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INTEGRATED RURAL WATER MANAGEMENT

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INTEGRATED RURAL WATER MANAGEMENT

Volume II

Technical documents prepared for the
Second Technical Consultation on
Integrated Rural Water Management
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Geneva

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Volume II contains the unabridged versions of the technical documents presented at the second Technical Consultation on Integrated Rural Water Management. The proceedings, conclusions and recommendations of the Consultation can be found in Volume I.

Contents

Acronyms

ACC	Administrative Committee on Coordination
ACC-SWR	ACC Sub-Committee on Water Resources
AFRO	WHO Regional Office for Africa
AMRO	WHO Regional Office for Latin America and the Caribbean
CSD	UN Commission for Sustainable Development
CTD	WHO/Geneva Division of Control of Tropical Diseases
DBL	Danish Bilharziasis Laboratory
DPCSD	UN Department of Policy Coordination and Sustainable Development
ECOSOC	UN Economic and Social Council
ESA	External Support Agency
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information Systems
GTZ	Gesellschaft fuer technische Zusammenarbeitung
HIP-LSTM	Health Impact Programme, Liverpool School of Tropical Medicine
HRD	Human Resources Development
ICWE	International Conference on Water and the Environment
IDRC	International Development Research Centre (headquarters: Ottawa, Canada)
IDWSSD	International Drinking Water Supply and Sanitation Decade
IIMI	International Irrigation Management Institute
ILO	International Labour Office (headquarters: Geneva)
IPTRID	UNDP/WB International Programme on Technology Research in Irrigation and Drainage
IRC	International Water and Sanitation Centre (The Hague, Netherlands)
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
O&M	Operation and Maintenance
PEEM	joint WHO/FAO/UNEP/UNCHS Panel of Experts on Environmental Management for Vector Control
TCDC	Technical Cooperation among Developing Countries
TORs	Terms of Reference
UNCED	United Nations Conference on Environment and Development (held in Rio de Janeiro in June 1992)
UNCHS	United Nations Centre for Human Settlements (headquarters: Nairobi, Kenya)
UNDP	United Nations Development Programme (headquarters: New York)
UNEP	United Nations Environment Programme (headquarters: Nairobi, Kenya)
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFPA	United Nations Fund for Population Activities
UNICEF	United Nations Children Funds (headquarters: New York)
WARDA	West Africa Rice Development Association (based in Bouake, Cote d'Ivoire)
WASAD	FAO Action Plan on Water for Sustainable Agricultural Development
WB	World Bank (officially: International Bank for Reconstruction and Development, headquarters: Washington DC)
WHO	World Health Organization (headquarters: Geneva)
WMO	World Meteorological Organization (headquarters: Geneva)
WSSCC	Water Supply and Sanitation Collaborative Council
WWC	World Water Council

Review of Progress on the Implementation of Recommendations of the First Technical Consultation

Food and Agriculture Organization of the United Nations[1]
Rome, Italy

1. Introduction

The First Technical Consultation on Integrated Rural Water Management (IRWM) was convened as a direct response to the recommendations of the Dublin and Rio Conferences concerning water management and sustainable development. These conferences asserted that:

- meeting the basic needs of rural populations, namely drinking water, food, shelter, clothing, sanitation and primary health care, and the environmentally sustainable transformation of the subsistence agriculture to a productive and economically viable venture is the basis of rural development;
- in order to meet the basic needs of the rural populations, water development and management will have to be considered in an integrated manner; and
- achieving food security is a high priority in many countries, and agriculture must not only provide food for growing populations, but also save water for other uses.

Chapter 18 of Agenda 21 encompasses a priority area on rural water management, namely: *Water for Sustainable Food Production and Rural Development*, which is based on the principles of integrated rural water management.

The First Consultation on IRWM was thus a logical first step for implementing Agenda 21 within an inter-sectoral and inter-agency framework. In March 1993, the Consultation was convened jointly by FAO/WHO/UNICEF/UNDP/WB and hosted by FAO. The objectives of the consultation were to:

- develop of mechanisms to promote integrated water management;
- identify issues for concerted and coordinated action among agencies, countries and the donor community, including technical assistance to developing countries; and
- establish principles and modalities for the preparation of guidelines for integrated rural water resources management.

To this end, the Consultation was structured on three themes, namely: (a) policy, strategy and planning; (b) research and the development of technologies; and (c) capacity building. Technical sessions, in plenary, on each theme were followed by Working Groups for the drafting of recommendations.

This paper reviews the progress achieved by the relevant agencies in implementing the recommendations of the Workshop, primarily through inter-agency collaboration, but also under the regular programme activities of each of the participating agencies. A summary is provided in Annex 1.

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[1] *Prepared by Arumugam Kandiah, Senior Officer, Water Resources Development and Management Service, Land and Water Development Division, FAO, Rome, with contributions from WHO and UNDP.*

2. Policies, strategies and planning for Integrated Rural Water Management

2.1 Guidelines on policy reviews and reforms

Recommendation

Following indications for future action in the keynote paper, it was recommended that initiatives be taken for support to policy reviews, reform and formulation at national level, with specific regard to the rural environment. It was suggested that attention should be given to the preparation of suitable guidelines, approaches and methodologies for this purpose, leading to the strengthening of mechanisms for inter-sectoral coordination, and to the creation of appropriate legal and institutional structures for the implementation of national water management and conservation policies. Advantage should be taken of recent experiences of national and state governments, and current FAO and World Bank work on policy reviews.

Progress

Considerable progress has been made with regard to implementing the above recommendation.

- The World Bank in 1993 formally published a policy document on water resources management. The publication is considered the Bank's guide to water resources management but, for all practical purposes, it is a very useful guide to all concerned with water resources management. The document was prepared by the World Bank in close consultation with a number of UN organizations, notably, UNDP, FAO, UNICEF and WHO and hence can be considered a product of inter-agency collaboration.

- Following the publication of the policy document, the World Bank together with UNDP embarked on a guide to assist developing countries in formulating water resources management strategies. Again through a process of consultation with relevant Organizations of the United Nations system, the Bank published the *Guide to Formulation of Water Resources Strategy* in 1994 as World Bank Technical Paper No. 263.

- Concurrently FAO developed a guide on water policy reform and review with particular focus on rural water management. After due process of consultation with relevant UN organizations, FAO has published this document under the title *Reforming Water Resources Policy: a guide to methods, processes and practices.*

- Noticing two parallel, but complimentary, publications on water policy and strategy formulation, the ACC-Subcommittee on Water Resources (ACC-SWR) recommended that the World Bank and FAO guides on water policy and strategy be integrated into one publication, to provide a unified guide to Member Nations on water policy reform and strategy formulation. For this purpose, FAO, World Bank and UNDP convened an Expert Consultation in January 1995 and discussed the preparation of the integrated guide. This guide, entitled *Water Sector Policy Review and Strategy Formulation: a general framework,* is in its final stage of review and will soon be published by FAO as a joint FAO/WB/UNDP document.

2.2 Global water information system

Recommendation

Bearing in mind that an adequate information base was essential to all resource management activities, it was recommended that support be given to governments in information management and the building of information systems for the collection and analysis of data. A suggestion was made for the enhancement or establishment of information system centres at national level, as a component of this activity. Investment in information management at country level draws all national agencies into the exchange and contribution

of information, and leads to improved intersectoral coordination, with mutual and overall advantages to integrated activities. There is a need to review current efforts to establish and operate information systems, at both national and global levels, in order to determine gaps and needs.

Progress

In this regard, FAO, in collaboration with national governments, has launched a programme called *Global Water Information System* (GWIS) which consists of two components, namely, (a) *AQUASTAT* which is a data base on water use, mostly in agriculture and rural development; and (b) *GIS-Hydrology*, which is a simulation capability for water resources and environmental assessment. With regard to *AQUASTAT*, data collection for Africa has been completed and the software is being developed and tested. By the end of 1996, it is expected that the *AQUASTAT* database would have covered more than 90% of the irrigated areas of the world.

In response to a request of the Commission on Sustainable Development, the ACC-Subcommittee on Water Resources, together with the Government of Sweden, is preparing a report on comprehensive assessment of freshwater resources which includes a section on water resources data. WMO, UNESCO and FAO are jointly working on the water resources data aspect.

2.3 National water policy reviews

Recommendation

It was recommended that national policy reviews, reform and formulation, demand management principles, and considerations for national information centres be tested on a pilot basis in selected developing countries, including giving assistance to national administrations.

Progress

FAO, UNDP, WB and WHO are actively involved in this subject both collectively and as individual agencies, the latter in response to requests from their respective Member Nations. Joint UNDP and FAO water policy missions were undertaken in Yemen and Vietnam; WHO and FAO undertook a joint water policy mission in Zimbabwe; FAO on its own (under its Regular Programme activities including the International Action Programme on Water and Sustainable Agricultural Development) has undertaken national water policy reviews in Egypt, Turkey, Tanzania, Indonesia, and Belize. UNDP in collaboration with DDSMS has undertaken water sector rapid assessments in a number of countries

In the context of policy issues linking water development and health, a considerable amount of inter-agency work has been done under the joint WHO/FAO/UNEP/UNCHS Panel of Experts on Environmental Management for Vector Control (PEEM). More specifically, a WHO/FAO national seminar on agricultural development and health was held in Benin in 1994. The activity was linked to an on-going FAO/UNDP project for small-scale irrigation development in that country.

3. Research and development

This theme was discussed in a wide range of contexts, from the level of integrated river basin management, through scheme and system design and operation, to the development and selection of equipment and methods for data acquisition, irrigation and domestic water supply. In all of these areas, the software and operational aspects, particularly the human element, were given high priority in a search for solutions to the common problem of diminishing quantities and qualities of water resources.

3.1 River Basin Management

Recommendations

The following activities were suggested for inter-agency collaboration under river basin management:

(a) resource assessment and management methodologies, including the use of advanced technologies such as remote sensing, Geographic Information Systems, computer expert systems and isotope techniques;

(b) user-friendly modelling techniques for both large and small basin-wide analysis;

(c) appropriate economic evaluation methods and their application in basin-wide water management, which take into consideration social, environmental and health aspects;

(d) adequate incentives and mechanisms for intersectoral cooperation and community participation in the context of water allocation policies and the implementation of sector activities; and

(e) ecosystem classification and innovative environmental management methods aimed at protecting the resource base and reducing the health risks associated with its development.

Progress

With regard to recommendation (a):

The WHO Division of Control of Tropical Diseases continues to promote the use of GIS in the monitoring and control of malaria, schistosomiasis and other vector borne-diseases. Efforts focus on Botswana, Morocco and Senegal and have a strong emphasis on promoting an integrated, inter-sectoral use of GIS and on capacity building in the health sector.

In FAO, a pilot phase is currently underway in the Niger River Basin on the application of GIS to simulate the distribution of water resources in the basin. Once operational, the GIS model can be used to develop various scenarios of water resources development at a river basin level.

With regard to recommendation (e):

PEEM organized missions to the Lower Mekong and Zambezi River basins to assess the options for incorporation of a health component into integrated river basin development and management. The reports of these missions were discussed at the technical discussion during the 12th PEEM meeting in March 1994. In addition, a desk study of the Senegal River Basin was prepared and discussed in the 12th Meeting of PEEM. The discussions resulted in recommendations for the implementation of a comprehensive package of capacity building and awareness creation activities in the Mekong Basin; studies on the association between wetland development and vector-borne disease risks in the Zambezi Basin and studies on reservoir management for vector-borne disease control in the Senegal River Basin.

3.2 Water Use Efficiency

Recommendation

In order to address relevant issues concerning water use efficiency, the Consultation recommended that R&D activities be undertaken with the following objectives:

(a) technical improvements for the more efficient conveyance and distribution of water in both irrigation and domestic supply systems, with special reference to local adaptability, durability, cost-effectiveness and easy maintenance; and

(b) the development and testing of improved on-farm irrigation methods that will contribute significantly to water saving. There should be an emphasis on the water saving potential of different irrigation and cropping methods and practices, in combination with crop/soil management, soil hydroponic systems, protected agriculture and genetic improvement. These R&D activities in particular should include an assessment of the environmental and health effects of new technologies.

Progress

- FAO and WMO jointly held workshops on the use of meteorological data for irrigation management.
- Concerning R&D in health and water development, PEEM was successful in launching a research programme on *the association between rice production systems and vector-borne diseases in West Africa* in collaboration with the West Africa Rice Development Association and IDRC (Canada).
- Under the auspices of the Water Supply and Sanitation Collaborative Council, in which several UN and bilateral agencies participate, the Working Group on Operation and Maintenance of Water Supply and Sanitation Systems continued to play an important role in promoting efficient use of drinking water.

FAO, in its regular programme, undertook a number of activities on irrigation water development and management. Some important activities undertaken by FAO include:

- development and testing of a computerized Irrigation Management Information System, (SIMIS);
- TCDC Regional Workshop (Near East and North Africa Region) on *Advanced irrigation technologies for sustainable agriculture in arid climates*; and
- a publication entitled *Irrigation water delivery models.*

3.3 Wastewater Management

Recommendations

The Consultation recognized the importance of low quality water (including wastewater, brackish water and drainage water) as part of the available water resources of countries in the arid and semi-arid regions of the world. It also recognized that further investigations are needed in support of the successful implementation of sustainable wastewater re-use systems. In order to address existing knowledge gaps it is recommended that the following initial R&D activities be undertaken:

(1) for the countries in arid and semi-arid areas, develop guidelines for the establishment of sustainable low quality water re-use systems and the upgrading of existing systems, and provide relevant information on policy, technological and institutional aspects and on pertinent environmental, health, socio-economic and cultural issues; and

(2) assist countries in translating these guidelines into national standards and codes of practice for the use of low quality water, taking into consideration local priorities and constraints.

Progress

Three inter-agency activities are relevant in this regard:

- *Regional Workshops on Wastewater Use*: WHO/FAO/UNEP/UNCHS jointly implemented three regional workshops, in Mexico, representing the Latin American and Caribbean Region, in India, representing Asia and the Pacific Region and in Zimbabwe, representing the southern African Region, on wastewater use.;

- *Mesquital Valley Project on Wastewater Use:* WHO and FAO, together with PAHO undertook an activity to evaluate the use of partially treated municipal wastewater of Mexico city for crop production in the Mesquital valley.;

- *Working Group on Water Pollution Control:* Under the WSSCC, a Working Group on Water Pollution Control has been established. The Working Group will be coordinated by WHO. The Working Group is preparing a text on water pollution control which will include strategies and methods for water pollution control, case studies, and a comparative evaluation of different management systems and approaches.

3.4 Optimization and system performance

Recommendation

The Consultation noted that the sub-optimal performance in all types of schemes, in the various water sub-sectors, results in high costs, declining services, environmental degradation and weakened benefits. There is a complex set of relationships among several key factors affecting this situation which includes:

- management: the provision of water services through operational control of human, physical and financial assets of the system;

- maintenance: the preventive and remedial actions necessary to keep a system functioning at the level of performance for which it was designed;

- financing: the willingness to pay for the desired levels of services by the users of the system;

- institutional strengthening: the legal and policy framework which assigns responsibility to agencies to implement and coordinate their programmes;

- technology application: the application of technologies that have been successfully used in one sector to other sectors, where such application has potential but is not yet adequately utilized;

- innovative extension methods.

The Consultation believed that greater attention should be given to identifying and developing techniques in each of the above areas in order to improve the performance of water resources management systems.

Specifically, the Consultation recommended that a joint task force be organized by those agencies that have active R&D programmes dealing with one or more of the above key factors. This task force should:

(1) identify the detailed aspects of each of these factors needing special attention;

(2) establish a framework for cooperative action to develop the identified aspects; and

(3) prepare guidance material for overall optimization of systems performance.

Progress

There has been very little progress in this area, particularly within an inter-agency framework.

With regard to innovative extension methods, PEEM is promoting the introduction of environmental management methods for vector control through agricultural extension systems. Following three regional workshops on this subject, there is a plan to develop guidelines for agricultural extension workers and village level public health officers.

The WHO/UNICEF Joint Monitoring Programme for water Supply and Sanitation (JMP) is designed to monitor a minimum set of water supply and sanitation indicators and is supposed to have the capability to collect data down to five administrative sub-levels of government.

FAO is making some effort to evaluate irrigation system performance by means of the SIMIS programme.

4. Capacity building for water-sector development and management

The basic components determining the capacity of the system were identified as human resources development (HRD) and the institutional structure. Three elements of capacity building are:

- the creation of an enabling environment for capacity building with appropriate policy and legal frameworks;
- institutional development, preferably building on existing institutions; institutional development includes national, local, quasi-governmental, public and private institutions, and community participation; and
- human resources development and the strengthening of managerial systems.

Key actors in capacity building include government at various levels, external support agencies, education, research and training and extension institutes, professional associations, national and multinational corporations, and the private sector.

Recommendations

The Consultation adopted the following recommendations:

(1) National Water Sector Assessments should be facilitated and supported by the UN system and bilateral agencies as a starting point for the identification of capacity building needs and priorities.

(2) National governments and support agencies should enter into long-term commitments to facilitate programmes for capacity building, which must be seen as a steady and continuing process. Relatively small inputs over a long period of time are considered to be more effective than larger inputs of short duration.

(3) Water Sector Capacity Building should form part of Integrated Water Resources Management. When focusing on the rural environment, capacity building should also promote the integration of national development objectives.

(4) Opportunities should be taken for the networking of institutions, which is a powerful tool for capacity building, and in particular for the exchange of experiences and capacities between developing countries.

Progress

Actions already initiated, in capacity building, by UNDP, are in harmony with the above recommendations, and it is intended that other organizations of the UN system would collaborate as appropriate.

