise procedures for oversight of community financial management.	Low	Medium	Low
	■ Engineering Firms & Consultants ■ Equipment & Material Manufacturers, Importers & Suppliers	■ Conduct studies and provide technical assistance under contract. ■ Provide equipment and parts	Low Medium	Low Medium	Medium Medium
Regional	■ Regional Water Resource Committee	■ Oversee community water user association legalization process and annual budgeting.	None	Low	Low
	■ Governor and Governorate Council	■ Provide funds to assist communities with O&M expenses, as needed, through budget negotiation.	High	Medium	Low ?
	■ Ministry of Agriculture	■ Assist in the establishment and monitoring of community user associations, negotiate O&M budgets and responsibilities with communities, train and assist communities to conduct O&M, conduct major repairs and rehabilitation work, develop and execute preventive maintenance programs with communities and private sector crews.	High	Medium	Med/Low ?
	■ Ministry of Health	■ Conduct hygiene education and disinfection programs in communities in cooperation with MOA.	Low	Low	Med/Low ?
	■ Ministry of Finance	■ Exercise financial control of expenses and revenue.	None	Low	Medium
	■ Engineering Firms and Consultants	■ Conduct studies and provide tech. assistance.	Low	Low	Medium
	■ Equipment and Material Suppliers	■ Provide equipment and parts.	Medium	Medium	Medium
	■ Contractors, Mechanics, & other Repair Personnel	■ Conduct repairs and other maintenance under contract to MOA or to communities.	Low	Low	Medium
■ Regional Training Centers	■ Conduct training for communities (planned).	None	None	Medium?	

Sectoral Level	Organization	Primary Role or Activity (Currently or in near future)	Degree of Organization's Involvement		
			Past	Present	Future
Delegation (District Level)	■ Ministry of Agriculture (only some regions)	■ Assist regional crews and communities w/ communication and logistics on maintenance.	Low	Medium	Medium
	■ Ministry of Finance	■ Exercise financial control of expenses and revenue.	None	Low	Medium
	■ Mechanics and other Repair personnel	■ Conduct repairs or other maintenance on demand or contract from communities.	Low	Low	Medium
Community	■ Board of the Community Water User Association	■ Oversee all O&M activities, oversee fee collection; hire and supervise operator; contract with repair people; negotiate responsibilities & establish budgets w/CRDA; attend and plan training; manage funds.	None	Medium	High
	■ Pump Operator / Caretaker	■ Operate system; conduct preventive maintenance and small repairs; stock parts and supplies.	Low	Medium	High
	■ Water Users	■ Use water and equipment carefully.			

most part men still dominate the water user association boards and occupy other key positions.

Complexity of Technology

The policy has been to choose the least complex technology that can deliver the desired supply of water at village standpipes. However, in many regions this has meant using more than very low operation and maintenance (VLOM) approaches, and the need for strong technical support by the regional governments.

The most common system consists of a protected water source, a storage tank, piped distribution, and several standpipes at convenient locations in the dispersed communities. The water source may be a spring, a hand-dug well, or a drilled well. The system has a pump powered by a diesel engine or electricity. The choice of water source depends on hydrogeologic conditions and the availability of grid power. In general, the north uses springs and the south uses wells. In the far south and parts of the central region, the only water sources are very deep wells that require diesel engine/pump sets expensive to procure, operate, and maintain.

A number of years ago, there were efforts to introduce handpumps in areas where the water table allowed, but their use generally has been abandoned for reasons that are not clear. Local engineers say there were maintenance problems and that users were dissatisfied. Perhaps the handpump could be reintroduced in some locations with the new emphasis on community-based maintenance.

Availability of Spare Parts

Government agencies purchase spare parts and there are reliable private sector suppliers as well, but redtape slows the import of highly specialized low-volume items. Few regional governments stock parts in any rational manner. The approach in the future should be to push communities to stock standard parts, and have the regional governments stock specialized parts for larger preventive maintenance needs.

Standardization and Local Manufacture of Equipment

While the basic designs of water supply systems have been standardized, there is still a great diversity of pumps, motors, and engines in use. The five most common types of pumping systems rely on pairs of components:

- diesel engine/mechanical turbine pump,
- diesel engine/horizontal axis centrifugal pump,
- electric grid/electric motor/horizontal axis centrifugal pump,
- electric grid/submersible motor-pump, and
- diesel electric generator/submersible motor-pump.

However, a recent survey of pump systems in eight regions showed that there were 12 brands of diesel engines, only four of which were manufactured or assembled locally. This lack of standardization greatly aggravates the problem of spare parts.

The Government of Tunisia (GOT) attributes this to the engineers who evaluate procurement bids without the technical knowledge to identify the most appropriate brands offered. Training is the solution.

Requirements Shared with Other Sectors

There is a potential for shared requirements with the irrigation and housing sectors, both of which have a strong private sector involvement.

Cost Recovery and Willingness to Pay

Tariffs have been established arbitrarily, with little reference to actual costs, on what is perceived to be a fair basis. More studies are needed in this area.

Government Leadership and Policy

Action by the national government to institute major changes in the water sector is evidence of strong leadership. However, implementation will take time.

4.5.3 Effectiveness of O&M Management System

As the transition from a government-based to a community-based approach is still incomplete, there are only limited data upon which to base any comparison.

Some information is available on the effectiveness of regional maintenance crews under the current approach. For example, breakdowns in summer in eight regions were on the order of 40 per month per 100 water systems and averaged from one to three weeks. These breakdowns could be considerably reduced in frequency and duration with better preventive maintenance.

Some preliminary data make the community-based approach look very promising. The conclusions of a recent study in four regions in the country were as follows:

- The communities are spending much less on diesel fuel than the government was because they are now far more careful about waste.
- Government savings on fuel greatly exceed current expenditures on assisting community water user associations. In fact, expenditures for staff to support the WUAs and regional crews, plus preventive maintenance, could be greatly increased without depleting these savings.

There is also considerable anecdotal evidence that community involvement has greatly improved the effectiveness of O&M. Government agents report that pump operators are now able to carry out basic preventive maintenance and minor repairs. Breakdown rates and repair times are improving, and some WUAs are bringing in private mechanics for major repairs.

4.5.4 Future Problems and Trends

Ownership of the Water Systems

The current policy is vague about the legal ownership of the water systems, implying that the government has made the investment and thus retains formal ownership but has made the equipment available to the communities. Some in the GOT see this as a justification for the government to retain a tight control on the water user associations. Others view it as contradicting the promotion of community responsibility and autonomy. The interpretation has important implications for maintenance and financial management.

Financial Management System

The Ministry of Finance insists upon the control of all WUA finances. Monthly water fees collected by the community are turned over to local or regional MOF personnel. Each WUA treasurer has a revolving fund for expenditures (25 percent of the annual budget), which can be replenished on production of receipts for payments. This procedure is not always smooth because the MOF staff is overloaded. But more important is the fact that it definitely discourages community responsibility and autonomy, and often denies communities access to their own funds because of bureaucratic delays. Many in Tunisia are advocating a less rigid system where MOF simply performs an audit function, rather than actually controlling the funds. The debate continues.

Establishment of Preventive Maintenance

Much work remains to be done in developing procedures, planning (equipment inventories), training, and other related tasks in preventive maintenance. Much of this will be attempted in the near future with A.I.D. support, but will have to continue after that support terminates in 1993.