The UNDP's water sector assessment programme is tailored to the state of a country's water resources as well as to the specific characteristics and requirements of the way they are managed. A multi-faceted assessment of the water sector at large by government and other national specialists, complemented, as required, by external expertise, will provide the basis for such strategies. The assessment process has four steps: (1) fact finding mission; (2) formulation of the Terms of Reference; (3) water sector assessment; and (4) national/regional consultation.

The national/regional consultation will bring together the various stakeholders and ESAs to discuss and outline medium and long-term strategies for comprehensive water resources management.

The programme will structure its efforts by putting the various capacity building experiences into case studies and training materials. In this regard, there will be close collaboration on this work with the Economic Development Institute of the World Bank.

The following are the outputs of the programme:

- a process of capacity building initiated by water sector assessment;
- a nucleus of officials and specialists committed to and trained in sustainable water sector development;
- water sector assessment reports;
- improved cross-sectoral and cross-functional collaboration; and
- improved coordination among national agencies and ESAs.

The PEEM activities on national capacity are relevant. PEEM has carried out, in collaboration with the Danish Bilharziasis Laboratory, three national training courses on *Health opportunities in water resources development*. The course has been held so far in Zimbabwe, Ghana and Tanzania and one is planned to be held in Honduras in 1996. The training course has adopted a task-oriented, problem-based learning approach, where participants from different ministries are given a chance to learn about inter-sectoral decision making that may lead to incorporation of health issues in the planning and design of water resources development projects.

A Near-East and North Africa Regional Workshop on Water Management Technologies for Arid Climates was organized jointly by FAO and UNDP under the framework of TCDC in March 1995. The Workshop was hosted by Egypt and attended by representatives from 11 countries of the region. It provided a forum to the participating country experts to exchange information on water management technologies. The Workshop recommended that a Second Regional TCDC Workshop be held in 1996 on the subject of *Use of Marginal Quality Water in Agriculture*.

FAO has produced, under its Water Management Training Manual Series, seven publications on various aspects of irrigation water management specifically designed for irrigation and agricultural extension workers.

5. Mechanisms of coordination and collaboration

Mechanisms of coordination and collaboration among UN Organizations and between UN Organization and Member Nations and External Support Agencies in the water sector were dealt with in a Discussion Forum. Existing mechanisms were discussed with respect to four programmes, namely:

- the Water Supply and Sanitation Programme under the framework of the Collaborative Council (WSSCC), with its secretariat in WHO;
- the International Action Programme on Water and Sustainable Agricultural Development (IAP-WASAD), with its secretariat in FAO;
- the International Programme for Technology Research in Irrigation and Drainage (IPTRID), with its secretariat in WB; and
- the joint WHO/FAO/UNEP/UNCHS Panel of Experts on Environmental Management for Vector Control (PEEM), with its secretariat in WHO.

Discussions focused on coordination of and collaboration in activities relating to programme formulation and implementation at national, regional and international levels and both within and beyond the umbrella of the ACC-Subgroup on Water Resources.

Some recent developments

The idea of a *World Water Council* (WWC) was first brought out, in a formal manner, at the Noordwijk Conference in March 1994. In November 1994, at the 7th World Congress of the International Water Resources Association, a consensus was reached by the participants on the need for a World Water Council. An Interim Founding Committee to do the preparatory work was established. This Interim Founding Committee met recently in Montreal and has produced a strategic document called the *The World Water Council-Montreal Initiative*. The document presents a mission statement, objectives, scope of activities, membership and other relevant details of the WWC.

Concurrently, UNDP and World Bank have jointly launched an initiative called *Global Freshwater Partnership* which will serve as a window for joint implementation of the UNDP-WB Programme on Water Supply and Sanitation and The International Programme for Technology Research on Irrigation and Drainage (IPTRID). FAO's WASAD programme is likely to form a component of the Global Partnership, to integrate the objective of water development for food security and sustainable agricultural development.

Recently, an external evaluation of the PEEM was carried out and consequently there may be modifications to its current modality of collaboration among the participating agencies.

6. Guidelines for Integrated Rural Water Management

The 1st Consultation provided a preliminary framework for the identification of principles for the preparation of guidelines on integrated rural water management. It was considered that components of the guidelines will emerge from the implementation of the recommendations of the Consultation. Thus it may be timely to discuss this subject at this 2nd Technical Consultation to decide: (a) whether such guidelines are needed; and (b) if so, what should be the modality to prepare the guidelines.

It should be noted that the proceedings of the 1st Technical Consultation, including the edited technical papers, were published by FAO and have been widely distributed. This publication, by itself, is a useful document on the subject of rural water management and it is not a substitute of the intended guidelines.

7. Conclusions

The 1st Technical Consultation had very clearly brought out two issues: the complex nature of rural water resource management, in particular the linkages between irrigation and (agricultural water use) water needs for drinking, sanitation and rural health; and (b) the interaction between the various UN agencies in the sphere of rural water management. The Consultation re-affirmed that an integrated approach is vital to sustainable management of water resources in the rural sector and that inter-agency collaboration is the best suited strategy for the UN system to assist Member Nations in a productive and cost-effective manner.

The scope of the 1st Technical Consultation was very broad, and so were the recommendations, which are too many to be followed-up in a practical sense. As evident from the paper, follow-up by the agencies in implementing the recommendations was only moderately successful, at best. There are several reasons for this situation as listed below:

(a) There is no formal mechanism, among the participating UN agencies for joint implementation of programmes. PEEM is perhaps an exception in this context. Although, the ACC-SWR has established a number of Working Groups for this purpose, they are practically non-functional as far as joint programming is concerned.

(b) Most UN organizations are faced with a lingering financial crisis and under such a situation, the organizations give priority to their own "regular programme" activities which are mandated by their respective Governing Bodies. This results in inadequate staff time and funds for inter-agency activities.

(c) Lack of external funding for coordinated activities hinder implementation of joint programme. Even if the financial situation of UN agencies improves, it is unlikely that they can implement joint programmes without external funding. Response from multi- and bi-lateral funding sources has been poor. It was believed that the UN would secure additional (extra-budgetary) funds to implement Agenda 21, but this is not happening.

(d) Inter-agency collaboration at the country level is found to be even more difficult. Agency representatives at the country level seem to be preoccupied with the activities of their own agencies and their respective national ministries;

However, the need for joint action among the UN organizations, is becoming increasingly evident. The UNDP-World Bank initiative, namely the *Global Water Partnership* could prove an effective mechanism for joint implementation of programmes. The WSSCC is functioning relatively well, but there is room for improvement. The joint WHO/FAO/UNEP/UNCHS programme, i.e. PEEM has worked reasonably well until now, but apparently it requires change and is approaching a stage of revitalization.

It is important that recommendations for joint inter-agency activities be based on the realities of budget and manpower that would be made available be the respective agencies. However, an over-riding factor is the relevance of the programme itself to the Member Nations and the value of the programme in assisting national governments to manage their water resources to achieve sustainable development and national capacity building.

The Influence of Technology on Operation & Maintenance of Rural Water Projects

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1. The background papers and the basis of the synthesis

This *Synthesis* paper seeks to draw together the conclusions of two background papers prepared for the Consultation: the **UNDP/IRC paper** (starting on page 61), prepared jointly by those agencies and covering technology issues relating to operation and maintenance of *rural drinking water supply* projects, and the **FAO paper** (starting on page 77), focusing on the influence of technology on O&M of *irrigation* projects.

These papers contain comprehensive coverage of the relevant technologies in their individual fields, put the O&M issue in a historical context, including past successes and failures, and provide a detailed rationale for their recommendations for future O&M strategies.

In this paper, the aim is to compare and combine those recommendations in a way which may assist Consultation participants to view the implications for integrated approaches to rural water resources development and management. With that in mind, the synthesis paper does not repeat the argumentation for the various conclusions, but concentrates on the similarities and the differences between them.

Any strategy for integrated management will clearly seek to take advantage of the many common features of sustainable drinking water and irrigation projects. In this regard, the most fundamental example is the widely accepted principle of users' involvement in the selection and management of local facilities. In the technology field, water intakes, pumps, pipes, valves, and many other elements of the two systems have overlapping maintenance needs for which common solutions should be feasible.

Equally, successful strategies must recognize the critical differences between O&M demands in the two subsectors. These may be as basic as the different objectives: achieving optimum sustainable agricultural output in the case of irrigation water management, compared with a mix of health, hygiene, quality of life and environmental benefits to be accomplished through well-maintained water supply systems. Or they may be more technical, such as the complexity of storage and flow control methods needed to match seasonal demands for irrigation water compared with the relatively constant demand for reliable daily supplies of drinking water.

It is clear from the two background papers that model solutions are not easy to formulate, even when considering each subsector in isolation. Local conditions vary widely and affect both technology choice and the organizational and financial mechanisms needed to manage installed facilities. Though institutional and financial issues were outside the terms of reference of these two papers, as they are covered separately at the Consultation, both papers emphasize that sustainability depends on the right balance of technology choice, a workable institutional framework, financial arrangements and support structures. Capacity building is seen as a high priority in any future strategies and the skill requirements, spare parts implications, and resource needs of different technologies are critical considerations.

Section 2 presents an issue-by-issue comparison of O&M principles highlighted in the background papers. The individual O&M needs associated with each technology type are summarised in Section 3. In this way, it is hoped that Consultation participants may more easily draw comparisons between the two subsectors and identify the issues to be resolved in any proposals for integrated rural water resources management. In formulating those proposals, they will need to refer to the supplementary information contained in the background papers.

2. O&M principles compared

Table 2.1 summarises the elements of operation and maintenance identified in the background papers as contributing to sustainability. The common, overlapping and divergent issues associated with each element are discussed in sections 2.1 to 2.9.

2.1 O&M objectives

Any integrated rural water management strategy must cater for the divergent, sometimes competing, objectives of irrigation water users and potable water consumers. Indeed, one of the prime advantages of integration is the capacity to resolve such potential conflicts. In O&M terms, while there is a common objective to keep delivery systems functioning reliably, the different uses of the water present quite different challenges, which need to be resolved in an equitable way. The drying up of community handpump wells due to large-scale irrigation pumping in the dry season is one example of conflict arising from competing priorities.

The UNDP/IRC paper puts forward the concept of *household water security*, initially proposed at the Noordwijk Ministerial Conference in March 1994, as a mechanism for assigning due priority to meeting basic needs for both potable water and subsistence agriculture. The concept has not been fully developed and may be an appropriate discussion area for the Consultation, as one of the potential ways of merging the priorities of the two subsectors.

2.2 User involvement

Both subsectors are committed to optimum involvement of users in decision-making and in the O&M of appropriately chosen technologies. However, the scope for user management of facilities varies enormously. The local nature of community water supplies makes it quite practical in most cases for community-based organizations to take responsibility for operating and maintaining the majority, if not all, of the water system. The same is true of on-farm management of irrigation systems, where users share the same type of vested interest in keeping the system operating efficiently. The difference arises because of the added scale and complexity of irrigation source works and conveyance systems, and the administrative complications involved in distributing water to farmers.

It may be appropriate first to seek ways of integrating management systems for on-farm irrigation and community water supplies, to make maximum use of available skills and materials and to focus capacity-building initiatives. Mechanisms for achieving maximum user involvement will need to recognize the different user constituencies: the challenges in the drinking water subsector include finding ways to ensure full representation of different social groups, to provide an influential involvement of women; and to develop appropriate ways of collecting payments and financing O&M; the vested interests of farmers create different priorities, some of which overlap with the drinking water ones.

2.3 User groups

Community management of village water supplies is commonly the responsibility of a village water committee, whose composition ideally reflects all segments of the community. The committee may employ or designate local caretakers for routine maintenance of installations; it may contract with local firms, or with the water agency for emergency repairs or for more complex maintenance tasks; and it may develop links with locally active NGOs for additional technical or administrative support. Normally the committee will also take on financial responsibilities, collecting charges from householders and arranging payments for support services.

Table 2.1: Key elements of O&M in drinking water supply and in irrigation

	Drinking water supply	*Irrigation*
Objectives (Section 2.1)	To ensure a reliable *daily* supply of safe water which is used effectively to bring health and environmental benefits to all members of the target community.	To achieve maximum agricultural output from the target irrigated area by matching the supply to *seasonal* demands of individual farms in an equitable and dependable way.
User involvement (Section 2.2)	Full involvement of users in planning, design and O&M of water improvements seen as a fundamental principle. Partnerships fostered with NGOs, private sector and water agency, under community management.	Users involved in decisions on service levels and responsible for on-farm management. User groups manage tertiary (distribution) systems contracting out work where necessary to private firms.
User groups (Section 2.3)	Village water committees based on local organizational structures and having legal status. Caretakers for pumps, taps, valves.	Autonomous Water User Associations with legal status and control over tertiary systems. Federations of WUAs for lobbying and resource sharing.
Water use implications (Section 2.4)	Water quantities relatively small, but required daily to avoid return to polluted alternatives. Hygiene education needed to stimulate most effective water use.	Water management is the most critical issue. Large volumes involved with significant resource implications from efficient use and equity considerations important.
Technology range (Section 2.5)	Simplest technologies involve hand-dug wells with rope and bucket; handpumps and/or standposts are popular choices. Pumping to storage tanks is often needed. Water treatment systems are generally designed for operational simplicity.	Sophisticated headworks including dams and/or large pumping plants. Conveyance by canals (preferably lined) or large pipes. Distribution system with a range of flow-control options from simple proportional distributors to computer-controlled regulators. Field applications range from watering cans to centre-pivot sprinklers, with choice related to on-farm skill levels.
Institutional framework (Section 2.6)	Primary objective is devolution of decision-making to the lowest appropriate level. Decentralized water agencies work in partnership with communities. Central government retains responsibility for protecting public health, maintaining quality standards and managing national water resources. Ministerial responsibility may be divided and needs coordinating mechanisms.	Decision-making devolved to lowest appropriate level. Vital central government control of national water resources management, conservation and pollution prevention. Significant scope for private commercial teams to manage distribution systems, providing a valued service to farmers.
Cost recovery (Section 2.7)	Full recovery of O&M costs seen as a fundamental principle, though yet to be achieved in many cases. Wide acceptance of the concept of water as an economic good	No explicit discussion of cost recovery in FAO paper, but good revenue generation seen as a requirement of sustainable O&M.
Capacity building needs (Section 2.8)	Reorientation of agency staff towards community-based partnerships,community level skills development of caretakers, treasurers and water committee members decentralization backed by legislation, legislative changes to facilitate spare parts availability.	Technological development, particularly related to low-maintenance systems. Skills training in WUAs. Education and training of farmers in water use efficiency and system maintenance. Data processing for improved management.
Role of support agencies (Section 2.9)	Refocused towards community-based approaches, perhaps using NGOs as intermediaries. Lengthened project cycles.	Avoidance of tied aid, support for R&D related O&M. TCDC.

User involvement in irrigation schemes generally operates through Water User Associations – collectives appointed by farmers to represent their interests. WUAs are recognized by government as legal entities with responsibility for the management of sections of the irrigation system, usually the distribution of water within a given area the size of which varies enormously from country to country. The best WUAs are powerful agencies and have strong lobbying power, increased by federations which promote common interests and may organize sharing of technical resources and information. WUAs are self-financing from user fees. They provide an institutional bridge between the farmers and the government, allowing the implementing agency to transfer responsibility once it has guaranteed agreed quantities of water as bulk supplies.

It is at this level that the different purposes of irrigation water use and drinking water provision are most significant. While administratively the functions of a WUA and a village water committee are similar, their constituencies and their objectives differ greatly. Integrating the two subsectors could bring benefits, but has to be approached carefully to avoid institutionalizing the domination of irrigation users at the expense of those still lacking basic water supply services.

2.4 Water use implications

The high volumes of water required to grow crops through irrigated agriculture make water conservation and efficiency of use prime criteria in the O&M of irrigation programmes. Water allocation is also important, as high use by upstream farmers can restrict supplies downstream. Allocation policies have a strong influence on the design and operation of the whole system.

The low-maintenance *continuous flow* system can be wasteful unless there is off-line storage and storage itself can present health problems as the reservoirs may become breeding grounds for vectors. The *on-demand* system involves pressure pipes and metered hydrants. It is costly and sophisticated but water efficient and with a good chance of achieving economic sustainability. It may also be highly appropriate for combining irrigation and drinking water supplies from the same source, as drinking water supplies can be metered and charged as bulk supplies to a water committee or agency. The FAO paper sees the *semi-demand* system as a more realistic model for most developing countries. It involves farmers indenting for supplies several days ahead of demand, with control structures on the secondary system providing the necessary flexibility. A fourth option is *rotation*. Water is delivered for a set period to one set of users (or the system can be applied within a farm unit) then diverted to others.

Whichever operational system is in use, farmers and system operators need education and training in ways of obtaining optimum benefit from available supplies and timing demands to match the needs of the crops.

Potable water supplies involve much smaller quantities. While it is important to avoid waste and to conserve resources as much as possible, a prime concern in the O&M of community water supplies is to avoid people having to revert to contaminated alternative sources. In the choice of technology and the maintenance arrangements, the aim is to ensure that there is access to safe water on a daily basis. Through hygiene education and sanitation promotion, the aim may often be to stimulate *more* water use for beneficial purposes.

Irrigation water users and domestic water consumers share common interests and responsibilities in preventing the contamination of rural water resources. Pollution may arise from inadequate environmental sanitation, from livestock wastes, or from irrigation drainage.

Introduction or expansion of an irrigation scheme may have a number of possible impacts on domestic water supplies. By bringing large quantities of water closer, it should make the provision of sustainable drinking water supplies easier; on the other hand, agricultural consumption may be so large on a seasonal basis that it interferes with domestic water resources, particularly if groundwater tables are lowered by heavy pumping; and there may be quality implications, if field drains or leaching from agricultural land contaminate surface or groundwater sources with nutrients or pesticides.

The potential effects on the proximity, quantity and quality of available water create a powerful case for joint planning and joint O&M of irrigation and community water supply schemes. If irrigation projects can be designed to assure a constant daily quantity of water to meet drinking water needs, the economies of scale can have a significant impact on the capital and recurrent costs of community water supplies.

2.5 Technology range

The differences in scale of irrigation and drinking water projects are reflected in the comparative cost and sophistication of the different technologies involved. Section 3 describes the O&M implications of individual technologies in the two subsectors. It is fruitless to make comparisons between the management of the large-scale headworks and conveyance systems associated with irrigation programmes and that of the predominantly local source works developed to meet community water supply needs.

However, if the benefits of integrated rural water resources management are to be achieved, the fact that water delivered through irrigation canals will also be used for drinking water supplies will have a significant influence on the pollution control measures needed and the operational rules for conveyance and delivery systems. In addition to the design, operation and management practices employed to minimize the threat from aquatic disease vectors, there is a need for protection against harmful contamination through wastes or debris discharged into open canals or reservoirs. It may be, for example, that concrete pipes will be the preferred choice as carriers in more cases than at present.

There would seem to be significant scope for greater collaboration in the operation and maintenance of local delivery systems for irrigation water and that of community water supply systems. Common skills, equipment, spare parts, fuel and materials are needed for the O&M of pumps, pipes, valves, storage tanks, etc. Collaboration between Water User Associations and Village Water Committees may result in attractive O&M contracts for private sector firms. Or an efficient WUA may be able to take on the role of a water utility, providing cost-effective services to rural communities. Collaboration will need to begin at the planning stages of programmes, to make optimum use of standardization and use of local materials and skills, and to foster appropriate partnerships with private entrepreneurs.

2.6 Institutional frameworks

Both background papers emphasize the need to devolve operational decision-making to the lowest practical level and both acknowledge the scope for commercializing water management operations through greater involvement of the private sector. The subsectors also have in common the problem of divided responsibilities among different ministries, which adds to the challenge of achieving integrated water management.

As institutional issues and community participation are covered in other Consultation papers, they are not developed further here, though the technology background papers stress that the administrative and organizational framework has a critical influence on technology choice and on O&M implications.

2.7 Cost recovery

Insufficient revenue to finance O&M activities is identified as a major cause of failure or poor performance of past projects in both subsectors. Though the FAO paper does not explicitly discuss cost recovery, it does point to the fallacious project appraisal economics which favours low capital costs and high recurrent costs and so puts an unrealistic burden on system operators. Full cost recovery for O&M is also implicit in the paper's conclusion that irrigated agriculture is increasingly being seen as a commercial enterprise in which profitable outputs generate revenue to pay for efficient services.

In the UNDP/IRC paper, technology and service level are seen to be dictated by *effective demand*, denoted by users' willingness to pay for the upkeep of their chosen system. Full recovery of recurrent costs is seen as a *sine qua non* for future sustainability. Cost recovery is, of course, also directly related to water

pricing. In the drinking water subsector, it is argued that people let down by past government schemes based on *free water* will willingly pay charges high enough to fund the upkeep of dependable locally-managed supplies, and that the poor benefit from realistic water pricing applied to all users.

The acceptance of water as an economic good has big implications in the irrigation subsector, where farmers are used to receiving water at highly subsidized rates. The FAO paper also poses the equity dilemma of increased costs of new irrigation projects meaning higher charges for farmers compared with those connected to older systems. With field application efficiencies ranging from 20% to 80% depending on the choice of application technology, water pricing may be seen as a crucial issue in terms of water conservation and with significant implications for O&M. Farmers who pay for a service rather than for the water they use have no incentive to install water-saving technologies.

2.8 Capacity building needs

The visions of sustainability emerging from the background papers depend on significant changes in past approaches to donor-assisted projects. In both cases, changes can only be achieved if there is substantial investment in building the capacity of local agencies and individuals to take on fresh responsibilities.

The papers identify specific needs in the individual subsectors covering a wide range of topics. In the UNDP/IRC paper, the emphasis is on the changing role of government from provider to enabler. That means that reorientation is needed for water agency staff, communities need assistance in developing management structures and training for their new roles, and legislative changes are necessary to provide the authority and autonomy for decentralized operations to function successfully.

The FAO paper focuses on the priority need to improve water management. Here there is a need to provide farmers with information and training in ways to operate and maintain more water-efficient technologies. Research and development is also seen as a critical area, with the aim of developing appropriate technologies for key maintenance problems such as aquatic weed control, desilting, drainage, control and measurement.

In the context of integrated rural water management, the Consultation may also identify other key capacity-building needs in relation to, for example, promoting partnerships and collaboration, establishing joint technology appraisal teams, fostering private sector involvement, or developing financing and cost recovery methods for unitary control of integrated systems.

2.9 Role of support agencies

With specific reference to technology aspects of O&M, the FAO paper identifies a need for inter-agency collaboration in relation to two parallel and concurrent approaches:

- O&M technology to improve water use efficiency, local adaptibility and cost effectiveness;
- evaluation and improvements to O&M technology from the point of view of health and environmental safety.

The background paper lists a series of specific activities to further these approaches and sees the second in particular as creating a possible bridge through WHO and UNICEF with rural water supply and sanitation programmes.

Another key collaborative activity is in the collection and analysis of data from different countries on the technology and costs of different irrigation application methods and organizational structures. Linked to this in the information sense is a proposal for the UN, through an appropriate agency, to establish a data base on research into irrigation and water resources in general and to make information available through the information super highway.

The UNDP/IRC paper calls on support agencies to direct their support away from programmes which conflict with the established approaches and to increase support for O&M components in all projects. Support for capacity building is seen as a vital need, particularly in relation to community-based approaches. Both papers condemn tied aid as counter-productive and urge agencies to adopt uniform approaches based on what is now a widespread consensus about future strategies.

3. The O&M implications of different technology options

Tables 3.1 and 3.2 present the background papers' conclusions on O&M needs for the various technologies involved in irrigation projects (Table 3.1) and community water supply projects (Table 3.2). In each case, the tables also indicate the scope for user/community involvement in the O&M of the technology concerned and, where applicable, the type of capacity building needed to make community management sustainable. The tables provide summary information only, Consultation participants should refer to the individual background papers for detailed assessment of operational needs for the different technologies.

It is evident that, in O&M terms, irrigation projects can be divided into three elements: *Headworks and conveyance systems*, which involve major engineering structures and heavy pumping equipment and need to be under the control of the main national implementing agency (groundwater pumping is an exception, being more localised in its influence and best managed by a Water User Association or private operator); *Distribution within the project area*, which is a direct responsibility of the scheme operator – WUA or private enterprise; and *Field application*, which is necessarily the responsibility of the end-user.

As there is a huge range of technologies available for on-farm application of irrigation water, and the amount of water used can vary enormously according to technology choice and operational efficiency, there is much to be gained by focusing on improvements to this end of the chain. This is also where common interests of farmers and other water consumers may best be merged to develop local integrated water management strategies.

Table 3.2 reflects the progress made in developing appropriate technologies for community management of rural water supplies. Though complications arise in the case of some water treatment technologies, and additional training is required to equip communities to manage large piped distribution systems, it can be argued that the challenge in achieving sustainable community water supplies relates more to remedying organizational and financial shortcomings than to developing the right technology.

Community Involvement, Education and Training

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Objectives and scope

This issues paper presents details and a discussion of UN system activities in Operation and Maintenance (O&M) in the fields of irrigation and drainage, water supply and sanitation, particularly in a rural environment. It aims to reflect a consolidated interagency analysis of community, education and training aspects of operation and maintenance, without emphasis on the policies, views and approaches of any of the UN organizations in particular. Its purpose is to assist the Consultation in a review of the present status of those activities and the formulation of measures which may be desirable for the improvement of their content, for interagency collaboration and for delivery to country level.

The paper has been prepared on behalf of WHO and UNICEF, with visits to the headquarters of both agencies, to FAO, UNDP and the World Bank, and also to the UN Department of Policy Coordination and Sustainable Development, (DPCSD) and to PAHO. In all cases, staff concerned with water resources and associated human resources programmes have been helpful with information, advice and documentary material, which is gratefully acknowledged.

In outlining the scope of the paper, it is worthwhile to define, and perhaps to interpret some of the key expressions relating to the subject matter and to the Consultation.

The term O&M trips easily from the lips, but deserves analysis. In analysing it, **maintenance** is in fact aimed at ensuring that a system functions at a designed standard of **operation**, although it will call for some specific actions and supporting measures.

WHO and the Water Supply and Sanitation Collaborative Council (WSSCC) define Operation and Maintenance as a general concept covering all kinds of activities carried out by water supply and sanitation utilities and by communities in order to sustain their public services and to maintain their existing capital assets (WHO 1994b). In this context, it is stressed that O&M should be viewed not only under a technological or operational perspective, but also, and more importantly, should take into account the aspects associated with the overall performance of the water supply and sanitation facilities. Aspects such as institutional arrangements, organization of the water supply and sanitation services and sound resources management (human resources, environmental, financial and economic aspects and assets management), should thus be among the issues to be tackled in the development of programmes addressing improved operation and maintenance.

The situation is even more complex in respect of agricultural use. Here, the standards of water management imposed by O&M practices will also be a directly determining factor on production, income and maintaining the agricultural resource base.

Within any system for water supply, **operations begin with the abstraction of water from the source, continue with its delivery and management for beneficial use, and end with its eventual disposal.** This spectrum of activities, with their implications for quantity, quality and temporal characteristics of the resource means that discussions must recognize the extremely broad scope of the context within which the subject lies. Limitations of time and space preclude detailed treatment of many such aspects, which will often include **impacts and conflicts among urban communities, industry, energy and rural water users.** It is essential that these be taken into account in any discussion of integrated rural water management, as their influence on the water resource, or on specific developments, may determine the **sustainability** of either, or both of these.

Whereas **education** and **training** are generally accepted as providing knowledge and instruction at different systematic levels, the concept of **community involvement** is more open to interpretation. With a focus of UN system efforts on the unserved and underserved populations, it is sometimes presented primarily as a "grass roots" issue. This may be entirely acceptable where a community can be considered in isolation for the development or operation of a specific scheme, and where such circumstances exist they permit the formulation of methods and procedures tailored to facilitate the involvement of that particular community.

The UN organizations have made considerable progress in this respect, evolving common approaches and methodologies, and a number of collaborative activities. In relation to the overall theme of this interagency initiative - **Integrated Rural Water Management** - dependence on a common resource will generally call for a much broader interpretation of the **community** to be involved, considering, rather, **a hierarchy of communities** linked by a system of institutions, infrastructure and legislation. External support must therefore operate in conjunction with such national systems.

Defining the scope of this issues paper then, there appear to be three possible areas for consideration in proposing an **integration of efforts** aimed at improving **O&M** in rural water management. The first is in the context of **the water resource itself**, the second in developing and adopting **common and proven methodologies** to facilitate involvement of the community, and the third is the development and application of **mechanisms and funding for collaborative action** of the UN agencies in delivering support at country level. This said, all such approaches must be tailored to suit local social, cultural and economic circumstances in a technically and institutionally complex system. There is no universal quick-fix solution.

The international policy framework

Mar del Plata and the IDWSSD

The Mar del Plata Action Plan, arising from the 1977 UN Water Conference, (UN 1978), in its fifty-eight pages of recommendations, contains many references to water development, management, operation and maintenance, and addresses the involvement of the international agencies in the entire range of sectoral interests. However, apart from the recommendation directed at international organizations on support to the International Drinking Water Supply and Sanitation Decade (IDWSSD), none of the others appears to have inspired any significant cohesion and collaboration among these organizations. Under the heading of Public Information, Education and Training, in the Action Plan, it is notable that community involvement was not mentioned. The closest approach was in references to *"citizens being made aware of, and informed of water-related issues."*

The IDWSSD did bring agencies together and, to a greater or lesser extent, encouraged the incorporation of its concerns for human health, safe water supply and improved sanitation in various sectoral activities. This was strongest in the arrangements involving WHO, World Bank, UNDP and UNICEF. The programmes of FAO, while taking community water supply into account, did so more in relation to overall health aspects in agricultural water development and management (under an already existing arrangement with WHO), and later especially as a founding, participating organization of the WHO/FAO/UNEP/UNCHS Panel of Experts on Environmental Management for Vector Control (PEEM).

The assessment of progress since Mar del Plata

It is largely through the **assessment of progress in the implementation of the Mar del Plata Action Plan**, in 1991, under the aegis of the UN Administrative Committee on Coordination - Inter-secretariat Group on Water Resources, which later reverted to its original title of ACC Sub-Committee on Water Resources (ACC SCWR), and the resulting identification of shortcomings, that the true importance of

Operation and Maintenance has been highlighted. So also has it been recognized that inadequate acceptance or participation by the community is often a major cause of underperformance, or even failure, of many systems, whether for domestic, agricultural or other uses. The change in perceptions since the 1977 Water Conference is illustrated by the following extracts:

Community awareness and the promotion of women's participation

"The role of the community, and particularly that of the women in the communities, in the promotion, implementation, maintenance and management of water supply and sanitation services has undergone a significant change over the course of the Decade. Ten years ago, the community was viewed primarily as a source of unskilled labour, and community participation was generally limited to its mobilization in order to reduce project costs. Most schemes were conceived, directed and financed by central government agencies or others external to the community concerned...

The continued improvement of operation and maintenance systems still constitutes a critical aspect of actions to be taken by governments at all levels, if the sustainability of programmes is to be ensured. This will depend largely on the success of actions taken to increase trained manpower, improve community participation, upgrade institutional capability, and institute suitable cost recovery measures."

Achievements of the IDWSSD 1981-90
Report of the Secretary-General to the UN General Assembly (UN 1990)

"An almost universal factor contributing to low efficiency in irrigation is the deterioration of scheme infrastructure through poor maintenance - commonly associated with a short-fall in scheme income due to inadequate cost recovery from the farmers. This becomes a vicious circle, for a farmer whose production is depressed by an unreliable service is unwilling, and may even be unable, to meet the costs of operating and maintaining that service. There is good reason for the current trend towards the decentralization of scheme management and the introduction of financial autonomy in place of centralized control and various forms of subsidy. At the same time, the efficiency and sustainability of any scheme depend ultimately on the farmer's incentive and ability to apply suitable standards of on-farm management of land and water. The key to this lies in an assured sufficient income from the sale of his produce."

Agricultural Water Use - Assessment of progress in
the implementation of the Mar del Plata Action Plan
Report of the regional assessment missions (FAO/UN 1991)

Recent developments in UN system water management programmes

In general, the UN organizations' mandates and programmes on water supply and management have been expressed in terms of broad technical issues, for example *Irrigation development, rehabilitation and improvement* (FAO), and *Water supply and sanitation in human settlements* (WHO). The process of evaluating progress sharpened attention to the influence of specific factors such as **operation and maintenance; the role of institutions; human resources development and community involvement**. We have, for instance, the World Health Assembly Resolution WHA42.25 of 1989, on the IDWSSD, which *inter alia*

"REQUESTS the Director-General:
to ensure the continuation of WHO's advocacy and leadership role in this sector, consistent with primary health care principles and with emphasis on the development of national institutions, human resources, information exchange, appropriate technology, water quality, community participation, including an enhanced role for women, health education, operation and maintenance and on the mobilization of internal and external resources."

In 1990, the Global Consultation on Safe Water and Sanitation for the 1990s called for a renewed commitment to sustainable water and sanitation systems for all, stressing the need for **socially acceptable services**...adopting community management and enhancing human access. This conference saw the participation of the newly created Water Supply and Sanitation Collaborative Council, which complemented the UN mechanism with bilateral organizations in a novel initiative. The status of WSSCC was reported to the First Consultation on Integrated Rural Water Management (FAO 1993), with details of its Working Groups, one of which is devoted to Operation and Maintenance.

In the more general context of water resources management, the ACC IGWR, at its annual meeting in 1989, proposed the formulation of a **strategy for capacity building** for sustainable development. Resulting from this, the UNDP prepared a paper on Capacity Building for Water Resources Management (UNDP 1991), which was presented to the Symposium - A Strategy for Water Resources Capacity Building, at Delft in 1991. This symposium culminated in the **Delft Declaration**, with its annex *Helping Countries to Solve their Problems Themselves.*

The next milestone in the continuing debate on water resources management was the International Conference on Water and the Environment - Development issues for the 21st century, held in Dublin in January 1992, in preparation for the United Nations Conference on Environment and Development (UNCED), the following June. With its theme of **Water for Sustainable Development**, the report of the Dublin conference (ICWE 1992) made specific reference to "political commitment and involvement from the highest levels of government to the smallest communities. Commitment will need to be backed by substantial and immediate investments public awareness campaigns, legislative and institutional changes, technology development and capacity building programmes". The report also suggested systems for intergovernmental overview of water-related aspects expected to be raised in the UNCED.

> *"Experience has shown that progress towards implementing the actions and achieving the goals of water programmes requires follow-up mechanisms for periodic assessments at national and international levels...*
>
> *In the framework of the follow-up procedures developed by UNCED for Agenda 21, all governments should initiate periodic assessments of progress. At the international level, United Nations institutions concerned with water should be strengthened to undertake the assessment and follow-up process. In addition, to involve private institutions, regional and non-governmental organizations along with all interested governments in the assessment and follow-up, the Conference proposes, for consideration by UNCED, a world water forum or council to which all such groups could adhere".*

The UN Conference on the Environment and Development

Within the Programme of Action for Sustainable Development of the UNCED, designated **Agenda 21**, (UN 1992), two chapters are of particular relevance to this Consultation. These are Chapter 18 - Protection of the quality and supply of freshwater resources: Application of integrated approaches to the development, management and use of water resources, and Chapter 37 - National mechanisms and international cooperation for capacity-building in developing countries. Chapter 38 - International institutional arrangements also merits reference, but is mostly a re-statement of the mandates of United Nations bodies and their responsibilities.