4.6 Indonesia

4.6.1 Description of O&M Management System

Background

Indonesia, the fifth most populous nation in the world, has substantial oil and gas deposits that have fueled recent growth in urban areas, particularly on the island of Java. However, agriculture remains the major component of the GDP and 70 percent of the population still lives in rural areas. The regional administration operates at four levels: provincial, municipal, district, and subdistrict. Five-year plans, known as Repelita, are the basis of national development in all sectors. Since the second plan, Repelita II (1974), rural water supply programs have been part of the national development agenda. Successive plans have increased emphasis on the solution of socioeconomic problems, more equitable distribution of the benefits of growth, and, more recently, greater participation of the private sector and greater efficiency in operation and maintenance. However, these principles have not yet been uniformly applied at the operational level of all government programs.

Basic Principles

The basic principles espoused in the national development plans stress the need for decentralized decision-making and authority for rural water supply programs. Repelita IV (1984) formally recognized this in the following statement:

Planning and responsibility for rural WS&S development activities should be decentralized, including the determination and inclusion of community priorities in program and project planning and implementation.

Operation and maintenance programs which help insure the long-term sustainability of projects should be developed.

There should be increasing use of local government and community resources in project implementation and greater consideration of cost recovery goals in project planning.

Repelita V reiterates this emphasis on community responsibility, but the planning process makes it difficult to put this commendable idea into practice. The central government must approve all budgetary allocations. A request for assistance from a community wanting a water supply system must pass through five levels of the bureaucracy. At each stage, it can be denied or modified without reference to the intended beneficiaries. Designs are finalized and construction managed with little input from the community. As a result, there is little sense of ownership and of responsibility for operating and maintaining the system. The rural water supply sector in Indonesia must find a better way to put its support of self-help into practice. Some areas are now showing signs of promise as sustainable operation and maintenance management methods are being introduced at the local level.

Roles and Responsibilities of Parties Involved in Maintenance

The current formal O&M roles and responsibilities correspond with those for the construction of rural water supply systems. Since the first development plan, Repelita I (1969), the design and construction of rural water supply and sanitation projects have been a function of the central government, exercised initially by the Ministry of Health and, since 1984, by the Ministry of Public Works through the Directorate General of Human Settlements (*Cipta Karya*). Actual construction is carried out by private sector contractors. Operation and maintenance initially are the responsibility of the Regional Water Supply Organization (BPAM), which uses a formula to set tariffs for each system and class of user that are paid to the Ministry of Public Works. Normally, after five years, the systems are handed over to the Regional Government Water Enterprise (PDAM), which assumes the responsibility for collecting fees to cover O&M.

In 1974, the INPRES (Instruction of the Government—National Subsidy for Local Development) program was introduced under the Ministry of Home Affairs to provide local governments with the funds to meet the high priority needs of rural communities. Pumped water systems, spring protection, and artesian wells have been constructed under this program. But the original intention of transferring responsibility to the user community was rarely carried out, and operation and maintenance are still under the direction of PDAM. The government has suspended funding for the INPRES program, which has been plagued by weak community recordkeeping, reluctance to relinquish responsibility to local agencies, poor quality control during construction, and cumbersome financial and management lines of responsibility. However, donor supported projects are continuing under this umbrella.

As regards O&M, the budgets of both BPAM and PDAM are inadequate for the services they are expected to provide, and the condition and profitability of a system frequently determine whether BPAM will transfer it to PDAM. Both agencies mainly provide emergency repairs and many systems fall into such bad shape that eventually they operate only sporadically, if at all, unless community leaders are motivated to take over. However, there is a growing emphasis on including community members in the O&M process from the outset.

Community leaders in many villages, frustrated by the backlog of requests for government assistance in constructing water supply systems, have taken matters into their own hands. These self-financed projects, sometimes constructed with technical and financial assistance from PVOs such as CARE, have a greater chance of providing sustainable benefits than those constructed by the government. CARE has adopted a model that makes a village water management committee responsible for O&M.

O&M Management

O&M management falls to BPAM or PDAM, and, as explained, which of them takes responsibility, depends on how well established the system has become. Although the Repelitas have stressed community participation, these two agencies have primary responsibility, at least until the cost and effort to continue maintenance become excessive. At

that point, the system either falls into disrepair and disuse or village leaders take it upon themselves to operate it as well as they are able.

The CARE/Indonesia Experience

CARE/Indonesia, over a number of years, has developed a model for assisting communities interested in establishing their own water systems. It encompasses community organization, system design, construction oversight, and training in financial management, community health, etc. A central feature is community management of O&M through the Association of Drinking Water Users (HIPPAM-*Himpunan Pendudukan Pemakai Air Minum*) or the Village Water Management Committee (BPSAB). The HIPPAM is a legal organization set up with the express purpose of managing the water delivery system and providing health education to villagers. In 1989, the government recommended that the HIPPAM model be adopted nationwide, but not all provinces have been willing or able to do this.

Where HIPPAMs exist, communities have taken over responsibility for O&M and have set up management structures appropriate for the technical sophistication of their systems and the skills and financial capacity of their members. Management covers construction, operation, maintenance, and financial affairs, and sometimes the services of contractors or voluntary community labor. The formal and informal models of O&M management are shown in Figure 12.

4.6.2 Issues Relating to O&M Management System

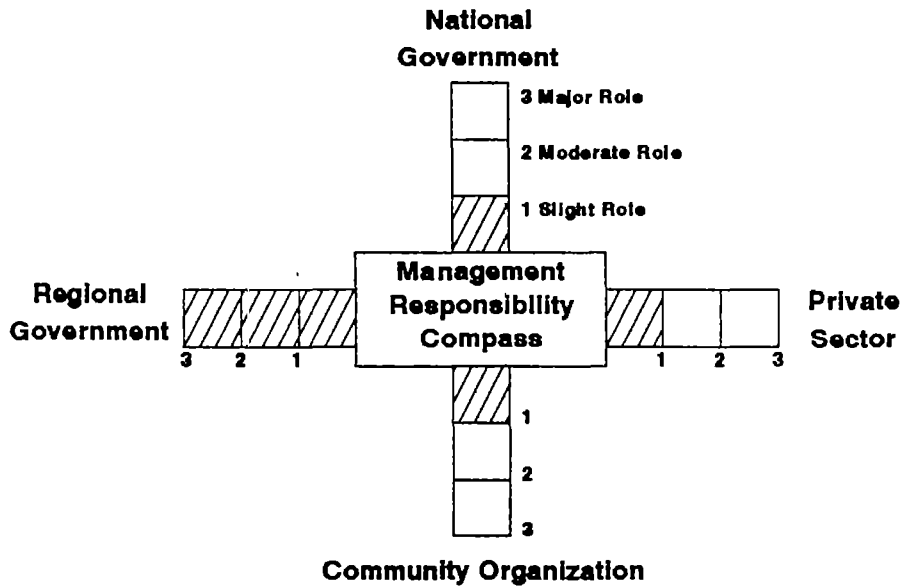
Capacity of Traditional Community Organizations

The traditional village structure has always incorporated self-help community action, now winning government recognition and support. Village organizations are responsible for village government, health, education, and in many areas for mobilizing the financial and human resources to meet priority village needs. These organizations must maintain links with government agencies at the subdistrict level in order to work within the official administrative structure.