Chapter 18 proposes seven programme areas for the freshwater sector. These include i) Integrated water resources development and management; ii) Drinking water supply and sanitation; and iii) Water for sustainable food production and rural development.

Each programme area is presented in the following sequence: Basis for action; Objectives; Activities; Means of implementation. With its emphasis on the environmental linkages with development, references tend to be on more general management issues than **operation and maintenance**, although

this is mentioned briefly under ii) and iii). However, all three programme areas give extensive and intensive coverage of community involvement, education and training. Each devotes considerable space to **human resource development, and capacity-building and institutional structures.**

These last aspects are encapsulated in the following paragraph under water supply and sanitation:

> *"Overall national capacity building at all administrative levels, involving institutional development, coordination, human resources, community participation, health and hygiene education and literacy, has to be developed according to its fundamental connection both with any efforts to improve health and socio-economic development through water supply and sanitation and with their impact on the human environment. Capacity-building should therefore be one of the underlying keys in implementation strategies...."*

The programme on Integrated water resources development and management, in its Basis for action, also makes a statement apposite to this Consultation:

> *"The holistic management of freshwater as a finite and vulnerable resource, and the integration of sectoral water plans and programmes within the framework of national economic and social policy, are of paramount importance for action in the 1990s and beyond. The fragmentation of responsibilities for water resources development among sectoral agencies is proving, however, to be an even greater impediment to promoting integrated water management than had been anticipated. Effective implementation and coordination mechanisms are required."*

Chapter 37, which elaborates on the potential role of the UN system and its agencies, in partnership with other external and national agencies, in capacity-building, includes the following item among its activities:

> *"Strengthening of the sustainability of projects by including in the original project design consideration of environmental impacts, the costs of institution-building, human resource development and technology needs, as well as financial and organizational requirements for operation and maintenance."*

The Commission on Sustainable Development

The CSD, formed in response to the UNCED, and reporting to ECOSOC, held its Second Session in May 1994 (UN 1994), and reviewed *inter alia*, a "sectoral cluster" of health, human settlements and freshwater. On this last item, apart from recognition of the outcome of many recent international meetings, the Commission's list of concerns and recommendations is remarkably similar to views and attitudes expressed at the time of Mar del Plata. The CSD intends to review the situation once again at its 1997 session, in preparation for the 1997 special session of the General Assembly. This treatment of freshwater seems hardly stimulating or progressive, but the CSD does request the Secretary-General "**to strengthen coordination within the system**, with a view to concentrating and consolidating the great amount of international action in the field of water, including the implementation of chapter 18 of Agenda 21, and to report to ECOSOC".

UN agency programmes with bearing on Operation and Maintenance

All the agencies visited have, for many years, incorporated O&M in water development and management programmes in their particular spheres of activity. Sometimes, this has involved a distinct element devoted to the subject, otherwise (and generally), it may be implicit in resource or system management programmes. There has, however, been a progressive shift in emphasis within the treatment of O&M by the agencies. Earlier O&M programmes gave almost exclusive attention to technology and

to the financing of schemes. Training was directed to technical issues, with recognition of the role of some form of extension service to instruct system operators and users. This is not to say that the potential benefits of a more comprehensive institutional support and community involvement were completely overlooked.

The report to the UN Water Conference by the ACC (UN 1978), analysing UN system experience in village water programmes, had this to say on **integrated rural development**:

> *"This type of project offers special difficulties if the water component has to be integrated into a more comprehensive rural development project where no village water administration exists, or where it is very weak. Generally, it might therefore be said that institutional weakness is probably the most important problem in rural water supply, and that institutional building and training is essential at all levels from the village operator to professional staff. Training and institution-building, for this reason, constitute important elements in many of the international organizations' programmes."*

This emphasis is reflected in the programme narratives of FAO, UNICEF, WHO and the UN, annexed to the ACC report.

Food and Agriculture Organization

The same theme is taken up in the study of Organization, operation and maintenance of irrigation schemes, (FAO 1982), which identifies the need for a special unit within the project organization to educate farmers about water use, operation and maintenance. The paper develops the concept of **group formation**, facilitated by these special units, but while concluding that local group formation is a key to a long-term process of social transformation within the project area, it recognizes the problems of implementation:

> *"The work of these special units is likely to be far from easy. Not only will individual farmers be unfamiliar with good water management practices, but there may be little natural cohesion among those whose land happens to fall within a particular watercourse command, and who are therefore expected to cooperate with one another in a mutually advantageous way. Friction is likely to occur in societies with religious differences and significant disparities in power between larger and smaller farmers, manifesting itself in refusals to share water equitably or to collaborate in watercourse maintenance. There is also almost always a potential conflict between the interests of head-reach and tail-reach farmers within the watercourse.*
>
> *Under these circumstances, group formation will often require much patient effort, backed by a capacity to use powerful sanctions against persistently uncooperative individuals or groups, and* ***an essential condition for success is a reliable and predictable water distribution service.***"

The FAO International Action Programme on Water and Sustainable Agricultural Development - IAP WASAD (FAO 1990), under a priority programme **targetting efficient water use at the farm level**, now gives special attention to:

> Enhance design, operation and maintenance of irrigation projects by training of relevant professionals and members of water users' associations:
>
> - initiate training for operation and maintenance personnel during the construction phase of new projects, and during rehabilitation of existing projects, to prepare them for project operations;
> - train system designers and operators in effective and economic approaches to modernizing irrigation and drainage systems, and in effective and economic maintenance technology including principles of preventive maintenance; and

- **develop operation and maintenance criteria**, taking into account the cost, manpower availability and requirements, and social and environmental protection needs. **Ensure that the criteria are taken fully into account in the design of irrigation systems.**

The FAO Programme of Work and Budget for 1994-95 also shows a positive approach. The programme element on **Irrigation management and performance** includes the following statement:

> *"Another aspect which will receive attention is the transfer of state-managed irrigation systems to **water users' associations**. Many countries are engaged in this process, and require guidance and exchange of experiences, to be supported by this element. Collaboration with IIMI (International Irrigation Management Institute) will be pursued."*

In the same programme, the element on Technology transfer contains the comment:

> *"The experiences of outstanding field projects concerned with water management training at the farm level will be analyzed, leading to a publication on **how to disseminate information to farmers** in water management and increase the cohesion of farmer groups."*

Constraints on water availability have brought strong criticism of generally low efficiency in agricultural water use, and there has been an upsurge of interest in the on-farm management of water in many countries. There is a realization of the potential for improvement offered by the increased involvement and abilities of farmers, farming communities, water users' associations, extension services and institutional support. Recent examples are the **Technical Consultation on Irrigation in West Africa**, and the FAO/Govt. of **Indonesia Programme for On-farm Water Management**.

The first of these was held in Accra, in December 1994, following a request from the 17th FAO Regional Conference for Africa, and brought together experts from 15 countries in the region, with representation from the West Africa Development Bank, the European Union, the International Programme for Technical Research in Irrigation and Drainage, (IPTRID), which is co-sponsored by the World Bank, UNDP, the International Commission on Irrigation and Drainage, IIMI, and many others. The subject raised considerable interest as the meeting focused attention on an essential condition to achieve sustainable agriculture in West Africa - the need for an **effective support service to farmers**. In the present trend to privatization and the transfer of management of irrigation schemes to farmers, this holds the key to success.

If they are to accept full responsibility in the operation and maintenance of the irrigation system, as well as adopting appropriate cultural and irrigation practices, farmers need basic information and support, which at present are often completely lacking. The role of the extension service, backed by competent technical services, was highlighted as a means to overcome present poor performance of irrigated agriculture. Proposals have been made for the establishment of a Regional Network for Irrigation in Africa, and for national projects for the **development of support structures for irrigation**, the first being in Ghana.

The programme in Indonesia has developed over about a decade, and aims at improved on-farm water management, with an emphasis on developing the self-reliance of farmers in the operation and maintenance of the farm irrigation system. Under the programme, from 1988-93, 670 Water Users' Associations initiated on-farm water management improvements on 40 000 ha. It is estimated that 160 000 farmers benefited directly or indirectly, and more than 800 agricultural staff received training in on-farm water management. The local multiplier effect is becoming evident.

United Nations Children's Fund

Of approximately $3.5 billion per year spent on water supply and environmental sanitation in the rural areas of developing countries, in the last decade, UNICEF's contribution, primarily in low-cost rural systems, averaged $65 million annually, (excluding emergency), which was less than two

percent of the total investment. However, with an emphasis on low-cost approaches, UNICEF contributed directly to the provision of water supply to an estimated 165 million people, and sanitation to 28 million, representing about 14 and 21 percent of the additional total and rural coverage respectively achieved in water supply, and 4 percent of additional coverage in sanitation. This demonstrates the catalytic effect of UNICEF support to the sector.

The organization is currently developing a strategy paper (UNICEF 1995) to indicate its approaches to assisting governments and communities in achieving their goals in water supply and environmental sanitation, building upon lessons and experience of the past, while responding to changing needs and challenges. The paper provides an overall framework for country programming, which countries can adapt to suit their own situations. It takes into consideration the findings and recommendations of the 1992 Multi-Donor Evaluation of UNICEF's Water and Environmental Sanitation programmes, builds on the lessons learned during the IDWSSD and draws on the conclusions and recommendations from several key international fora.

In recent years, there has been increasing attention to comprehensive water resources management, within the framework of sustainable development. This includes the rational intersectoral allocation of water, taking into account its economic value; **abstraction controls and demand management measures to conserve water; and pollution controls to protect water quality**. Capacity building, including the development of appropriate institutions, and the adoption of economic and regulatory instruments are central themes in achieving these goals. There are implications for the poor which require attention and are at risk of being neglected. First, it is essential to ensure equity in the provision of water and waste services, as the lack of such services is among the most serious environmental problems that affect human society today, with potentially even more serious repercussions tomorrow. Second, there is a key role that rural and peri-urban communities can play in acting as guardians of their own "water environment", conserving and protecting the resource. **Community management of the water environment** is a powerful application of the principle **"think globally and act locally"**.

The evolving situation, and new challenges in the sector have reached a point where the lessons and sound experiences from the past need to be applied widely in programme strategies. Greater emphasis must be placed on health and socio-economic benefits, as well as providing the knowledge, skills, tools and techniques; generating motivation; and fostering supportive systems for communities and people to take decisions and make choices to help themselves.

This suggests the need for new emphases in programme activities, and these include the following:

- greater attention to environmental sanitation and hygiene promotion as well as operation and maintenance in water supply;
- emphasizing communication methods and behavioural and attitudinal change;
- focus on utilization and sustainability of services, not merely on coverage;
- increased attention to health impact on populations and geographic areas with high prevalence of water-related and sanitation-related disease;
- attention to sustainable community-based water resources management, linking to national and sub-national programmes, where appropriate;
- pilot research and development projects on cost-effective approaches, community participation and management and **inter-sectoral linkages, with continuous learning and dissemination of learning experiences**;
- greater emphasis on policy development at country level, with a priority of reaching the largest numbers of underserved groups in affordable ways.

In its operational strategies, UNICEF will continue to play a catalytic role for the expansion of WES coverage through the implementation of service delivery, but increasingly through advocacy of approaches that enable governments to act as promoter, coordinator and facilitator in going to scale. In supporting government programmes, UNICEF will take account of the need to coordinate and develop complementary approaches with other partners - NGOs, other international agencies and the private sector, so that these are mutually reinforcing.

Three main features of these operational strategies are **capacity building**, to enable national programmes eventually to be self-sustaining; **empowerment of communities and households through participatory approaches**; and **partnerships**, including national governments, UN agencies, other ESAs and, in particular, NGOs working in traditional water resources development and protection, and in sanitation and hygiene education and the management and sustainability of water and sanitation services.

World Health Organization

The World Health Assembly, in 1993, approved an organization-wide strategy, detailing the future work of WHO in the area of Health and Environment. The activities to be pursued in water supply and sanitation are guided by the **Action Plan for the Programme for the Promotion of Environmental Health**, (PEH), with its three components for urban; rural; and global and integrated environmental health (WHO 1994). The section devoted to rural environmental health notes that "Projects to develop coordinated responses to country-based problems will be undertaken with WHO's urban environmental health programmes".

The provision of community water and sanitation services is described in the Action Plan as a traditional WHO concern. This programme area supports efforts to improve water supply and basic sanitation concerning those most at risk in communities, health centres, schools and households. Communities may consist of complete settlements (such as villages and small towns), or distinct interest groups within larger settlements (such as low-income areas within towns and large villages). As least progress was made in Africa during the IDWSSD, emphasis will be placed on the acceleration of water and sanitation development on this continent. This involves the establishment of an international programme known as **AFRICA 2000**, bringing together initiatives sponsored by UNICEF, UN ECA, and encouraging the support of other UN organizations through the ACC SCWR.

Under the Action Plan, WHO will maintain its leadership in Operation and Maintenance of water supply and sanitation systems through awareness-raising and promotion of sector needs and of the inclusion of O&M in the programmes of other development organizations. As a focal point for the Working Group on Operations and Maintenance of WSSCC, WHO is coordinating the following activities:

- to promote the improvement of Operation and Maintenance performance, and raise the level of awareness of the need for and benefits to be derived from better operation and maintenance services;
- to improve the profile of Operation and Maintenance in the sector, and promote optimum management of existing assets through prepared presentations to agencies, conferences and workshops, and through promotional literature;
- to consolidate work carried out to date by various agencies on guidelines, manuals and training packages on optimizing Operation and Maintenance of water supply and sanitation facilities, dealing with aspects such as design, selection of technology, materials, equipment, quality control of construction and installation, management, monitoring and evaluation;
- to improve Operation and Maintenance through development and application of guidelines, manuals and training packages used in ongoing or planned programmes and projects of multilateral and bilateral agencies in developing countries;

- to promote and facilitate the exchange of information on Operation and Maintenance among water agencies and interested professionals and officials;

- to promote and facilitate the use of the tools prepared by the Operation and Maintenance Working Group among the members of WSSCC and country agencies.

Examples of the above are the WHO regional workshops, either conducted recently or planned to take place in 1995, addressing different operation and maintenance issues: in the Africa Region, three sub-regional workshops for the anglophone, francophone and lusophone countries, organized in support of AFRICA 2000 (WHO/AFRO/IRC 1994); two regional workshops, in Pakistan and Egypt, in the Eastern Mediterranean Region; and one in Malaysia in the Western Pacific Region.

WHO recognizes that integrated water resources management is a relatively new area for the organization, and that this will involve developing new approaches and institutional linkages, both with governments and other development agencies, especially FAO, UNEP and the World Bank, to appraise and manage projects involving multiple water resources elements, with appropriate health inputs. The organization is therefore increasingly basing its rural environmental health activities on the full involvement of community residents and the resources they have available to them. Community management activities will include those at the village level intended to identify and strengthen community control over the planning, implementation and operation of water supply, sanitation and other environmental services which affect overall health. Community participation also involves the promotion and strengthening of the role of women as local managers and decision-makers regarding the use and protection of community resources.

Field studies and workshops for community workers will be carried out on community monitoring and evaluation, operation and maintenance of village water supplies, and on the planning of village programmes in sanitation and hygiene education. Headquarters and the Regional Offices will work closely on developing an effective community-based approach which can be implemented in country activities.

The WHO Regional Office for the Americas (AMRO/PAHO) deserves special mention here, for its initiatives in stimulating public awareness of the issues of water supply, water quality and sanitation in Latin America and the Caribbean. One such activity is the **Inter-American Water Day** campaign, held annually, early in October. Posters, leaflets and information papers such as Freshwater Supply - A quest for better resource mangement (PAHO. 1994) have generated a marked response at national level in a number of countries, which are now producing their own material.

But even more significant in creating community awareness is the 12-month **educational project** in Peru, "La Escuela y Nosotros Promotores de Higiene y Salud", financed jointly by WHO and SIDA, at a cost of some $40 000 and implemented by the Centro Panamericano de Ingenieria Sanitaria y Ciencias del Ambiente (CEPIS). The project prepared training kits for teachers and pupils, aimed at pre-school, primary I and II, and secondary levels. These modular kits covered 14 items, five on water, seven on sanitation and two on the social environment. Participating schools and trainers were selected, and the enterprise launched at a training seminar. The training kit was officially adopted by the Ministry of Education in January 1995. Moreover, with support from Servicio de Agua Potable y Alcantarillado de Lima (SEDAPAL), funding of the project was almost tripled, to over $97 000, and was further supported by the Unidades de Servicios Educativos (USE) and many local companies.

In addition to publicity through the journals of CEPIS and SEDAPAL, a popular version of the kit was presented in a national newspaper, and it is hoped that the model of the project can be disseminated throughout the region. The final report, (CEPIS/WHO/PAHO 1995), refers to the project as "filling a vacuum in the official education curriculum of Peru". As the only major example of its kind encountered during this consultancy assignment, it may also illustrate a vacuum in the UN system's treatment of the subject. Perhaps UNESCO has a role here.

United Nations Development Programme

In general, UNDP activities in water supply and sanitation are collaborative with other UN agencies, both at headquarters and at country levels. With regard to the latter, the earlier, large UNDP funded field programme, with nominated project executing agencies has declined to a very small scale compared with the period 1960-1980. At that time, there was a major input to agricultural water development, particularly irrigation, through FAO, but the emphasis was strongly developmental, with a view to attracting investment. Community involvement was not stressed, most probably because it was not then a feature in the programmes of the government departments responsible.

During the main era of the field programme, UNDP exercised a **coordinating role** among the UN agencies in their country activities, (a function which remains in its mandate). Project proposals for UNDP funding were scrutinized in the headquarters office to identify implications for sectors other than the main developmental purpose. For example, an irrigation project may have an impact on human health or employment. Executing agencies would be required to discuss appropriate inputs with the other UN agencies concerned - in these cases, WHO and ILO - and provision for the necessary expertise would be included in the staffing plan and budget of the project. With the revised terms of reference of the UNDP Resident Representative, designating him Resident Representative/UN Coordinator, this headquarters function passed to country level, where it atrophied. At about the same time, UNDP created its Office of Project Execution, later to become Office of Project Support, placing it in the role of an executing agency, and leading more toward competition than coordination with the specialized agencies. This no longer appears to be the case, but the coordination function is not very evident.

However, a shift to national execution of UNDP projects threatens to make the organization's interagency coordinating role even more difficult at country level. Future efforts could be aimed at encouraging **intersectoral and interdepartmental collaboration within national institutional structures**, with the UNDP coordinating role being applied to developing closer interrelationships at country level with the UN agencies, and through them with their partner ministries.

One specific programme initiated by UNDP, and in 1991 merged into the UNDP-WB Water and Sanitation Programme, is the Promotion of the Role of Women in Water and Environmental Sanitation Services (PROWWESS). This programme has conducted many workshops on the theme of **participatory training**. As part of its mandate to replicate experiences, PROWWESS has developed, documented and disseminated information on the participatory methods it promotes, and on the outcome of their use, to help enrich policies and programmes both nationally and internationally. A Technical Series of *Lessons, Strategies, Tools* was launched in 1988, and includes:

LESSONS - case studies, research reports, evaluations, giving lessons from specific experience;

STRATEGIES - guidelines for project analysis, planning, monitoring and evaluation, strategies for interagency action;

TOOLS - field manuals and instruments for training in participatory methods, materials production, participatory research.

The UNDP paper Capacity Building for Water Resources Management (UNDP 1991) presents an overview of local, national and international institutional and human resources development in this field. With reference to the coordination of External Support Agency (ESA) activities, the paper comments:

> *"Failures in meeting water supply and sanitation service objectives and in achieving effective water resources management in developing countries lie not in the realm of technology nor even in the availability of funds. Ample evidence exists that even where adequate funds are made available and the appropriate technology involves only well established practices, projects, and programmes, **these have not been sustained after ESA intervention ceases**. The need is for establishing the capacity in a country to receive ESA development assistance such that local programmes and projects can be expected to be sustained with indigenous human and financial resources."*

The Delft Symposium, in its consideration of the UNDP paper, produced a series of recommendations, sub-titled *Helping Countries to Solve Their Problems Themselves*, which contain the following, addressed both to countries and ESAs:

> *"For the purpose of optimum utilization of resources, countries and ESAs are encouraged to adopt common policies tailored to each country to the largest extent possible.*
>
> *ESAs, when dealing with countries, should coordinate their agendas and address conflicting interests with each other. The way in which this coordination could take place is through consultative groups, roundtables or local consultations organized by the governments or through UNDP Resident Representatives/UN Coordinators. Countries should make an effort to coordinate effectively the ESA contributions.*
>
> *ESAs have to play an important role in assisting developing countries in strengthening their capacity to deal with water systems, e.g. to collect and manage information on surface and groundwater hydrology, as well as on water quality, and to integrate this information into* ***data systems****, interrelating these with demographic, economic and social data, and information on water uses. It must be understood that* ***this is a long-term, continuing process.****"*

The World Bank

The Bank's experience of investment in water resources development for irrigation, water supply, sanitation, flood control and hydropower is presented in its policy paper Water Resources Management (World Bank 1993). The Bank has contributed to the development of many countries, and helped to provide essential services to many communities. Yet, as pointed out in the reports of its Operations Evaluations Department (OED), the investments supported by the Bank in these areas have often encountered implementational, operational and social problems. Underlying these problems is a vicious cycle of poor-quality and unreliable services that result in consumers' unwillingness to pay, which in turn generates inadequate operating funds and a further deterioration in services. Moreover, the Bank and governments have not taken sufficient account of environmental concerns in the management of water resources.

Within a framework for improving water resources management, the Bank considers that an approach that follows the principles of comprehensive analysis, opportunity cost pricing, decentralization, **stakeholder participation**, and environmental protection will yield more coherent policies and investments across sectors, promote conservation and improve the efficiency of water allocation. Among the Bank's objectives are the following improvements:

- **For water supply and sanitation**, more efficient and accessible delivery of water services and sewage collection, treatment and disposal. This will be achieved by extending existing supplies through water conservation and reuse, and by using other sustainable methods. **Greater involvement of the private sector, NGOs and user groups** will be required, as will **cost recovery** to ensure financial viability, while applying graduated fees to assist the poor.

- **For irrigation**, modernized irrigation practices, greater attention to **cost recovery**, drainage and salinity control, measures to reduce pollution from agricultural activities, **improvements in operation and maintenance** of existing systems, and investments in small-scale irrigation and water-harvesting methods. This calls for the development of **institutions and technologies that respond to the needs of farmers** for higher quality services, including greater participation of community groups and user associations, while reinforcing the efficient management of demand. Particular attention will be given to the needs of small-scale farmers, who comprise most of the agricultural community.

The emphasis on cost recovery and financial viability will no doubt be expanded in the World Bank contribution to this Second Consultation. In this present paper, where community participation is a major issue, the economic and financial aspects are entirely supported. If a scheme is not financially viable it will not be maintained at a reliable standard of operation and delivery. The users will then be unwilling or, if depending on water for productive purposes, may be unable to pay for the service. Community participation must include stakeholders in all phases and components of system design, operation and maintenance, and this entails its financial support - one of the features of "**ownership**" that participatory approaches promote.

A study by the Bank's Operations Evaluation Department revealed that the physical sustainability of both irrigation and WSS projects has been hampered by poor maintenance. In 67 out of 123 completed irrigation projects, O&M was rated as unsatisfactory. Insufficient funding, poor construction standards, and weak planning at the appraisal stage were cited as reasons. The OED also note a tendency to support project construction and not O&M. The OED reviews of both irrigation and WSS projects have highlighted the **need for the Bank not to detach itself from postconstruction activities.**

Farmer participation in water management and in O&M is recommended in all Bank studies on irrigation. Positive results have been demonstrated by Bank projects when water user associations have been introduced. The review of 21 impact evaluations found that when responsibility for water management and O&M were given to user groups, the rates of cost recovery were excellent.

In the Guide to the Formulation of Water Resources Strategy (World Bank 1992), the chapter on Stakeholder Participation offers a number of principles, or lessons learned, that can help choose appropriate techniques of participation. These include:

- if people share the process of generating alternatives, they are more likely to make realistic decisions among alternatives;

- frequently, the way something is done builds trust and legitimacy. It is not just the final answer, but the way the answer was obtained that can make a difference. To arrive at strategies that people will implement, individuals must be satisfied procedurally, psychologically, and substantively. Participation is an attempt to build trust and communicate openness and concern throughout the strategic assessment process;

- a participation programme must be visible at all times. Sometimes this is difficult when there are long periods between meetings and workshops. With new technical data, interactive computers and decision support systems, the time between actions can be shortened. The main point, however, is that some appropriate level of publicity, without over-saturation, should be maintained. **Public access to databases should be considered.**

A subject that is receiving considerable attention in all the agencies visited, not only the Bank, is that of gender issues. This is true of water supply and sanitation, irrigated agriculture and other rural uses. It is elaborated here because it is so well encapsulated in the World Bank Infrastructure Note on **Water Supply, Sanitation and Gender** (Wakeman 1993) which, while not directed specifically at O&M, is so applicable to community participation in those activities.

INVOLVING COMMUNITIES IN THE WSS PROJECT CYCLE

Policy and practice in the water and sanitation sector have focused increasingly on the importance of "software" issues (those relating to the human element: community participation, training). It has been recognized that the technical, or "hardware" issues may be resolved for a particular project, but if the software issues have not been adequately addressed the project may still fail. Sector strategies are also emphasizing ***"demand-oriented" approaches*** *(undertaking projects based on what people want. This can for example be determined by their willingness to*

pay for the new service). Software issues and demand-driven approaches both require close interaction with communities. Yet ***communities are not necessarily homogeneous entities****. They may be composed of different sub-groups based on income, ethnic group, gender and religion. Awareness of the different preferences, water and sanitation practices, and contexts of each sub-group may well be essential to project success.*

Different forms of socio-cultural analysis may be used to obtain information on different sub-groups. In terms of gender issues, what is called "gender analysis" may be used to generate a detailed picture of men's and women's roles and preferences in sector activities. This information can then be used to develop projects which are more likely to be successful, because they properly reflect the community context relating to gender...

Gender and development, as opposed to women in development, is an evolving field. *Methods of designing and implementing gender-sensitive projects, as opposed to WID components, still need to be further elaborated, tested and refined. It must be remembered that focusing on gender is not meant to be a focus on women, but on both women and men, even though gender-insensitive projects are more often insensitive to women than to men.* ***Water and sanitation is a sector which fundamentally affects the lives of community women, men and children. Therefore all need to be appropriately involved in determining sector activities.***

Key issues in operation and maintenance

With the focus of the Consultation on O&M of systems for irrigation, drainage, water supply and sanitation, within a framework of rural water management, the key issues for this paper fall into two groups. These relate to **the water resource,** and the **involvement of the community** in the management and use of the resource, including the enablement of the community (or communities) through education, training and other means to facilitate participation, and empowerment to play an effective role in management.

Taking firstly the water resource, the primary concerns in its management are **availability** and **quality**. The main operational practices influencing these are in the control of abstractions; the efficiency of systems for delivering water to the user, whether domestic, agricultural or other; and the contamination of the resource from agricultural drainage, domestic or industrial wastewater, and from unsanitary human waste disposal.

The control of abstractions, to avoid overdrawing on the resource, determines sustainability and reliability, while recognizing the overriding influence of rainfall (and recharge in the case of groundwater), which introduces an unavoidable risk factor. System efficiency plays a vital role, in reducing waste of the available resources, and therefore limiting the abstraction or, alternatively, serving a greater area or population. In irrigation, excessive water use may generate problems of waterlogging and salinization, and this lack of water control may also encourage the increased propagation of disease vectors.

Irrigation is generally accused of low efficiency in water use, a feature that affects the reliability of supply, especially to system tail-end farmers, and in areas of scarcity the relatively low value of water leads to competing demands from domestic and industrial users, which will enforce the adoption of improved Operation and Maintenance practices by agriculture. But community water supply systems are also often guilty of poor efficiency, due to inadequate performance of maintenance and operations. This can be assessed by measuring unaccounted-for water, and a 1987 World Bank review of 54 water supply projects showed an average figure of 34 percent, with a 3 percent annual rate of increase during a six-year project cycle (World Bank 1993).

Unreliable and discontinuous water supplies to irrigation cause production losses - with accompanying income loss to farmers. In small-scale farming, this may mean a lack of food for the community. In reticulated domestic supply systems, the same defects may have serious results on human health, due to bacterial contamination from local groundwater, affected by poor sanitation. Where domestic supplies depend on wells or boreholes, this is also a common feature of contamination where latrines are sited in the close vicinity, or when defective design or maintenance allows the entry of surface water into the source.

Water quality is a vital issue on a larger scale, often extending to that of a river basin and a major aquifer. The discharge of domestic wastewater, industrial wastes and agricultural drainage into rivers, or seepage into aquifers may have so severe an effect on water quality that the resource becomes unusable, or requires costly treatment or the resiting of abstraction works. In the case of groundwater, the source may be irretrievably damaged. **Urban effluents have destroyed many sources of rural water supply in developed and developing countries.** Where low-quality waters can still be utilized for agriculture, this calls for specially adapted operational practices, both in water management and in the selection and cultivation of crops. If domestic wastewater reuse is feasible, operational measures must also take account of human health factors.

The community, at all levels, is unavoidably involved in these issues of water management and the operation and maintenance of systems for water supply and disposal. Many communities have become so accustomed to inadequate and unreliable water services over periods of years, or perhaps decades, that they are resigned to, or even apathetic to that condition. Whether the members of the community are involved only **as victims of the problems** and defects of those systems, or **as participants in the improvement** of resource management and system operation and maintenance, depends on their **awareness** of the situation and the potential for its improvement, and their **enablement** to play an effective role.

Awareness must begin with recognition of the value of water. In many water-short communities, this is already too evident in the effort and labour required to obtain minimal supplies, but in less deprived societies it tends to be considered a free good, rather than a precious natural resource. In fact, good quality freshwater is seldom free, and is becoming a rarer commodity. This understanding can best be generated through campaigns with both immediate and long-term impacts. The Water Day campaigns, and the school educational initiative in Peru are good examples, while the global range of social, economic and cultural conditions will demand suitably adapted approaches.

When faced with dependence on a specific system, rather than the generalities of sound water management and sanitation, experience has shown **the value of stakeholder involvement** in the management, operation and maintenance of that system. It is to this end that the majority of examples of agency programmes for community participation are directed. The past decade has seen encouraging, even exciting results in the development of methodologies suited to all types of water-user communities. The important issue now appears to be the replication and expansion of these techniques by national personnel. In the same way as the Lima project on water, sanitation and social environment filled a vacuum in the national school curriculum, there is surely a case for a component on the role of the community in water planning and management in the national curricula for higher education at technical, graduate and professional levels. This would also establish a better general understanding and appreciation of the essential **linkages between the development components of technology, economics and finance and the socio-cultural issues** affecting the involvement of the water-user community.

Although O&M probably offers better economic returns on investment than do most new developments, it tends to have an **image problem**. It is less glamorous or challenging than new construction, and therefore fails to attract the more enthusiastic professionals. With commonly depressed revenue as a result of poor cost recovery, low scheme income and staff incomes are further deterrents to the recruitment and retention of committed personnel. Competent contractors and entrepreneurs see only limited profits in O&M work, which is therefore left to lower grade companies. Politicians gain more visibility

and votes from the creation of new services. The same issue of visibility determines the support of many ESA's. It is more impressive to have an agency's aid programme publicized by photographs of a brand new construction than to have assisted in ensuring the sustained improvement of existing services. The important status of O&M in water services (and it is not limited to these) deserves greater prominence in the training of professional groups, including engineers, planners and economists.

With regard to the foregoing issues, there is one particular uniting feature, that of **information.** The majority of education, training and community participation projects referred to have been single, isolated examples. Certainly those supported by ESAs will have been reported in publications, mostly available through the UN system, bilateral, NGO or associated institutions. But this can not be considered as widely available or easily accessible. Neither does it present the longer-term results and effects of these interventions, their successes, failures, adaptations and transfer. To answer this deficiency calls for **long-term involvement, monitoring, a network for information reporting and exchange, and an associated data bank for more general access.**

If this is to be supported by external agencies, it implies more open-ended budgeting than most of the UN system permits, two-year budget cycles being the rule, with extended funding dependent on resources at the time. Water conservation and management, environmental quality and human health are, however, features of major concern and of priority action in the programmes of all the main donor agencies and countries, and improved O&M is of increasing importance in all these subjects. A possible approach to long-term support may lie in forming an **international water-management consortium,** which offers greater possibility of a **"rolling input"** from a series of donors, and reduces the risk of premature termination by the withdrawal of an individual ESA. To be effective, this must be accompanied by a **campaign to raise the status of O&M** among the participants and to incorporate the relevant components into development programmes.

Areas with a potential for interagency collaboration

Interagency collaboration already exists, and in fact is widespread, especially in activities directed at community water supply and sanitation, but also in agricultural water use. Attention is not necessarily, and not usually limited to rural communities, which properly demonstrates the reality of **interdependence of urban, peri-urban and rural water users on a common resource.** The approaches to interagency undertakings also recognize that an **improved water supply,** particularly in urban and peri-urban areas, **carries with it the need for and the cost of improved** sanitation.

Urban effluents may in some cases offer a benefit to rural populations in the form of an opportunity for irrigated agriculture and aquaculture and, with increasing demands on freshwater resources in many countries, wastewater reuse is expanding. Global data are listed in Guidelines for the safe use of wastewater and excreta in agriculture and aquaculture (WHO/UNEP 1989), giving an estimated total of about 2 million hectares in 16 countries in 1987. The implications for operational measures to sustain the quality of water and soil resources and to safeguard human health have brought WHO, FAO and UNEP together in a number of activities.

Other health issues associated with water management and scheme operation are treated in collaborative initiatives such as **PEEM,** with WHO, FAO, UNEP and UNCHS. The Panel's activities extend to field studies and to training for national professional staff, in addition to its many publications.

The areas of collaboration among agencies, (usually in groups of two or three), are best illustrated by a few examples. Some consist of headquarters' joint efforts in producing publications on specific aspects of community water management, others are in the form of guidelines or manuals. There are also workshops and field missions at regional or country level. Generally, one agency has taken the lead, with support from others.

For the most part, an outside observer sees only the resulting documents, not surprisingly as many examples are very recent, but **follow-up; monitoring; evaluation; and the dissemination of information** are obvious issues to be raised in developing the potential for interagency collaboration.

The following list is a small, representative selection of recent collaborative activities:

1. **UNDP-World Bank.** The **Water and Sanitation Program** operates through four Regional Water and Sanitation Groups (RWSGs) for management of its field activities, with a total programme expenditure of $77.5 million in the period 1989-94. Approximately 59% UNDP funded, 8% WB and 33% bilateral agencies (from the Annual Report for 1994).

2. **UNDP, UNICEF, UNDP/WB RWSG-SA, with Govt. of Pakistan.** Community Participation, Strategies and Tools - **a trainer's manual for the rural water supply and sanitation sector** in Pakistan (Srinavasan, Zafar, and Minatullah, 1993). Also: Community participation in rural water supply projects in Northern Punjab, Exploratory Studies, Vols. I and II. (Zafar 1994)

3. **UNDP, UNICEF, WHO, UNDP/WB Water and Sanitation Group, with IRC.** Community Management Today - the role of communities in the management of improved water supply systems (IRC Occasional Paper 20, 1993).

4. **UNICEF, WHO, UNCHS, with ODA-UK. Mission to South Africa**, coordinated by UNICEF. Community water supply and environmental sanitation for South Africa's unserved - Supporting the transition (UNICEF 1994).