Key Community Skills

The growth of village organizations has given a larger voice to educated people, often religious leaders, teachers, or businessmen. However, the technical skills to construct and maintain water systems are not always available and may have to be brought in from outside the immediate community to ensure proper standards of maintenance and repair.

INDONESIA
Formal: Three-Tier Regional Government Focus



INDONESIA: HIDDAM/PBSAB
Two-Tier Community Focus

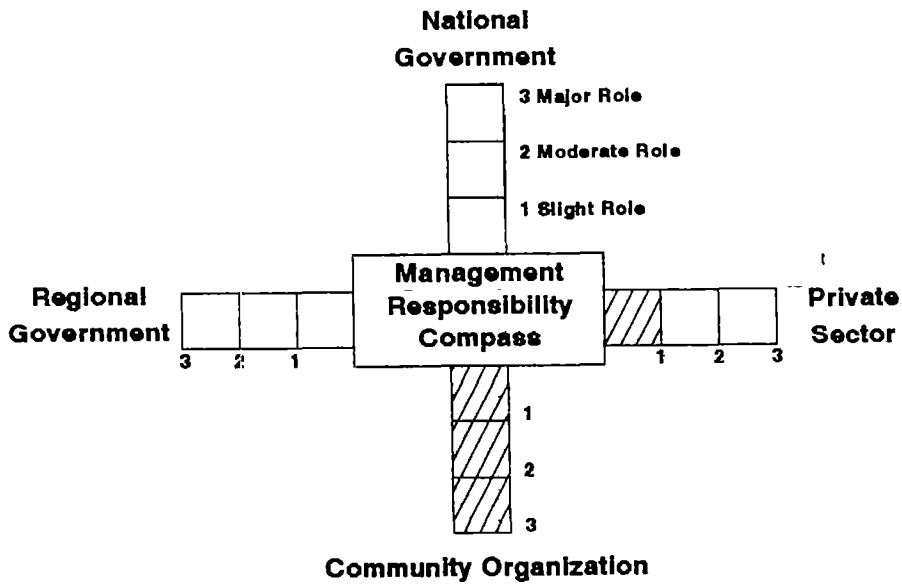


Figure 12

Indonesia: Responsibility of Actors in O&M Management

Health Education and Community Participation

The impetus for an improved water supply generally is convenience, and there is little concern for the connection between water quality and good health, even where rural water projects have attempted to stress this.

Community participation depends on who builds the system. In government-sponsored projects, the villagers provide labor for construction and in some cases food and temporary lodging for the workers. There is little sense of community involvement and ownership. However, in partially or wholly self-financed projects, communities participate in all aspects from raising funds to designing and constructing the system. They are responsible for O&M management when the system is complete, a significant factor in its continued functioning and use.

Participation of Women

Women have a limited role in maintenance, particularly in the more religiously conservative communities, despite a government mandate that their participation should be encouraged. Women are involved in the Family Welfare Movement, but there is scope for their contributions in decisions about the location of taps, bookkeeping, fee collection, and management.

Complexity of Technology

The wide geographical and geological variations in the Indonesian archipelago, as well as differences in hydrologic environment and village size, explain why the technology ranges from rainwater catchments, dug wells, and handpumps to gravity-flow systems, slow sand filters, hydraulic rams, and diesel or electric driven pumps. Generally, the simplest technology that can deliver water is the one used. Community systems commonly have several storage tanks in an extensive pipe network. However, many rural communities still make do with untreated surface water, a practice with obvious health implications.

Availability of Spare Parts

Gravity-flow systems require few supplies other than replacement pipes, fittings (shutoff valves, taps, float valves), and cement, and the availability of spares does not affect continued system functioning. However, where diesel, electric, or hand pumps are used, the availability of spare parts can be a serious problem, particularly in remote parts of the country.

The Indonesian government is pursuing a policy of promoting growth in the industrial sector, and the rupiah is freely convertible. Therefore, many fairly complex items such as pumps and motors are now being built or assembled in the country, and those that are not can be imported without difficulty although procurement may take time.

Standardization of Equipment

The wide range of technologies required in conditions peculiar to the country permits little standardization of equipment and materials. Cipta Karya does use a consistent design similar to that used by PVOs and others. Standard sizes for pipes and fittings are followed, but these items are supplied by different manufacturers. However, standardization does not appear to affect the success or failure of O&M programs. In fact, experience in the design and construction of water systems for the IKK (district centers) suggests that uniform standards may hamper effective O&M because they are unsuitable in the diverse technical and social conditions prevailing.

Cost Recovery Mechanisms

In areas managed by BPAMs or PDAMs, fees are set according to a nationally mandated formula based on the type of equipment installed, the size of the community, and other factors affecting operating costs. However, the funds collected are not administered by the community and often are not sufficient to cover the overhead expenses of these agencies as well as adequate O&M costs. When revenues fall short, the systems that perform reasonably well are given priority and the rest are left to fend for themselves.

The self-financed systems have a range of fees usually collected monthly or annually (post-harvest) by household. However, there is considerable variation in the systems. In a number of villages with few recurrent expenses, fees are collected only as needed, an arrangement that can lead to problems when repairs are costly or if a demand is made before the harvest when communities are cash-poor.

Ability and Willingness to Pay

The progression of the CARE/Indonesia programs towards 100 percent self-financing is an indication that even poor rural communities are able and willing to pay for services. Banks and other institutions (particularly equipment suppliers) are ready to provide credit at commercial rates, with land certificates as collateral to finance system construction. There have been instances of default, but as a rule these loans are repaid. Financing O&M through a fee structure decided by the villagers is not a major problem. However, as the O&M fund increases, villagers feel they don't need such a large reserve and collection rates fall. This is particularly true for gravity systems, where O&M costs initially are very low, and for new systems that have not yet had maintenance problems.

Fee collection rates for systems managed by BPAMs or PDAMs are also an indication of ability and willingness to pay. They vary widely but appear to depend on the service and quantity of water provided. If service is sporadic and water pressure is low, users are less willing to pay.

National and Regional Economies

The Indonesian economy is prospering, but most of the wealth and the benefits of this prosperity accrue to the urban areas, although the regions beyond Java benefit indirectly. The rural areas are poor but able to mobilize resources to meet priority needs. However, there is a tremendous need for services that the central government is still unable to meet despite the thriving economy.

Logistics and Transportation

Logistics and transportation for the delivery of O&M services, as for the whole rural infrastructure, are complicated by the island setting of the country. The INPRES program was designed to ease this problem by giving responsibility to district level agencies.

Government Leadership

Under successive Repelitas, or national development plans, the water sector has greatly improved services. However, it has focused on the water delivery systems in the larger towns and cities, while many rural areas, for lack of funds and clear operational programs at the district and village levels, have been left without access to improved water supplies.

Strength of Government Agencies

The structure of the Indonesian government is very complex. Each Ministry has a headquarters and 27 provincial offices under which are regency/municipalities, districts, subdistricts, villages (desa), and hamlets (dusum). There are more than 60,000 gazetted villages and many more that are not so recognized. The large number of villages and the geographical spread of the agencies responsible for rural infrastructure (including water supplies) make communication and control and coordination of programs difficult. Funding limitations, particularly at the subdistrict and village levels, and limited staff capability and skills pose further impediments. These problems are manifest in the ineffective O&M services provided by the PDAMs and BPAMs which have led the villages to finance and operate water supply systems outside formal government control.