5. **PEEM, with DBL, HIP of LSTM** (in collaboration with Min. of Health and the Environmental Protection Council of Ghana, and Ghana University). **Health opportunities in water resources development. A two-week course** to promote collaboration between middle-level officials from various ministries, for the incorporation of health safeguards and health promotional measures in water resources development projects (WHO 1994).

6. **WHO, FAO, UNEP, UNCHS. Workshop** on health, agricultural and environmental aspects of the use of **wastewater**. Mexico, (1993).

7. **FAO, WHO, PAHO.** (follow-up to 6). **Project formulation mission** for the implementation of a regional centre for research, development and training in the use of **wastewater for irrigation**, to be based on the Mesquital Valley Project, Mexico. (1994).

Programmes involving communities for rural development, forestry and land conservation purposes offer a rich source of material and experience, with relevance and transferability to the management, operation and maintenance of systems for irrigation, water supply and sanitation.

This was raised in Discussion Paper 11 of the report of the First Consultation on Integrated Rural Water Management, (FAO 1993), Lessons from IAP-WASAD country missions:

> *"It has become evident from the country missions that people's participation is more evident in soil and water conservation and watershed management activities as compared to irrigation and drainage. In fact, many governments promote community and people's participation in such activities."*

Within the context of rural development, there are therefore numerous parallel activities in training and community participation, using common or very similar methodologies, which could be made effective for water-related operation and maintenance programmes through mutual contacts and cooperation. In an agency such as FAO, this opportunity is found at interdepartmental level, and could be extended among agencies. The concept of **integrated rural development**, promoted some 15 to 20 years

ago by the UN system, although later found to be overcomplex, was not a complete failure, and offered a base for community services. The history of such projects is available in the World Bank and could be analysed to assess appropriate measures for the incorporation of operation and maintenance of water supply and sanitation systems.

The possibilities for collaboration and an overlap of activities between WSS and Irrigation and Drainage have often been put forward and, during the visits to gather information for this paper, current examples have been sought, with virtually no success, apart from the Water Users' Association Support Organization recently introduced in Kenya with government and donor funding. WUASO operates on a cost-recovery basis, in order to prevent collapse after the handing over of water projects for irrigation or domestic water supply. It does not take over the O&M of projects, but provides only additional support to the WUAs.

For the preparation of a report to the 17th Meeting of the Steering Committee for the IDWSSD, in 1989, FAO investigated the incorporation of water supply and sanitation components in Integrated Agricultural Development, which was being promoted in accordance with the Organization's programmes. The following extracts illustrate the reality in the field:

> *"The number of FAO-operated field projects where there is a distinct component of drinking water supply or sanitation is small. Among all sources of funding, FAO/TCP, (Technical Cooperation Programme), UNDP and various Trust Funds, a total of 24 projects operational in 1988 can be identified which contain one or both of these elements. This represents only about 15 percent of the 155 projects where agricultural water development is a major objective, and the proportion is similar for all sources of funding, whether TCP, UNDP or Trust Funds. These figures should also be seen in the context of a total of 2 700 ongoing FAO field projects....*
>
> *In all regions, there have been examples of progress in creating an awareness of the importance of safe drinking water and, to a lesser extent, of sanitation within the context of integrated agricultural development. This has occurred in emergency situations, in the transition from subsistence to market-oriented farming, and in major investment programmes for large schemes and regional plans. The incorporation of drinking water supply and, occasionally, sanitation has perhaps been most successful in the last cases, where the necessary formal arrangements have brought together the capital and expertise needed to implement such work and to mobilize the organizational support required for continued operation and maintenance.*
>
> *Where finance and skills have been less readily available, as illustrated in schemes with a high reliance on self-help, results have, understandably, been less satisfactory. To overcome this situation, it is suggested that future initiatives aimed at incorporating components of water supply and sanitation in agricultural development projects and programmes should first give close attention to the* ***priorities for these services, as perceived by the local population, in order to assess the local support that will be applied to their installation and use****. It is recommended that checklists and guidelines be prepared to ensure that the formulation and design of projects offering opportunities for the incorporation of water supply and sanitation should truly reflect the needs of local communities, preferably after they have been advised of the potential benefits of such services. Next, the ability of national organizations to provide technical advice must be established and, finally,* ***an organizational structure for operation and maintenance and the recovery of charges must be ensured, to guarantee the sustainability of services.****"*

In final comment on this issue, there are distinct differences in the characteristics and requirements of water supply for communities and for irrigation, in quality, quantity and timing. Pumped supplies tend to provide the best opportunities for conjunctive services, or at least for some linkages in organization and management, being flexible to meet different scales and timing of demand, using similar technical facilities offering a higher degree of operational control and consequently of cost recovery and maintenance. The basic design of an irrigation supply system will decide its suitability to combine a domestic community

supply, and will strongly influence future operational and maintenance standards. Above all, community priorities and support should be determined at planning stages. Many agricultural communities faced with options for improved services will place heavy emphasis on access roads and transport before water supply, and well ahead of sanitation, as has been seen throughout the IDWSSD. Such priorities will determine their willingness to put efforts into O&M.

An area of promise for further collaboration is that of **information exchange in water programmes**. Examples exist, such as the WHO/UNICEF joint monitoring programme for water supply and sanitation, but this relates basically to numbers of system connections and populations served, not to evaluations of qualitative factors. A more valuable form of exchange and dissemination of information would be on lines similar to those proposed by the O&M Working Group of WSSCC (WHO 1994a). This would relate to experience gained in the testing, adoption and application of O&M methodologies at country level; community attitudes, involvement and response to change; evolution and monitoring of water-user systems, their technical and economic performance.

Such an approach is also in accordance with the report of the 1994 Ministerial Conference on Drinking Water and Environmental Sanitation. The "Action Plan", Section 5, WATER AND THE WORLD - promoting international support states, *inter alia*:

"In order to facilitate the implementation of national activities, the international community is urged to:

> *1. support country-level collaboration as as essential tool for the successful preparation of sector strategies and social mobilization initiatives;.....*
>
> *5. request the UN Commission on Sustainable Development to consider how existing institutions can provide regional clearing houses for the exchange of data and information, and how to strengthen the role of development cooperation and other support funds for drinking water and environmental sanitation."*

While considerable attention has been given to community participation and training issues in various areas of water resources management, and in O&M specifically by WSSCC (WHO 1994a), formal education has not been prominent in the activities of the UN agencies engaged in rural water development and management. With the increase in emphasis on community involvement, this must be considered an essential component in the progressive process of **awareness - participation - empowerment** of water users, in all aspects of water management. These extend from conservation and protection of the resource to its beneficial use and to the operation and maintenance of systems, whether WSS, irrigation or other purposes. The development of national curricula at all levels will be necessary to achieve this, and the UN system could assist by assembling and analysing data on such curricula, where they already exist, preparing an information note for wide distribution in order, first, to assess the interest of national ministries responsible for water resources; rural and urban development; and education, and eventually to respond to any requests for external support.

The foregoing notes refer to the **potential** for interagency collaboration, particularly at country level. They are valid, but may remain hypothetical. Proposals for UN action in respect of water resources development and management (as also in other sectors), have tended to receive a poor response. This is not to say that the committees, assemblies or groups concerned were incorrect or uncommitted in their proposals. The fault has frequently arisen from failure to recognize the extremely limited resources available to the specialized agencies addressed, and perhaps even more so in the case of offices responsible for interagency coordination. Often, a major programme or activity depends on no more than one or two professional staff, with a tight regular budget. So, while references to **collaboration** may be found in agency programmes, the resources for implementation are often inadequate or absent.

At headquarters levels, collaboration is usually nominal, in the form of meetings, joint publications and minor inputs to each other's programmes. This is illustrated in the examples earlier in this section, where the only collaboration of any magnitude is that of the UNDP/WB Water and Sanitation Programme, which is delivered at country level.

The Development Dialogue - Renewing the United Nations System (Childers and Urquhart 1994) analyses the in-country relationships among UN organizations in the following excerpt:

THE COUNTRY LABYRINTH

Some 23 entities of the UN system have grant development assistance funds to spend at country level. The Secretary-General reported in 1992 that "the bulk of the countries have an average of between 5 and 10 United Nations organizations present....in others, there are up to 15 or more organizations (sometimes including regional centres)".

The UNDP country office does gather together much of the system. It represents UNESCO, UNFPA, UNIDO, WFP, and virtually all the smaller technical agencies. However, this does not mean that assistance from these bodies is integrated in UNDP's ***country programme*** *with the government. UNFPA's governors demand a separate country programme. So do UNICEF's. WFP programmes its development food aid separately....*

UNICEF, FAO and WHO currently maintain their own separate offices and lines of authority back to their headquarters, with separate programming procedures and documents. In many developing countries, there are thus four quite separately directed and staffed offices (UNDP, UNICEF, FAO and WHO), and in an increasing number a World Bank office as well....

The burdens the UN system's fragmented programming procedures impose on governments are particularly egregious when added to those of up to 20 bilateral and other multilateral "aid" sources. Each of these wants country programmes to be drafted and negotiated, with additional documents for each project within all these programmes....

If there is an inevitable lack of coherence between bilateral assistance flows, there is no conceivable rationale for the fragmentation in every country of the UN system's limited resources. If each fund and agency did quite different things, the aggregate effect would still be incoherence in what should be a holistic development process. The fact, however, is that ***they work separately in a considerable number of the same development fields.***

Naturally, each fund or agency, imbued with enthusiasm for its particular mission, has developed well-rounded arguments for its separate status, separate fund-raising and separate procedures. ***Each enjoys support in corresponding branches of governments.*** *Demands for "accountability" in each separate governing body reinforce the separate programming procedures, documents and offices.*

This is hardly a problem to be addressed by the Technical Consultation, but it illustrates the background against which proposals for collaborative action at country level will be viewed. On a more positive note, it shows that any successful collaborative efforts among UN organizations should be nurtured and used as a foundation for future joint programmes.

With these constraints in mind, suggestions for recommendations, in the following section, have been designed so as not to be over-ambitious, but hopefully to permit a progressive approach to the further development of interagency cooperation at country level, toward the involvement of communities in the management, operation and maintenance of water resources and water systems.

Draft Recommendations for Cooperation

Should the following suggestions be adopted, it is left to the Consultation to target lead agencies for particular activities, projects or programmes. In all cases, these involve collaborative action, with elements of rural development, agriculture, the environment, human health, community water supply, sanitation,

education, and of course the participation of the various communities concerned. However, in accordance with the themes of **community involvement** and **facilitation**, where national inputs are indicated they must be decided, developed and **supported by the commitment of appropriate national resources.**

Furthermore, the essential long-term processes for education and community participation tend to conflict with the more limiting procedures of UN system budgeting. It is therefore suggested that agencies from outside the UN system be invited to collaborate in such activities, with the prospect, at least, of jointly securing a more **open-ended financing**, which would reduce the risk of premature termination. WASSANCO could be approached for advice on this aspect.

Finally, the Consultation will also be discussing the technological, economic and financial aspects of operation and maintenance of water resources systems and, with recognition of the linkages and interdependence among these aspects, it should, where relevant, consider combining and adapting recommendations to incorporate the different components.

With those *provisos*, the following recommendations are draft proposals for the consideration of the Consultation:

1. Continue collaborative programmes and projects with components relating to rural water development and management, operation and maintenance, health and community participation, as at present, and prepare an inventory of these on a national and regional basis. Where possible and appropriate, include projects additional to those with UN system support.

2. Establish criteria to identify projects and programmes with potential for replication, and design a format for reporting and analysis. Select examples suitable as case studies on O&M in relation to particular aspects of rural water management (for example, institutional arrangements, community participation, environmental health, irrigation), compile and publish these, preferably by regions. Make such material available to institutions responsible for information and training of personnel engaged in the above activities.

3. **Depending on national interest and responses to the above,** consider introducing a network and data base for reporting on activities meeting pre-determined criteria, and providing access to, and an exchange of information. (N.B. This requires decisions on location, and some minor staff and equipment resources for a system using e-mail, **not hard-copy material**, which proved impractical in previous attempts at information exchange by the ACC ISGWR).

4. With support from agencies' national and regional representatives, **the invitation of UNESCO**, and the involvement of UNDP with its Resident Representatives/Coordinators, and building on national campaigns and programmes (e.g. Water Days), approach national ministries of health, education, and those responsible for water resources, the environment, agriculture and rural development to discuss and assess the desirability of, and opportunities for introducing material into national curricula, at levels from primary school to graduate and professional training courses. The objectives will include an increase in the awareness, understanding and capabilities of the community in improving the conservation, protection and management of water resources, and associated benefits to human health and the environment. Report regionally on this investigation, analyze the results and, **if justified by demand**, develop suitable material for national testing and eventual adoption and incorporation in national curricula.

5. In any publications, training material, education curricula etc. produced by, or with the support of the UN system, draw attention to the **importance of sanitation as an essential complement to community water supply**, for the protection of water resources, the environment and human health, and to the need for users of water supply and sanitation systems to participate in their planning, design, operation and maintenance.

6. In contacts among UN organizations engaged in water resources development and management programmes, and between UN organizations and bilateral and multilateral agencies involved in similar work, **develop common approaches to creating an appreciation of the importance of O&M** among professional staff, both national and international, and of the potential sustainable economic, social and environmental benefits offered by the commitment of human and financial resources in such activities.

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The Financial and Institutional Implications of the Operation and Maintenance of Rural Water Supply and Sanitation Schemes

Commissioned by the UNDP/World Bank Water and Sanitation Programme, as an input to the Second Technical Consultation on Integrated Rural Water Management, Geneva, June 1995[1]

1. Introduction

The track record of donor-supported rural water supply projects is poor. Attempts to accelerate the provision of safe water to rural communities through government-sponsored programmes too often lead to badly performing systems and disenchanted "beneficiaries". In contrast, communities which have made their own provision for obtaining supplies and maintaining the facilities through their own resources are generally able to achieve more a reliable performance. The key question therefore is: how can the financing and institutional arrangements of government schemes with donor support be modified to complement self-help activities in a sustainable way?

1.1. A legacy of O&M failings

Inadequate Operation and Maintenance has long been a serious obstacle to meeting the basic water supply and sanitation needs of rural communities. Throughout the 1980s and continuing into the 1990s, evaluation of donor-supported rural water programmes has produced regular reports that 40%, 50%, even 60% of installed facilities are either out of order or functioning at unacceptably low levels of performance.

This kind of wasted investment is a serious disincentive to governments and donors. It also means that "coverage" statistics give a distorted impression of the number of rural people with access to satisfactory water and sanitation services.

Poor technology choice, shortage of skilled staff, and unavailability of fuel or spare parts are among the reasons often given for O&M failings, but financial and institutional inadequacies are usually the underlying causes. Pricing policies which yield insufficient revenue, and attempts to manage O&M of dispersed rural systems through a centralized, government-controlled organization, have proved unsustainable. Even where attempts have been made to decentralize and to raise water charges to more realistic levels, failure to involve users fully in the decision-making processes has condemned well-intentioned schemes to failure.

The legacy of broken down or malfunctioning rural water and sanitation systems is a reminder of the urgent need to develop better O&M systems; it is also an opportunity to supplement investment in new water supply systems with cost-effective extension of service coverage through rehabilitation programmes supported by more effective O&M.

1.2. Evolution of new approaches

The launch of the International Drinking Water Supply and Sanitation Decade (1981-1990) brought water and sanitation professionals together to develop new approaches to the sector's development, with improved O&M as one of the top priorities. Comparison of experiences from many different developing countries highlighted the problems faced by all government agencies in attempting to service remote village water supplies.

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Divided responsibilities among ministries of water, agriculture, health and public works aggravated the problems, but even where ministerial responsibility for rural water supply and sanitation was clearly defined, the logistical and financial difficulties inherent in centralized management systems made Operation and Maintenance unsustainable.

The widespread concept in the early 1980s that water should be provided free of charge as a basic human right added to government's problems. Not only was it impossible to finance the Operation and Maintenance of rural projects, but any transition towards user involvement was hampered by the communities' beliefs that it was government's duty to provide the services free.

At first, in seeking ways to achieve improved performance, the focus was on **technology**. New "appropriate" technologies were developed, including VLOM (Village-Level Operation and Maintenance) handpumps and on-site sanitation systems. That was not enough. Government agencies did not provide the support systems needed, or villagers could not get spare parts, or the repair tasks proved beyond local capabilities. For all these reasons, systems continued to break down almost as quickly as new ones were being built. Simplification continued through research and development programmes throughout the 1980s, but responsibility for O&M remained a grey area between agencies and users, and there was little improvement in the sustainability of completed projects.

In parallel with technology development, the Decade brought a new focus on **hygiene education** and with it a recognition of the need to involve users more in the management of their new systems. A package of messages was developed, designed to raise community awareness of the health benefits of water and sanitation, to stimulate "ownership" of the improvements, to change hygiene behavior and promote effective use of new facilities, and to foster user operation and maintenance. Combined with the VLOM concept in technological development, the encouragement of users to undertake O&M tasks had some successes. Problems remained though, primarily because the institutional arrangements were not clear. Communities still, in the main, continued to depend on government agencies for breakdown repairs, and that support could not be sustained at affordable costs.

Even with decentralization and the will to pass operational responsibilities to communities, sustainability proved an elusive goal. A major problem was the need for different attitudes and skills in agencies to support the community-based approaches. Training, job descriptions and promotion prospects of agency staff are almost always related to developing skills in the design and construction supervision of water systems (usually of the high-tech kind).

There were few if any incentives for staff to accept the longer timescales and less stimulating design challenges offered by community-based approaches. To a large extent, the technical bias in agency staffing remains a problem today, though post-Decade experiences are helping in the evolution of recruitment and training policies and new incentives are being developed to encourage collaboration between agency staff and WASAs in the community management of rural water and sanitation systems. Another problem with the 1980s approach to community involvement was that the messages were all one-way. Agencies saw their role as one of educating the users in what was best for them. Towards the end of the Decade, it became clear that the sustainable water and sanitation schemes were the ones in which user preferences, matched by willingness to pay, were the ruling influence on project planning and implementation.