Regional Autonomy

Beyond general policy guidelines and funding allocations by the central government, the provincial and district offices have considerable autonomy in carrying out their tasks. Where villages have constructed systems on their own or with help from nongovernment sources, they have control over O&M management.

Policies and Legislation

Repelita V, the current development plan, continues a high level of government involvement in the water supply sector while clearly identifying increased community participation as a major objective. Under the present system of project and budget approval, project plans may be altered on their way to the central government without any reference to the intended beneficiary communities. This process, which can result in a project very different from what was originally envisioned, is a major impediment to effective community participation and management. Rural communities are at a further disadvantage, since attention to the needs of urban areas first leaves them little chance of inclusion in government sponsored projects to improve water supplies. The acceptance of the HIPPAM model for local control of O&M in one province is a positive step in policy development.

Communication and Information Sharing

Communication, information sharing, and coordination in the sector are poor. The number of government agencies at the subdistrict, district, provincial, and national levels adds to the problem. Several studies have pointed out the need for improving interdepartmental and intersectoral coordination.

4.6.3 Effectiveness of O&M Management System

The government approach expressed in the Cipta Karya water development program has not been effective in providing sustainable water supply systems at the district level and below. Maintenance shortcomings have been attributed to insufficient revenues, a poor understanding of good management practice, limited technical staff, and a highly bureaucratic organization.

The INPRES program, intended to address the needs of rural areas, has not been considered a success for reasons explained earlier. However, an evaluation of the program in 1987 indicated that 39 of 44 community systems (piped water and springs) in three provinces were in continuous service. The general dissatisfaction with the program arose from a much lower use of handpumps and rainwater catchments. The successful community systems led to recommendations for simple, passive technologies. Unfortunately, the government has not seen fit not to continue funding the program.

However, the new interest in self-financed systems holds considerable promise. In selecting such projects, CARE/Indonesia emphasizes motivation, availability of financial resources, and the involvement of villagers in all phases of design and construction. The flexibility of the community-managed maintenance model, although untested over the long term, has the potential to ensure competent management of the water systems.

4.6.4 Future Problems and Trends

The Government of Indonesia is moving towards more active community participation, recognizing that villagers in some areas are willing to commit considerable resources to developing their own water systems. However, government agencies need to be sensitive to the desire for village control over fee collection and financing of O&M.

The success of the CARE/Indonesia program and the HIPPAM model for O&M management has aroused the interest of the Asian Development Bank and the World Bank. The World Bank is developing the Water Supply and Sanitation Project for Low Income Communities, which will build on the experience of the INPRES program and the community self-financing approach of CARE/Indonesia. Village participation in the financing, construction, and O&M of their own water systems, with technical assistance in design and construction supervision and training in system management and community health, provides a workable model for the rural water sector in Indonesia.

4.7 Benin

4.7.1 Description of O&M Management System

Background

The Republic of Benin has seen considerable change in the past five years. Recent elections have installed a government that has begun economic reforms to rescue a country on the verge of financial ruin in 1989. Benin offers an example of an O&M management system successfully implemented at the project level and now embodied in national policy.

The Benin Rural Water Supply and Sanitation Project, begun in 1987 as a joint effort by USAID, UNICEF, the Peace Corps, and three government agencies, aimed at improving the health and living conditions of rural populations in selected regions. Its primary objectives were:

- drilling boreholes and equipping them with handpumps;
- constructing demonstration latrines;
- creating and training village committees for self-management of the water and sanitation systems;
- providing education and training in health and hygiene;
- reducing the incidence of guinea worm disease in the heavily infested project zone; and

- establishing a system of O&M with private sector participation in repair and spare parts distribution.

In accomplishing all these objectives, the project has provided a model for a national water and sanitation policy.

National Policy

This policy is guided by the following key principles:

- WSS facilities must be constructed only where the demand for them and the ability to maintain them have been demonstrated.
- The maximum participation of local government and community organizations must be fostered.
- Communities must be given primary responsibility for managing their WSS systems, including financing the O&M and at least part of the capital costs.
- Health education and sanitation facilities must be accorded equal importance with water supply as essential components of health improvement.
- Women must be encouraged to play a larger role in community management.
- Handpumps must be limited to three models to allow competition but still maintain regional standardization.
- Research must continue to seek the cheapest means of providing water and sanitation facilities, with particular emphasis on solar energy, large diameter wells, and piped water systems.
- The private sector and nongovernmental organizations must be given a larger role.

Project-Level O&M

Since the Rural Water Supply and Sanitation Project has been so successful, a description of its operating elements will provide some useful insights into O&M management. At the national level, the Water Agency in the Ministry of Energy, Mines, and Water Supply heads the sector and collaborates with the Ministry of Health and departments of social affairs and sanitation. The project has established an interministerial coordinating committee that includes representatives of the principal government implementing agencies, the Ministry of Planning, and all donor organizations, and the technical assistance contractor. The committee periodically reviews the project work plan and any pressing issues that require approval or solutions.

The regional offices have considerable independence. One position in particular, that of field agent for the various government offices, is critical for the efficient functioning of the sector. The field agent is responsible for day-to-day contact with the communities and is the catalyst for establishing health committees to manage all sector activities at the village level. The agent trains the committees, conducts courses in health and hygiene, monitors ongoing activities, and sees to it that the private sector repairman and the spare parts distributor provide good service. The field agent, in summary, is the pivotal link between the government, the communities, and the private sector.

There is one repairman for about 20 villages, trained and certified by the project and paid at rates fixed by the Water Agency. Preventive maintenance is required every six months, and transportation is provided by the village whenever the repairman is needed. Spare parts are stocked by local businesses within a reasonable distance of the villages. A national level importer assures entry of spare parts and distribution to the regional businesses.

The community maintains a bank account for its O&M fund and potentially may obtain loans, although the processing of community loans has not yet become functional. The community is fully responsible for managing its system as the de facto owner. A health committee oversees O&M activities, ascertains the needs and interests of people regarding water, sanitation, and health, and is responsible for collecting the user fees decided by the community. Communities must establish an O&M fund as a prerequisite to the construction of a WSS system. All management decisions, such as how the system is to be used and who may use it, are made entirely by the community.

When the pump breaks down, the health committee summons the repairman and pays him from the fund or occasionally with money raised at the time. Sometimes the repairman will provide his services on credit. The responsibilities of the various actors in O&M management are shown in Figure 13.

4.7.2 Issues Related to O&M Management System

Key Community Skills

The project has spent considerable time in training health committee members (president, secretary, treasurer, and advisors), pump operators, and repairmen, believing that training is essential for sound O&M management.

Health Education

Health education has covered the role of potable water and latrines in disease prevention, guinea worm disease control, village sanitation, and personal hygiene. Since rural literacy rates are low, many communities request adult literacy programs once their WSS needs have been met.