The new **demand-oriented approach** emerged, with its emphasis on the government agency as a *promoter and facilitator* rather than just a *provider* of services. It has different expressions – *user-driven development, the partnership approach,* etc – but a common principle is that users are helped to obtain the services they want and are willing to pay for and sustain. This is normally accompanied by a further principle that planning and management of water resources should be undertaken at the lowest appropriate level. While this change in orientation of investment planning has been widely accepted, its implications in terms of institutional and financial reform are still emerging.

Of particular relevance to the theme of this paper is the need for institutional arrangements which provide an incentive for service producers to respond to consumer demand. A variety of mechanisms have been tried in recent years, and a review of experiences leads to some preliminary conclusions on the implications for future policy and project formulation.

1.3 What is a WASA?

One way in which the World Bank has been seeking to help operationalize the demand-oriented approach in low-income communities is through support for projects which involve *Water and Sanitation Associations* (WASAs). The term is used to cover a wide range of formal and informal groups of users who act together to plan or provide sustainable water and sanitation services. It therefore includes formal village water committees, but may also describe a local non-governmental organization focused on water and/or sanitation in the community or an informal grouping of individuals with a vested interest in meeting the expressed needs of a target community. In some cases, WASAs gain power and influence through federation in wider regional associations which share knowledge and resources.

WASAs have much in common with Water User Associations (WUAs), which represent the user views on many agricultural projects. The similarities and linkages are clearly important in relation to the Consultation's focus on integrated management of rural water resources. Differences are also important. In many cases, WASAs and WUAs can have very different constituencies – the WUA representing the interests of farmers and seeking equity and efficiency in agricultural water use over an irrigated area, while the WASA's focus is the human settlement and the use of water and sanitation facilities at the household level. As resolving any inherent conflicts in water allocation and use is a prime objective of integrated water resources management, the institutional links between domestic and agricultural users are going to be of fundamental importance in future strategies.

While there are many situations in which WASA-type organizations may be the most effective way of achieving sustainable water and sanitation services in low-income communities, it is by no means always the case. Indeed, the World Bank's review of WASAs notes that *"there are as yet more examples of WASAs having failed because of the public goods problems than having succeeded in large projects funded by the World Bank and national governments"*. Nevertheless, the review indicates good cause for optimism that, in the right circumstances and with the right initial support and self-imposed ground rules, WASAs can play a vital role in project sustainability. In other circumstances, the institutional costs of operating through WASAs can be extremely high and an alternative approach may be more appropriate.

2. The way forward

2.1 Working with the community

After the sharing of experiences over the last decade and a half, water and sanitation sector professionals are universally agreed that user-driven development is the key to sustainability. Working with the community calls for some fundamental changes in the way that sector agencies operate, with implications for the recruitment and training of staff, the procedures for communicating and decision-making, and the way that agency performance is monitored and evaluated.

The term *community management* is now widely used to describe the range of partnership arrangements through which water users work together with agencies to ensure the most effective use of resources in the operation and maintenance of water and sanitation facilities. Similarly, this paper uses the acronym WASA (Water and Sanitation Associations, described in section 1.3. to encompass a wide range of community-based organizations which may be formed to represent user interests and to take key investment and operational decisions on behalf of the community. The right type of WASA and the role that it should play in sector activities can only be determined in a project-specific context, but the World Bank's review of WASA experiences has led to some conclusions on the key areas where WASAs help in sectoral decision-making. WASAs provide:

- a platform to discuss and negotiate individual preferences for services and match the collective demand with the appropriate service level option;
- a mechanism to work out financial contributions by members, pricing and cost recovery arrangements;
- a body with sufficient collective voice to interface with water utility organizations; and
- an overseeing agency for training, operations and maintenance.

In different countries or regions, WASAs may act simply as pressure groups for gaining access to services or improving public accountability or, at the other extreme, they may take full control over design, construction, pricing, management and operation of water and sanitation services. The choice will relate to how users' needs can be met in the most effective way, taking into account local policies, local conditions and local institutions.

The change to community management will also mean an ongoing, though different, role for government and, usually, an expanded involvement of intermediary non-governmental organizations and small private firms.

2.2. "Water is an economic good"

Following the widespread consensus among sector professionals on new approaches to sustainable community water supplies achieved during the 1980s, another significant step forward came during preparations for the 1992 Rio Conference on the Environment and Development. The preparatory International Conference on Water and the Environment in Dublin in January 1992 gave prominence to the concepts that water is an economic good and should be managed as such, and that management should take place at the lowest appropriate level.

Taken together, these concepts provide important directions for future strategies, emphasizing:

- the economic demand for water is extremely important and should receive more prominence in sector decision-making;
- institutional arrangements (rules, processes and structures) matter and the behavioral incentives they provide have causal influences on performance;
- because of their incentive effects, more attention should be given to economic instruments of management. These include the introduction of market-friendly rules, regulations and incentive structures and the economic pricing of water.

The focus on *economic* demand has major implications for rural water supplies. It effectively counters the prevailing misconception that rural communities are too poor to pay for reliable services. Offered a range of service levels, with proper explanation of the cost implications, rural householders will make their own assessment of the value of the improvements over current arrangements (traditional sources, vendors or their own pumped services) and opt for the service which matches their desire for more convenient and reliable supplies with their capacity to pay. If that can also be matched with institutional arrangements which allow willingness to pay to be translated into effective O&M of the chosen service level, the prospects for sustainability are very much improved. Government contributions, for example to meet the capital costs of what is deemed to be a minimum acceptable level of service, do not generally distort the concept of user choice, provided the option of paying for a higher level of service is available.

2.3. Sorting out the financial and institutional aspects

Inadequate financing of O&M has been a major cause of the lack of sustainability of past water and sanitation programmes. Willingness to pay is the principal indicator of economic demand or, in other

words, the way of validating the user preference as the basis for the demand-oriented approach. The clear principle is that people's choice of an appropriate service level is matched by a commitment to ensure its upkeep.

In low-income communities, many governments do not insist on recovering all investment costs, on equity grounds. However, full user financing of recurrent costs is now an established condition for the support of water and sanitation projects. Far from penalizing the poor, this principle in fact improves the equitable sharing of resources, as it reduces government subsidies which in the past have mainly benefited the better-off sections of society. Numerous studies have shown that the unserved poor are willing to contribute a high proportion of their incomes towards gaining access to dependable supplies of water. Indeed, it is well documented that many pay high prices for supplies from private water vendors, and this could make a major contribution to the future provision of sustainable community supplies which meet their criteria in a more cost-effective way.

WASAs can play an important role in the financing of O&M, and in collecting contributions from users towards investment costs, labor and material contributions, and provision for future expansion. The WASA may, for instance, maintain a bank account for cash contributions and collection of water charges, organize work brigades, and ensure that all beneficiaries honor their share of commitments to the upkeep of the scheme.

Willingness to pay can be inhibited if users are being asked to pay the upkeep of their water supplies through a WASA while other communities are receiving services free through social programs or poverty-alleviation initiatives. Governments need to ensure that cost-recovery rules are applied consistently across all programs, or the benefits of the demand-oriented approach may be lost.

Widespread dissemination of the rules of project participation, clarity in how the rules are intended to be used and transparency in their use reinforce the value of local participation. Many institutional options are available, depending on cultural settings, national and local policy frameworks and rules guiding project implementation. Key criteria in the development of appropriate institutional arrangements with performance incentives include:

- eligibility of rural areas to participate with transparent selection procedures for project selection;
- a range of service levels on offer, with information provided about each level, including expected performance and costs;
- specified cost-sharing arrangements for both investment and O&M, with particular reference to the share of costs to be borne by the users;
- identified roles assigned to intermediaries and other non-user groups.

2.4. New roles for WSS agencies

A crucial element of the switch to community management is that water supply and sanitation (WSS) agencies are converted from service producers to customer-oriented support agencies. The support needs to be local and dependable, so effective decentralization of financial and technical management to provincial and district centres is a prerequisite.

Agency staff in these operational centres require different skills from those they have employed in their former roles as direct providers of services. Supplementing the skills in engineering design, construction supervision, tariff collection and internal management are new skills in social mobilization, communication and conflict resolution. In a number of Latin American countries, the blend of technical and social skills is provided through cadres of paraprofessional field staff, similar to agricultural extension workers. Commonly stationed in local health centres, their prime role is continuous liaison with the WASAs and/or community representatives, providing timely and practical information and support.

Sometimes the para-professionals may have all the technical and management skills needed to support the community-based WASAs from their formation through project design to construction, operation and maintenance. More usually, the extension workers will be able to call on sanitation professionals within the agency to provide these support services.

Training, retraining and incentives are important elements in the conversion process, which necessarily takes time. The transition does not mean that conventionally trained professionals are unsuitable or less effective, once they have adapted to the new approach. Reorientation courses and new forms of training for agency staff need to be accompanied by clear messages about the enhanced role that the new skills will bring – allaying fears that earlier training and experience is no longer necessary. In fact, community management generates a significant demand for technical support, as even the best community mobilization and WASA formation will come to nothing if the ensuing water supply and sanitation improvements fail to perform properly through lack of engineering advice.

The social mobilization and communication skills required to make community management work successfully may not always be easy to obtain within the WSS agency. On the other hand, they may well exist already in other government agencies, dealing with social programmes. Interagency collaboration can be mutually beneficial, as the social programmes may also obtain important feedback from their extension workers' involvement in water and sanitation programmes on behalf of the WSS agency.

The Consultation will also no doubt wish to pursue the potential for joint activities involving agricultural extension workers, used to dialogues with farmers over irrigation water use, in the promotion and implementation of domestic water supply and sanitation programmes.

2.5 NGOs and the private sector

In some instances, resource constraints may mean that WSS agencies are not able to recruit and train enough extension workers or technicians to provide the support services needed at community level. In these circumstances, intermediary non-governmental organizations (NGOs) or private sector firms can provide the bridge between the agency and the community. There are advantages in this arrangement, as NGOs and private firms have more flexibility and can tailor their incentive structures to match the needs of the communities they are serving.

Private firms may often be the most cost-effective source of the skills and equipment needed for such O&M activities as leak repairs, refurbishment of wells, pump and valve repairs, the supply of spare parts, or cleaning of pit latrines. Demand-driven community water supply programmes can generate a substantial amount of work for local industries in the manufacture of key elements such as handpumps, pipes, latrine slabs, well covers, etc, and spare parts for routine maintenance or repair. The mutual benefits to the community and private enterprises develop readily if the community is empowered to procure goods and services for the upkeep and extension of its water system from outside contractors.

NGOs offer a different kind of support. They can help to build the capacity of the community to cope with the tasks it has taken on with the new water or sanitation system. They may, for example, provide training in management, finances, bookkeeping and group decision-making. NGOs also provide links to other resources outside the immediate community, such as government programmes, credit institutions and international donors.

2.6 The enabling environment for community management

For demand-driven sector development to work effectively, it needs an enabling environment of authority and legislation which stimulates cooperation between local WSS agencies and community-based WASAs. Institutional frameworks designed to plan and implement large infrastructure programmes have to be adapted for the user-led approaches now favored.

An important aspect is the need to create incentives for local agency staff to work effectively in collaboration with communities. Decentralization is important, to create a structure which supports local implementation, operation and maintenance of water and sanitation improvements. It must be accompanied by capacity-building initiatives, to develop the capabilities of provincial and district agencies for their new roles.

Sometimes, existing legislation or government policies inhibit community management. WASAs may need to be given legal standing before they can open bank accounts, take out loans, collect tariffs, sign contracts, or receive technical assistance from WSS agencies.

In creating enabling legislation to facilitate community management, central governments need to retain important powers and responsibilities for themselves. Protection of public health and the environment depend on proper controls and enforcement. Local management of a community's water and sanitation systems must not be allowed to impair the capacity of a downstream community to manage its system. What is needed is a national water resources strategy which incorporates community management of rural water systems.

2.7 The influence of technology

The influence of technology on O&M requirements is the subject of a separate Consultation paper and will not be discussed in detail here. Technology choice is however closely linked to the financial and organizational capabilities of the users, who will become joint managers of the completed scheme.

Where technology choice is dictated by geographic or hydrological constraints, it may well be that sophisticated headworks and delivery systems are needed to bring water to the community. A distinction then has to be drawn between these *trunk* systems, which in general require a comparatively high level of technical skills and equipment for operation and maintenance, and the *feeder* systems which distribute water within the community and which can normally be managed by suitably trained and supported WASAs.

If community management is to succeed, the community's capacity to keep its feeder system operating reliably must be matched by agency assurances that the trunk system will deliver dependable supplies. Again, private sector firms may be important partners in enabling the WSS agency to provide those assurances.

2.8 Expansions and upgrades

An improved water supply is frequently seen as an entry point for accelerated community development. It follows that user requirements change with time. Population growth and economic progress create demand for more supplies and for enhanced levels of service. It is important that local management organizations should evolve as the water system evolves.

A WASA which was quite capable of operating and maintaining a system of public standposts may well find upgrading the system to individual house connections a much more challenging proposition. Where treatment systems or major trunk mains are involved, the challenge is even greater.

Without affecting the principle that service provision should be user-driven, the balance of O&M activities may change as the supply becomes more sophisticated, with the community contracting out more services either to the private sector or to the WSS agency.

3. Areas for agency collaboration

While the basic principles of community management of rural water supply and sanitation systems are now widely accepted, experience of their application in developing countries is still quite rare. It is

important that as many experiences as possible should be documented and disseminated. In particular, models need to be developed for different institutional arrangements which stimulate partnerships involving users, sector agencies, NGOs and private sector firms.

The WSSCC's O&M Working Group may be a convenient gathering point for case studies and other feedback. Agencies are encouraged to document as many experiences as possible (good and bad), which will help to formulate institutional models.

It is important that the new concepts become firmly established as prime requirements for new water and sanitation programmes. Discredited centralized systems and programmes which impose systems on users without considering their views need to be discouraged. ESAs can speed the transition to community-based approaches by supporting only those programmes which clearly identify those approaches, and by promoting the establishment of WASAs and capacity building in local sector agencies in their dialogues with recipient governments.

In the light of the integrated approach to water resources management, it will be important to seek new forms of collaboration in relation to community use of water for irrigation and domestic purposes. There are clear overlaps between the roles of WASAs in managing domestic supplies and those of Water User Associations in irrigation water management. There are also important differences and issues to be resolved relating to the special interests of farmers, equity in water allocation and, crucially, ministerial responsibility for the resource. This may well be a substantial discussion point during the Consultation.

The Influence of Technology on Operation and Maintenance of Rural Water Supply Projects

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1. Introduction

1.1 Background

Operation and Maintenance (O&M) has been an issue of considerable concern among water supply and sanitation professionals for more than 15 years. As early as 1979/80, in the preparatory phase of the International Drinking Water Supply and Sanitation Decade (1981-1990), the World Health Organization and the World Bank carried out *Rapid Assessments* in more than 100 developing countries. Along with other key sector information, the studies revealed that inadequate O&M ranked high among the constraints hindering progress in almost every country.

Since then, the sector has learned a great deal about ways to make rural water supply projects more affordable and more sustainable. Concepts such as decentralization, partnership, community management, effective demand, gender analysis and cost recovery are deeply engrained in the minds of all those who have taken part in the massive collaboration exercise which characterized the 1980s and early 1990s. Guiding principles for sustainability and integrated water resources management are enshrined in the outputs of global meetings in New Delhi, Dublin, Rio de Janeiro and, most recently, Noordwijk[1].

Yet, despite all this acceptance of the need for new approaches, and despite the increasing availability of manuals and guidelines on best O&M practices, too many rural water supply projects are still being designed and implemented with no proper provision for their subsequent operation and maintenance. They are still falling into disrepair and disuse; and the "beneficiaries" are still having to resort to their previous contaminated water sources, with all the health risks that involves.

The problem rests with both governments and donors. Having helped to shape the rules, the policy makers now need to recognize the implications for their own methods of working. The golden rule is **partnership**. Planners and designers of water supply improvements need to involve future users from the start, especially in the critical decisions about technology selection. Too many well-intentioned programmes are doomed before they are built because agency staff at national or district level (sometimes even at project level) decide on a technology which the community does not have the resources or the management capacity to sustain. They thereby take on unsustainable commitments of their own, to operate and maintain a village-based system from a remote base.

The partnership approach includes making joint arrangements for the future upkeep of planned water installations from the start, equipping communities and their local partners to take on the management of new facilities, and, where necessary, extending the project period (and the financial and technical support provided) to ensure that the necessary infrastructure is in place when the scheme is finally commissioned.

1.2 Scope

This paper has been prepared by UNDP and IRC as an input to the *Second Technical Consultation on Integrated Rural Water Management*. It focuses specifically on technology issues, though these are necessarily linked with the organizational and financial frameworks needed to achieve effective O&M of

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[1] *Safe Water 2000, Global Consultation on Safe Water and Sanitation for the 1990s*, New Delhi, India, September, 1990.
International Conference on Water and Environment, Dublin, Ireland, January 1992
UN Conference on Environment and Development (The Earth Summit), Rio de Janeiro, Brazil, June 1992
Ministerial Conference on Drinking Water and Environmental Sanitation, Noordwijk, The Netherlands, March 1994.

rural water projects. Those elements are considered in accompanying papers: one focusing on community involvement, education and capacity development; the other on financial and institutional issues.
The consultation has a rural focus, so the discussion excludes the O&M needs of large utility-managed water systems serving urban communities. It is, however, increasingly being recognized that rural technologies and rural management systems have widespread application in the problematic low-income urban areas which have become a focus of renewed attention in recent years. The dividing line for the purposes of this paper is that users should be actively involved in the planning, implementation, operation and maintenance of the water system, with the water agency or local government authority providing support and backstopping services.