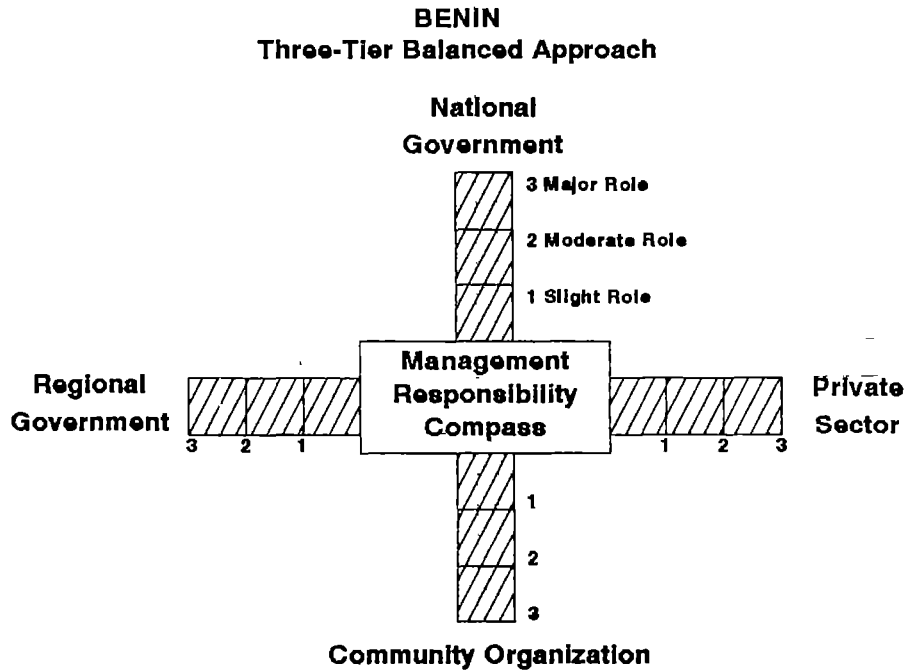


Figure 13

Benin: Responsibility of Actors O&M Management

Availability of Spare Parts

The Water Agency has contracts with importers who distribute the parts for standardized handpump models to regional suppliers from whom repairmen or communities purchase what they need. There must be a sufficient demand for parts to enable the repairmen, distributors, and importers to make a profit, but so far the Indian Mark II pumps have had few breakdowns. The arrangement for spare parts and repairs works well, but it is a fragile system dependent on the overall economy.

Willingness to Pay

National policy requires beneficiaries to demonstrate a willingness to pay at least for O&M costs as a prerequisite to receiving a water and sanitation system. Communities are required to open a bank account and to produce a deposit slip as proof of compliance. In spite of a very weak economy over the past few years, communities have met this condition, although often with some difficulty.

National Economy

The national economy is slowly recovering after virtual collapse. A structural adjustment, with tight controls on government spending and reductions in staff, is being carried out. Future development is dependent upon an economy whose course is difficult to predict.

Strength of Government Agencies and Staff

The Ministries concerned with water, sanitation, and health are generally staffed by competent and dedicated individuals. The field staff, particularly the field agents, have done an outstanding job. However, the agencies are dependent, on donor contributions to carry out projects, since their budgets are inadequate even for basic monitoring activities.

Policies and Legislation

The national policy for the WSS sector is soundly conceived and well written and is a model that follows the guidelines of most donor organizations. The government has demonstrated effective leadership in this area.

4.7.3 Effectiveness of O&M Management System

O&M management under the USAID project is very satisfactory. The health committees take action when needed, pumps are repaired without delay, and the private sector is providing service as planned. However, the project is to be terminated shortly and some reduction in effectiveness can be expected. Other areas of Benin have not all had the degree of inputs that the USAID project has provided and therefore do not function as well. Nonetheless, the present O&M management system is the best in the circumstances.

4.7.4 Future Problems and Trends

The existing O&M system at the project level and at the national policy level is exemplary. All the requisite components are in place including appropriate technologies, community management, education in health and hygiene, and a well-conceived O&M system. Critical staff within the communities and government agencies have been well trained and are capable of carrying out their duties. However, the national economy is fragile and consequently the maintenance and repair program which is dependent on private market forces is also fragile. As long as the economy continues to improve, particularly in the rural areas, the O&M system should be able to sustain the benefits of the WSS facilities that have been installed.

4.8 Costa Rica

4.8.1 Description of O&M Management Systems

Background

During the 1970s, Costa Rica was able to achieve a level of development in health, security, and education comparable with that in developed countries. An economic crisis in the following decade reversed this progress and brought about a serious decline in living standards.

In spite of this setback, the government has achieved levels of water supply and sanitation coverage that are among the highest in Latin America. In 1990, 92 percent of the population had drinking water from household faucets (coverage levels were nearly 100 percent in urban areas and 84 percent in rural areas). About 96 percent of the population had access to either a public sewerage system, latrines, or septic tanks.

Basic Principles of Rural Water Supply

When San Jose's pipeline network was installed in 1968, the construction and administration of Costa Rica's water supply systems were entrusted to government agencies and municipalities. The municipalities set fees that were not enough to cover operational expenses and did not worry about recovering capital costs or about replacing damaged pipelines. Meanwhile, population growth and the increased demand for water triggered a crisis that called for drastic corrective measures. In response, the Costa Rican Congress sought to establish an institution with the power and resources to impose a solution.

In 1976, it created the Costa Rican Water and Sewer System Bureau (*Instituto Costarricense de Acueductos y Alcantarillados, or AyA*) to assume the following responsibilities as an autonomous organization:

- provide the urban population with drinking water, sewage and liquid industrial waste collection and disposal, and rain water drainage;
- operate all the sewer and water systems of the country;
- monitor the investment of government resources in water and sewerage; and
- delegate the management, operation, and maintenance of rural water systems to administrative boards consisting of representatives from AyA and the communities.

The Community Assistance Program (*Programa de Ayuda Comunal, or PAC*), begun in 1977, a time of great prosperity, has greatly improved the living conditions in rural areas, where three out of four low-income people live, according to the National Statistics Bureau (*Dirección General de Estadísticas y Censos*).

The current four-year national development plan emphasizes community participation, which strengthens the PAC's endeavor to harness local energy to governmental plans for the construction, management, and operation of rural area systems.

After the feasibility of a water supply system has been established, each village agrees to provide unskilled labor and materials (sand, cement, stone, etc.) for the trenching stage of construction. AyA's role is to provide design plans, pipes, and miscellaneous accessories with money from *Asignaciones Familiares*, the government fund for community assistance. The completed system is transferred to a local administrative board known as *Comite Administrativo de Acueductos Rurales*, or CAAR. AyA believes that community responsibility not only ensures greater efficiency in the use of public resources but also guarantees that the system will be maintained.

Both the Ministry of Public Health (*Ministerio de Salud Publica*) and AyA are responsible for water quality, but AYA is more effective. In 1990, 75 percent of the systems administered by AyA met WHO water quality standards; in 1991, the figure was 81 percent. By contrast, almost 40 percent of the population served by systems not run by AyA uses untreated water.

Actors in Management System

The administration and maintenance of water systems are shared by the government and the communities, who are represented by CAARs with the following responsibilities:

- manage, operate, and preserve the water system according to the standards established by AyA;
- ensure continued community participation;
- cooperate in educational campaigns;
- explain AyA regulations to the community; and
- protect water supply sources from contamination .

AyA supports the CAARs by:

- giving technical, legal, accounting and administrative advice;
- monitoring the management and general operation of the water system;
- assisting the community and the Administrative Board when major repairs are needed; and
- auditing the books of the Administrative Board.

Figure 14 shows the actors involved.

4.8.2 Issues Relating to O&M Management System

Capacity of Community Organizations

During construction, local leaders, who may come from organizations such as the *Asociaciones de Desarrollo Integral* (Organization for the Integral Development of Rural Areas) which are supervised by the *Dirección General de Desarrollo Comunal—DINADECO* (the office for community development), or from organizations temporarily formed to represent their communities, function as extension agents. They motivate the people, solicit assistance from businesses, supervise the voluntary workers, and alert AyA to trouble spots.

After construction, they are entrusted with directing the operation, maintenance, and management of the system according to the experience and knowledge they have acquired. From among them, a CAAR of five members is elected for a two-year term.

The CAAR authorizes new services and repairs, and hires plumbers from the private sector to fix pipeline damages, clean wells and springs, and operate pumping equipment. In some communities, these people are volunteers and many of them are active members of the Administrative Board.

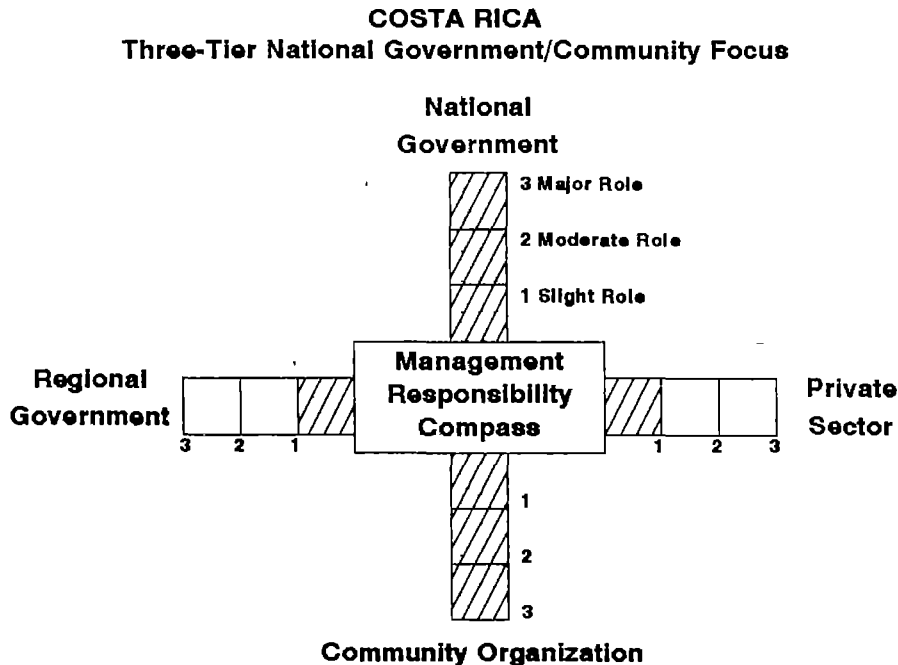


Figure 14

Costa Rica: Responsibility of Actors in O&M Management

AyA authorizes system expansions and replaces defective pumping equipment at the expense of the communities.

Key Community Skills

The people entrusted with the management of rural water systems are usually farmers with only a primary school education. But since they are literate, they can be trained in the basics of water legislation, natural resource preservation, and bookkeeping. Plumbers and equipment operators generally have some carpentry and masonry skills and are given additional training by AyA if they need it. The number of volunteers serving rural water systems is estimated to be over 6,000.

Health Education and Community Participation

Before the cholera epidemic in Peru in January 1991, rural health education was conducted exclusively by the Ministry of Public Health. Since then, a number of other agencies including AyA have been involved.

AyA's health education programs cover public health, water quality, disposal of solid waste, and sewer maintenance, and complement its training programs in the management, operation, and maintenance of water systems.

Participation of Women

Women play an important part in the O&M of rural water supply systems and in health education planning. They are involved in many of the activities carried out by the PAC because the men usually are away at work, and are members of various local organizations.

Complexity of Technology

Most of the water systems are simple gravity-fed systems consisting of a harness tank, a storage tank, a gradient-breaking tank, and a distribution pipeline. A few systems are deep wells with mechanical pumps. In rare instances, slow filtering treatment plants that require little technical equipment have been built. AyA has no experience with handpumps.

Availability of Spare Parts

Spare parts are available readily from an importer or a local distributor. Certain spare parts for pumping systems may be harder to find but are usually carried by the importer of the equipment.

Standardization of Equipment

All systems use standardized submersible electric pumps that meet AyA's technical specifications. The northern zone (Guanacaste) and the Atlantic zone (Limon) have extensive pipelines but few sewage disposal facilities. Electricity is now available in most rural areas, permitting the installation of electrical pumping equipment. Pumps operated by Lister/Peter generators will be switched to regular current when power arrives in towns that do not have it yet. Turbines or diesel horizontal pumps are used only in places where there is no prospect of electric power.

Requirements Shared with Other Sectors

The Ministry of Public Health constructs "mini-piped systems" financed by UNICEF to provide shantytowns with a five-year water supply. These systems are maintained by the communities following AyA guidelines.

The National Irrigation and Flooding Service (*Servicio Nacional de Riego y Avenamiento*—SENARA) has constructed large-scale irrigation works in the north for agriculture and stockbreeding. There are similar private projects that use diesel or electrical pumps.

Cost Recovery Mechanisms

There are a variety of rate structures in Costa Rica. AyA has three rates: metropolitan (the highest), urban (10 percent less), and rural (30 percent less). In municipally administered systems, each town council sets its own rates that have to be approved by the National Electricity Service (*Servicio Nacional de Electricidad*—SNE), the public service rate regulating institution.

In rural systems, the CARRs set their own rates and do not require approval. They also set connecting and reconnecting fees, fines, and other charges according to their needs.

Most of the income is used on repairs but not preventive maintenance. The CARRs are now being persuaded to collect sufficient funds to cover all O&M expenses. It should be noted that the costs of construction by AyA are not recovered.

Ability and Willingness to Pay

Users contribute labor, cash, and goods as a precondition for hooking into the water system. However, many systems are running a deficit on O&M expenditures because of poor economic conditions in the rural areas.

The CARRs pay for the technical, legal, managerial, and accounting training conducted by AyA. Upon request, AyA will assist with difficult repairs.

Logistics and Transportation

Since the country is small, even the most remote rural areas are easily reached. The larger towns have stores, most of them run by cooperatives, that offer convenient payment plans and lower prices than the big city, where materials for construction, maintenance, and operation of the systems are available.

Government Leadership

Costa Rica has a solid democratic tradition that produces governments interested in education and health. It has an illiteracy rate of only 10 percent, a child mortality rate that was less than 15 per 1,000 births in 1988, and a social security system that covers 94 percent of the population for sickness and maternity and 86 percent of the population for old age, disability, and death.

In addition to AyA, there are other agencies whose operations affect the sector. The *Instituto de Fomento y Ayuda Municipal*—IFAM (the government's office for municipal development) supports local governments with technical assistance loans. The *Servicio Nacional de Electricidad*—SNE (National Electricity Service) regulates rates for all public services, including water and sanitation. The National Controlling Office and the General Prosecutor's Office supervise the enforcement of legislation on public institutions.

Regional Autonomy

The government wants to encourage local development councils to take responsibility for the needs of their communities in line with national policies. Local and regional committees are considered essential for coordinating and implementing government programs for facilitating the decentralization process. The aim is to give greater decision-making power to the regional branches of public institutions and provide more financial support for local projects.

Policies and Legislation

Health policies are established in the four-year national development plans. The 1990-1994 plan calls for greater popular participation as an indispensable vehicle for achieving development and specifies the priorities that guide most health activities, including the need for piped water systems, latrines, and related WSS facilities. Adequate drinking water is guaranteed by law.

4.8.3 Effectiveness of O&M Management System and Future Trends

Costa Rica is blessed with favorable topographic and hydrologic features. Springs with water of excellent quality can be found almost anywhere, permitting the operation of simple gravity-fed systems with low O&M costs. While these costs are higher where pumping equipment is necessary, most pumped water systems are operating as designed.

Getting communities organized to meet their own needs is the foundation of the PAC's philosophy and enables AyA to fulfill one of its basic objectives: to provide drinking water for rural and marginal communities. Community participation not only guarantees better use of public resources but also instills a sense of responsibility for the maintenance of WSS facilities that communities acquire. All O&M management of rural water supply is in the hands of the CARRs.

As indicated earlier, Costa Rica has one of the highest WSS coverage levels in Latin America, and although recent economic problems have raised concerns about the continuing ability of communities to finance maintenance needs, the O&M management system is considered exceptionally good.

Future trends include increasing the use of water meters as a means to improve distribution among various economic zones. Many administrative units want easier access to public funds. There are also plans to unify the fee structure in the interests of equity among communities.

5

CONCLUSIONS

The case studies in this report were chosen to demonstrate a range of management models for the operation and maintenance of rural water supply and sanitation systems. Each model has been shaped by the needs and conditions of a particular country, and although most of them employ a three-tier management mode, the responsibility given to each tier varies considerably.

In Botswana, the division of responsibility between a national and a regional administration in a two-tier management system has proven highly effective. The strength of the economy enables the national government to bear the costs of water and sanitation services, and proximity to South Africa provides access to supplies and services that are difficult to obtain in other parts of Africa. The arid climate dictates the need for deep wells and diesel pumps and some solar- and wind-powered systems.

In Yemen, rural communities have assumed control of their water supplies, which are provided by gravity-fed, pumping, and storage systems. The Middle East oil fields, where many Yemenis have found work, have provided these communities with foreign exchange, skilled mechanics, and access to spare parts. Private sector entrepreneurial skills are used to advantage to keep the systems operating. The regional government plays a role in management but is only moderately effective.

Sudan is an example of a very poor country where the political leaders in power maintain firm control. The formal management system that depends on the national and regional governments has failed, and an informal system with a private sector and community emphasis has replaced it. The vast size of the country, climatic variations, difficult access to some areas, and poor communications have contributed to regional differences in approach.

Tunisia, following a worldwide trend to empower local governments and communities, has begun a process of decentralization that marks a significant change. The process is moving cautiously and it is too early to evaluate its effectiveness. The government is asking consumers to pay the full costs of O&M, even in areas where pumping from deep wells is required and these costs are beyond their means.

Belize is an interesting case of a dual system of O&M management determined by the choice of technology. The piped system is under a three-tier management with primary responsibility in the hands of the community, whereas handpumps are managed by the national and regional governments with minor community involvement. This is the reverse of the typical arrangement, where government agencies manage piped systems and communities manage handpumps, and is explained by the fact that the piped systems in Belize serve the more

affluent communities, which can afford the costs of development, and handpumps serve the poorer communities, which the government believes it must assist.

In Indonesia, a country with a comparatively wealthy treasury, a highly centralized administration, but a vast island territory, there is increasing recognition that local initiative is acceptable and should be encouraged. CARE/Indonesia has developed a model that gives village water management committees full responsibility for O&M after their communities have agreed to design and construct their own water systems with little or no government inputs. Since most Indonesian government resources are concentrated in urban areas, this community-based management model offers a desirable decentralized alternative for rural areas.

Benin provides an example of collaboration among several organizations (USAID, UNICEF, the Peace Corps, and Benin government agencies) in a WSS project that has become a national model. The project has emphasized health education and community participation along with the construction of water facilities. Its attempts to promote latrines have achieved limited acceptance. The project is an excellent illustration of a balanced three-tier system with the national government providing overall policy and leadership, the regional government undertaking extension and monitoring activities, and the community health committees taking responsibility for O&M management and all recurring O&M costs since the government has no funds for such expenditures. The private sector supplies parts and does repairs. This model wisely has been adopted as national policy but its success is dependent on the continued growth of the national economy.

Costa Rica is a relatively wealthy Latin American democracy that places great value on health, education, and social welfare. The country has achieved an admirable level of success in providing water and sanitation coverage to both urban and rural dwellers, aided by a combination of strong government leadership, enlightened policy, and good community management skills. Costa Rica has been blessed with an abundance of springs in rural areas that have allowed the use of simple low-cost technologies in water supply.

Each of these models has evolved in response to circumstances peculiar to a particular country. In some cases decision-makers have chosen to ignore, or have been incapable of changing, certain factors and the result has been an O&M system that is less than effective. Table 2 provides a ranking of the most important positive and negative issues affecting O&M management in each country. The most significant issues are the capacity and skills of community organizations, complexity of technology, and government leadership. Ability and willingness to pay, national economies, logistics, and policies and legislation also rank high.

Despite differences in national conditions, there are some common themes that emerge in achieving effective O&M:

- As beneficiaries of WSS projects, communities should be involved in the decision-making process. Increasingly, communities are given more responsibility for managing their own affairs because this is perceived as a more efficient process. The purpose of decentralization is to allow beneficiaries to have greater control of their own destinies, a process that will require more thoughtful decisions. Even in

Table 2
RANKING OF ISSUES AFFECTING O&M MANAGEMENT
OF WSS SYSTEMS BY COUNTRY

	<i>Botswana</i>	<i>Yemen</i>	<i>Sudan</i>	<i>Belize</i>	<i>Tunisia</i>	<i>Indonesia</i>	<i>Benin</i>	<i>Costa Rica</i>	<i>Total</i>
Capacity of Traditional Community Organizations		X	X		X	X			4
Key Community Skills		X	X	X				X	4
Health Education and Community Participation							X		1
Participation of Women					X				1
Complexity of Technology	X	X			X			X	4
Availability of Spare Parts	X							X	2
Standardization and Local Manufacture of Equipment						X			1
Requirements Shared with Other Sectors									0
Capacity of Private Sector				X			X		2
Cost Recovery Mechanisms			X	X					2
Ability and Willingness to Pay		X		X		X			3
National and Regional Economies	X		X				X		3
Logistics and Transportation	X	X				X			3

	<i>Botswana</i>	<i>Yemen</i>	<i>Sudan</i>	<i>Belize</i>	<i>Tunisia</i>	<i>Indonesia</i>	<i>Benin</i>	<i>Costa Rica</i>	<i>Total</i>
Government Leadership	X			X	X			X	4
Strength of Government Agencies and Staff			X				X		2
Regional Autonomy									0
Policies and Legislation					X		X	X	3
Communication and Information Sharing						X			1

* The five most important issues that influence O&M management, either positively or negatively, are indicated by an "X" for each country.

cases such as Botswana, where WSS services are provided entirely by the government, it is important at least to have a communication network to receive feedback on consumer satisfaction.

- The choice of technology must be dictated by local economic conditions. It will often be necessary to choose lower cost technologies in order to fit local economic conditions. Careful analysis of the ability and willingness to pay must be undertaken to ensure that there will be funds to support the WSS structure. Since many countries choose to subsidize the WSS sector, the analysis should include an assessment of both national and individual financial solvency.
- Finance is also an important consideration when choosing communities for WSS projects. Generally, individuals are willing to pay a high percentage of their income for improved water supply if their access to water is difficult. They will pay for an increase in quantity and convenience. They will not pay merely for an improvement in quality, and few are willing to pay for sanitation in rural areas.
- Many communities need training to be effective managers. Tailored training is needed to organize and run meetings, communicate health and hygiene messages, and keep accounts.
- Contrary to popular belief, local repair skills are not usually a significant problem for rural WSS technologies. Assuring a steady supply of spare parts is, however, a major difficulty and requires particular emphasis in O&M management.
- Despite the increasing emphasis on community control, decentralization, and private sector involvement, there always will be a necessary role for government WSS agencies. Water and sanitation is a key component of public health for which the government has a clear responsibility. At a minimum, it must monitor the sector and be prepared to step in when communities are unable to help themselves.
- Establishing communication links between the government and the communities is a critical step. Government extension agents are a vital link with the communities, guiding them with advice and offering solutions when problems arise. Regular visits by the extension agent to the community are essential to O&M.
- Strong leadership is required at the national level, so that people are confident that the WSS policy is wise and equitable and will deliver the benefits it promises. The choice of an appropriate O&M management model must be a fundamental part of this policy.

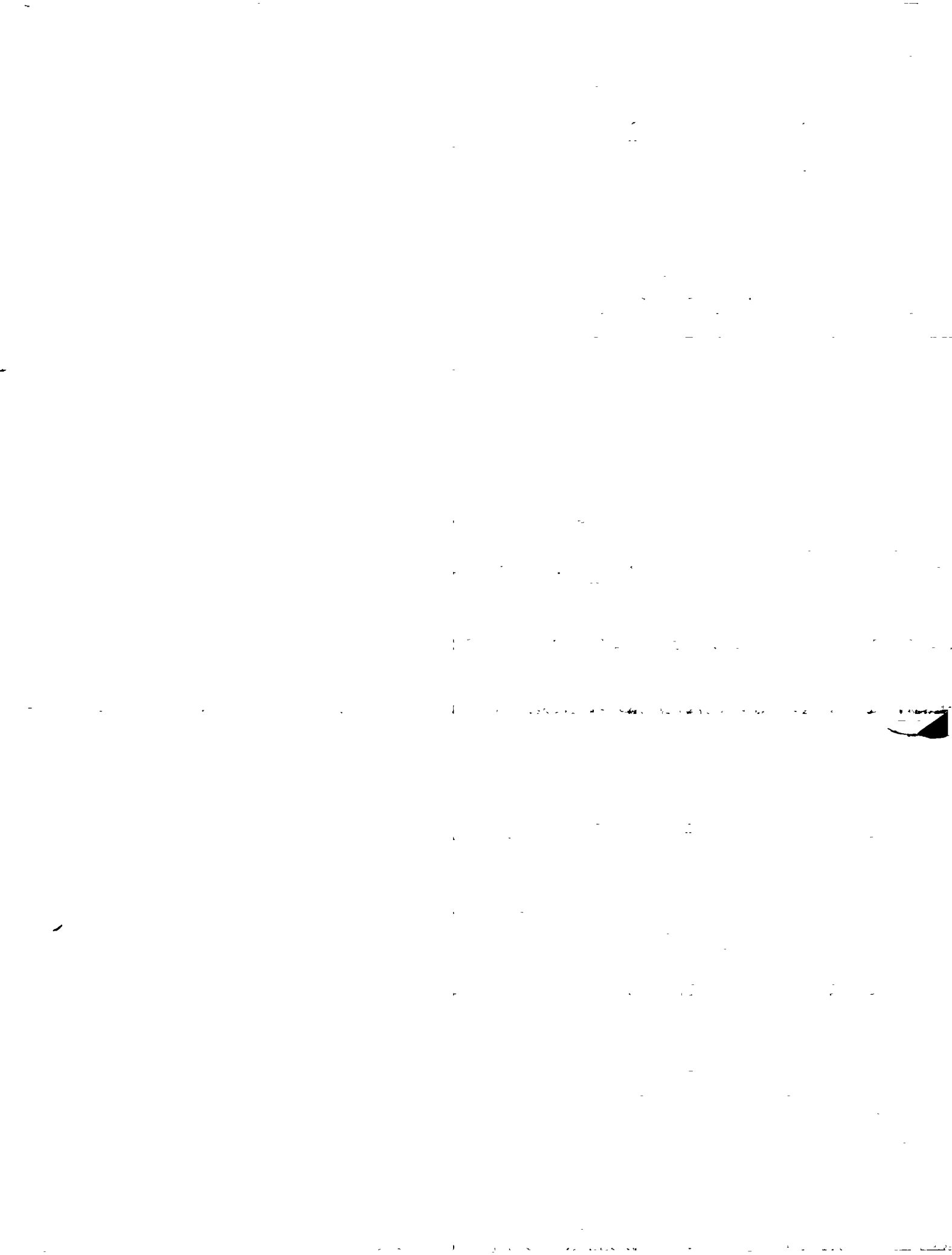
Much attention in recent years has been given to the continuation of benefits after donor inputs have ceased, and it should be apparent by now that sustainability and effective O&M are inextricably tied. Unfortunately, donors and host governments often overlook O&M both at the project design stage and when monitoring the project after completion. Remedying this omission through the choice of a proper O&M management system will pay significant dividends in project sustainability and assure beneficiaries that their WSS facilities will serve their needs for a long time.

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THE WASH PROJECT

With the launching of the United Nations International Drinking Water Supply and Sanitation Decade in 1979, the United States Agency for International Development (A.I.D.) decided to augment and streamline its technical assistance capability in water and sanitation and, in 1980, funded the Water and Sanitation for Health Project (WASH). The funding mechanism was a multi-year, multi-million dollar contract, secured through competitive bidding. The first WASH contract was awarded to a consortium of organizations headed by Camp Dresser & McKee International Inc. (CDM), an international consulting firm specializing in environmental engineering services. Through two other bid proceedings since then, CDM has continued as the prime contractor.

Working under the close direction of A.I.D.'s Bureau for Science and Technology, Office of Health, the WASH Project provides technical assistance to A.I.D. missions or bureaus, other U.S. agencies (such as the Peace Corps), host governments, and non-governmental organizations to provide a wide range of technical assistance that includes the design, implementation, and evaluation of water and sanitation projects, to troubleshoot on-going projects, and to assist in disaster relief operations. WASH technical assistance is multi-disciplinary, drawing on experts in public health, training, financing, epidemiology, anthropology, management, engineering, community organization, environmental protection, and other subspecialties.

The WASH Information Center serves as a clearinghouse in water and sanitation, providing networking on guinea worm disease, rainwater harvesting, and peri-urban issues as well as technical information backstopping for most WASH assignments.

The WASH Project issues about thirty or forty reports a year. *WASH Field Reports* relate to specific assignments in specific countries; they articulate the findings of the consultancy. The more widely applicable *Technical Reports* consist of guidelines or "how-to" manuals on topics such as pump selection, detailed training workshop designs, and state-of-the-art information on finance, community organization, and many other topics of vital interest to the water and sanitation sector. In addition, WASH occasionally publishes special reports to synthesize the lessons it has learned from its wide field experience.

For more information about the WASH Project or to request a WASH report, contact the WASH Operations Center at the above address.