An important lesson of the Decade has been the complementarity between water supply and sanitation. If full health and environmental benefits are to be achieved, water supply programmes need to be accompanied by parallel activities in environmental sanitation and hygiene education. Rural water resources can be seriously affected by pollution from inadequate environmental sanitation, livestock wastes, irrigation drainage or industrial discharges upstream. Inevitably, therefore this discussion needs to include the need for complementary programmes, the impact of these programmes on the sustainability of water systems and the effects that effective environmental sanitation promotion can have on water supply. The scope of the paper does not extend to consideration of specific sanitation technologies or their O&M needs.

To help structure a discussion on the O&M implications of different technologies, it is first necessary to consider how communities and their advisers reach decisions about the most appropriate technologies for their own situation. The process of technology selection is covered in Section 2. Some general principles of O&M are common to any rural water supply scheme. The lessons of the last 15 years and the guidelines for improving performance of all the partners are discussed in Section 3. Different technologies require different levels of skills and resources at community level and different forms of support from other stakeholders. Section 4 highlights the O&M considerations associated with a range of alternative technology choices. In Section 5, the discussion turns to the links between water supply and environmental sanitation and their relevance to the O&M of water systems. Preliminary summarized conclusions are presented in Section 6 along with implications for the roles of UN agencies.

1.3 Characteristics of rural water supply projects

A large majority (80%) of the 1.2 billion people still lacking access to a safe water supply at the end of the IDWSSD lived in rural areas. Of the remaining 20%, most were in the low-income urban areas where rural water technologies are frequently the most appropriate.

An improved and more convenient water supply is a strong felt need among rural communities, who are willing to devote a significant proportion of their meagre resources to achieving dependable supplies. This willingness to pay for reliable supplies which they themselves have chosen has been termed "effective demand" and is now seen as the key to sustainable progress, enabling governments to devote scarce resources and limited outreach capacities to a facilitating and enabling role rather than that of "provider". By stimulating local partnerships involving communities, NGOs, private enterprises and water agency staff ("stakeholders"), governments enable the people themselves to evaluate alternative ways of meeting their needs. Given access to information, basic training, credit and periodic technical support, communities will be able to decide for themselves what technology and service level is most appropriate and how they and their partners can best provide for its operation and maintenance.

To some extent, technology choice is dictated by the type of water resources available (groundwater, springs, surface water, rainwater). Technologies may range from simple lifting devices to handpumps, and from gravity-fed standpost supplies to a variety of mechanically pumped systems drawing water from rivers or wells and distributing it via storage tanks, distribution mains, standposts, yardtaps and house connections. Particularly where surface water is the source, there may also be a need for simple treatment systems such as sedimentation, slow sand filtration and disinfection. Given these constraints, there remains scope for the future users to choose from a range of options, depending on their assessment of the benefits,

their ability to pay for the selected level of service, and their judgement on whether the system can be maintained in reliable operation with resources available locally.

The rewards for government in adopting this local partnership approach come in several forms. First, local maintenance avoids the logistical nightmares involved in servicing hundreds of dispersed installations from a central base. Second, by using the preparatory phase as an opportunity also for hygiene education and sanitation promotion, agencies can encourage self-improvement in these critical areas too, while at the same time raising awareness of the most effective use of the improved water supply. Third, by mobilizing local resources, tight national budgets and external support can be spread further. By building community confidence, success with the management of their own water supplies can stimulate wider development efforts, including income-generating activities. Better water management will generally also mean more efficient use of water for all its different purposes, including domestic use, livestock watering and irrigation. Together, these dividends from the partnership approach provide a strong incentive for governments to make the change from "provider" to "enabler", as the global fora repeatedly encourage them to do.

There is growing evidence that, with the right support, community management of improved water supplies works well. It does however depend on new forms of government support, including a legal and administrative framework which allows local ownership of systems and encourages local initiatives, rather than inhibiting them. It also demands a new approach from agency staff, whose role is one of seeking out and responding to community needs through awareness raising, motivation and backstopping support. Gender sensitivity is especially important; women often play an influential and beneficial role in successful community management, but their involvement has to be encouraged in ways which are sensitive to local culture.

This "enabling environment" for community management involves capacity building at all levels. It takes time and requires prolonged commitments by governments and donor agencies. Technical "solutions" cannot be imposed, they need to evolve from community-based analysis of needs and resources.

At the community level, management structures need to be created, or existing structures modified, to enable community members to take on their new responsibilities and to perform them in an equitable and transparent way. Caretakers, treasurers and water committee members will require training and backup support.

Agency staff need to acquire new skills in social mobilization and communication with users. For that they need training or retraining, or the technical staff need to be supplemented with specialists in communicating with users. New incentives have to be found to encourage agency staff to seek sustainable solutions based on consumer demands, avoiding imposed solutions.

Governments have a vital facilitating role to play in fostering local management and control of community water sources and supplies. They need to retain responsibility for protecting public health, maintaining quality norms and standards, conserving and protecting national water resources and planning their allocation among competing users. And, they retain responsibility for mobilizing internal and external financial resources.

Measures for achieving the transition from centralized to local management are the subject of other papers, but in considering the O&M implications of different technologies, it is important to recognize also the critical influence of the administrative and organizational framework in which the scheme is being managed.

1.4 O&M failings

Decade statistics show that huge numbers of rural people were provided with access to safe water during the 1980s. Almost a billion more rural people were "served" with water at the end of the Decade

than at the beginning. That means that more than a quarter of a million people gained access to an improved water supply *every day* in those ten years. The figures are a source of justifiable pride for the promoters and supporters of the IDWSSD, but they do not tell the full story. Rural water supply coverage is significantly less than the figures suggest for two main reasons: first, there is an implicit assumption that when a new supply is made available in a village all the population is served – in fact, for a variety of reasons that is far from being the case; second, and most important for this paper, the statistics ignore the number of new installations (as much as 50% or more according to some estimates) which are out of use at any particular time because of breakdowns or maintenance failings.

In the drive to make the most effective use of all available resources, rehabilitation of defunct water systems is rightly seen as a more efficient form of investment than development of new facilities. There is however one important proviso: before any rehabilitation is undertaken, a full diagnosis is needed of the reasons for the scheme's earlier failure, and all the O&M defects need to be corrected ahead of new investment. It may turn out that a different technology would be more sustainable and therefore more cost-effective.

There are numerous reasons why O&M of rural water systems may be inadequate:

- no involvement of users in the planning of the system and arrangements for its upkeep;
- poor planning, with no data on servicing requirements of critical components and no provision for convenient supplies of materials and spare parts;
- lack of the necessary skills at community level (or accessible to the community at affordable cost) to maintain or repair system components;
- insufficient financial resources in the agency and/or the community;
- dependence on remote centralized government departments with inadequate resources to service dispersed rural communities;
- low priority for O&M in regional/district agencies, resulting in inadequate budgets and staff favouring new construction (this last point applies also to central government and donors, who concentrate resources on new projects);
- the belief that water is free and that government must provide it;
- scarce or expensive spare parts and tools;
- unreliable fuel or electricity supplies.

Not all of these O&M shortcomings relate directly to the rural water supply technology in use, but by guarding against them in the planning phase, the partners in RWS programmes will certainly enhance their chances of selecting the most appropriate technologies.

2. The process of technology choice

2.1 Planning approaches

As noted at the beginning of this paper, direct government provision of rural water services, based on presumed demand has proved inappropriate and unsustainable in developing countries. Through their participation in the landmark Earth Summit in Rio de Janeiro in June 1992, governments are committed to a more people-focused approach to development, to decentralization and to working in partnership with communities, NGOs and, where appropriate, the private sector, so as to relate investment to the true needs and desires of the "beneficiaries" and to ensure the long-term sustainability of water resources and the environment.

In the specific case of rural water supply, that leaves government with the critical roles of planning and managing national water resources so as to safeguard supplies for meeting at least the basic needs of the whole population, and of adopting and enforcing quality standards and pollution controls which will protect human health and the environment. Governments' tasks also include the establishment of effective decentralized agencies with the authority and the resources to plan and implement local programmes in partnership with other stakeholders. In some cases, to aid procurement or to simplify maintenance, a government may choose to establish national standards for water supply components (only India Mark III handpumps, standardized plumbing fixtures and fittings, etc). Standardization should not be such as to create monopolies and inhibit competition. Nor should it lead to imposed technologies inappropriate for local conditions. The aim is to avoid unnecessary complications in securing spare parts and training mechanics or caretakers.

The water and sanitation specialists from donor agencies have repeatedly acknowledged the benefit of such standardization and in some cases they have influenced their agencies to recognize it when framing support packages. Cases continue to arise, however, in which conditionality pressurises recipient governments to accept equipment from the donor country which conflicts with the standardization policy. The ensuing problems as agencies struggle to establish servicing procedures and spare parts distribution for a multiplicity of pumps, pipes, valves, etc are well documented. UN agencies need to reinforce the message that uniformity and standardization are important aspects of strategies for sustainable development.

At local level, there has often been a tendency to see community involvement as the provision of free labour and local materials during construction and little else. That approach too has been discredited by Decade experiences. In the favoured partnership approach, local agency staff respond to community requests for improved services through a consultation process which seeks to guide the community members to a solution which meets their real needs, which they are willing and able to pay for, and which, with accessible support, they have the skills and resources to maintain (and enhance when necessary). The process may often include local NGOs and private enterprises who can provide cost-effective support during implementation and operation of the proposed systems.

2.2 User preference

Choice of technology and service level involves users and agencies in the assessment of a wide range of variables covering environmental, technical, organizational and financial issues. Before communities can make reasoned judgements about the most suitable, sustainable and acceptable service level, they need full information on the options available. Local conditions will determine water sources and impose constraints on available technologies (most of the convenient springs suitable for gravity supplies have already been developed). Users then need to be guided on the cost and maintenance implications of practical alternatives and on the degree of external support to be provided by the agency or by other partners.

Table 1, taken from the IRC publication *Partners for Progress* illustrates the type of considerations that communities need to analyze with the help of agency staff, before finalizing a choice of technology and service level.

When agency support is going to be limited to guidance on technology selection, the final choice will be heavily dependent on local financial and management capacities and the community's own technical skills for construction and O&M. The term "community self-improvement" is being used as a description of this type of solution, either at family or community level.

It is generally true that higher levels of service demand more complex maintenance provisions and higher charges (see section 4), but by no means all scheme failures arise from selection of too high a service level. If community members believe that they can afford a high level of service and manage its maintenance, then choice of a lower level simply to cut costs may well lead to disenchantment and disuse. The general principle is that the consultation process should seek to reach the highest level of service that the community will pay for.

Table 1: Choosing an appropriate water supply system

QUESTIONS	CONSIDERATIONS
1. *INITIAL SERVICE LEVEL ASSUMPTION* What service level is reasonably expected ?	- improved traditional source - handpumps - public standposts - neighbourhood taps - yard taps - house connections
2. *WATER SOURCES* Which reliable water source is available ? Can this provide the required amount of water ?	- springs - groundwater - rainwater - surface water - streams - lakes, ponds
3. *ENERGY SOURCES* What reliable energy source is available ?	- gravity flow - electricity - diesel supply - wind - solar energy - biomass - human power
4. *WASTE WATER DRAINAGE* In which way can waste water be disposed hygienically ?	- soakaways - gardens - sewers - drains
5. *TECHNICAL RESOURCES* What skills and materials can be made available to sustain the desired service level ?	- skills/technical advice: diesel/electro mechanics, pump mechanics, plumbers, carpenters, masons, caretakers - materials: pipes, pumps, taps, valves, fuels stores, chemicals, spare parts
6. *ORGANIZATION* What is the most appropriate organizational structure to sustain the desired service level ?	- village organization - water committee - water supply agency - extension service - power utility - training opportunities
7. *CAPITAL RESOURCES* What are the financial resources available for the desired level of service ?	- users's funds - government subsidies - ESA support
8. *RECURRENT RESOURCES* What kind of payment system is most appropriate for the users' ability to pay ?	- fund raising - communal income - regular contributions - water vending - contribution in kind
9. *APPROPRIATE LEVEL(S) OF SERVICE* Is/are the level(s) of service chosen appropriate for all segments of the community ?	- acceptibility of different levels of service - social justice - rates tailored to users' abilty and willingness to pay
10. *SELECTION OF APPROPRIATE SERVICE LEVEL(S)*	

As the choice is finalized, both the community and its partners take on commitments and it is important that these should be formalized and accepted during the planning phase. The tasks of the water agency staff in responding to a request for support from a community are to:

- assess with the community the prevailing conditions and management capacities
- determine and present the possible options of technology and levels of service

- determine and present the implications for the community in terms of management, finance and operation and maintenance
- allow the community to decide on the most appropriate technology and service level
- explain and accept the agency's own obligations/commitments
- help establish necessary community organizations for planning, financial management, hygiene education, operation and maintenance
- provide necessary training
- obtain all physical and socio-economic information necessary for detailed design
- explain the importance of accompanying improved water supply for all with improvements in sanitation and hygiene education if community health is to improve
- explore other potential benefits and their implications for project planning and design.

It is vitally important that community participation in project planning includes all sections of society. Special provision may need to be made to encourage women to play an active part, but their contributions at this stage are essential, if the water improvements are to meet all the community's needs and to be used to full effect.

2.3 Management capacity

Community-based management of water supplies demands new skills both from within the communities themselves and among the agency staff providing support and backstopping. The implications for recruitment, training and institutional development are covered elsewhere, but technology selection needs to be influenced by the extent to which communities and agencies can adapt and develop the necessary skills.

Typically, in a small rural community, the structure for managing the water supply will include a village water committee, village caretakers or water-point committees, village pump mechanics or scheme attendants, and a village water fund. The level of service which can be sustained will depend on the extent to which the community already has these structures in place and their effectiveness. Incremental improvement has advantages over ambitious attempts to achieve sophisticated management structures in one step. That becomes practical as the community gains experience in managing its new facilities.

2.4 Household water security

In a paper on *Effectiveness* prepared for the Noordwijk Ministerial Conference, Colin Glennie of UNICEF put forward the concept of "household water security" as a basis for the application of community management principles. The idea is that governments and donors should direct scarce resources first towards projects which will serve to safeguard the basic water supply needs of individual households, including support for community self-improvements. The merits of this approach include focusing resources on those in greatest need and thereby assuring that investments have maximum impact. The approach also links well with approaches in the agriculture and health sectors, where food security and community health care involve similar objectives. A great attraction too is the incentive for incremental improvements. As communities reap the financial/economic, comfort and health benefits of their first protected supplies, they will, the argument goes, attain the management capability, the desire, and the financial capacity to initiate further improvements for themselves.

No concrete examples have been found of this principle being applied, but it is highly relevant to the topic of this consultation, and could well be an important discussion point in relation to the planning and management of integrated rural water supply programmes.

3. O&M problems and solutions

3.1 Wasted investment

It is tragic that such a high proportion of government and donor investments in water and sanitation systems have produced schemes that are either out of use altogether or being used well below their capacity. The "free water" concept has had expensive consequences in wasted investment and disenchanted "beneficiaries". A substantial number of the urban poor are paying water vendors up to 40 times as much for their meagre supplies as they were deemed unable to pay when their richer neighbours obtained subsidized piped supplies. In the rural areas, numerous studies indicate that people let down by the government's derelict free water schemes will willingly pay charges high enough to fund the upkeep of dependable locally-managed systems.

Treating water as an economic good has become a guiding principle of integrated water management strategies. The principle, as propounded in Dublin and endorsed in Rio, incorporates access for the poor to sufficient water to meet basic needs at affordable cost. The qualification is not an onerous one. The woman who spends eight hours of her day trudging to the dirty pond and back with her household's water needs would willingly pay just as much for 100 litres of water from a nearby yardtap as the farmer or the industrialist wanting the water for economic reasons. More importantly, water which is paid for is valued, protected and conserved. Realistic pricing of water according to the costs of its production does not penalize the poor; it benefits them, but only if it is applied to all water users.

3.2 Organizational inadequacies

Many of the O&M failings listed in section 1.4 can be ascribed to organizational inadequacies. Either centralized authorities do not have the outreach to support schemes for which they have accepted sole responsibility, or the multi-level planning process has concentrated on the installation of new facilities, not their upkeep. In each case, operation and maintenance suffers because the resources are not available. In fact, appropriate organizational structures are needed at each level if water programmes are to achieve sustainability.

As well as the community-level management structures outlined in section 2.3, decentralized sector agencies need well-defined lines of authority and responsibility. The organizational framework necessary to facilitate and support community management is quite different from the traditional structure with government as the provider. Communities need to be trained in the technical, financial and managerial aspects of operating a water system and in hygienic use of the installed facilities; they need support and encouragement, which requires monitoring and evaluation not just of the functioning of the technology but also of the financial performance of the village water committee and the hygiene behaviour of the users. To fulfill these roles, and to encourage more and more communities to initiate water improvement projects, agencies need to be staffed and organized appropriately, with technical skills accompanied by competence in communication, social mobilization, and hygiene education. It is at this level too that the stimulus must come for other partners – eg NGOs and private sector firms – to contribute their expertise where appropriate. Agency staff therefore need to maintain links with these other stakeholders and be aware of their capabilities and limitations. Their potential role in rural water supply development and management has often been neglected in the past in centrally planned administrations.

Depending upon the complexity of the chosen technology, any particular water project may require technical support and backup from several different levels in the water agency. Where heavy lifting gear or drilling rigs are required for major maintenance work, for example, it may well be that the community will have to call on a regional or central office for assistance. The institutional arrangements in a country have to cater for many different types of community supplies. The organizational frameworks appropriate for different levels of national infrastructure development are the subject of a report prepared by the Water and Sanitation for Health Project of USAID (WASH Technical Report No. 71: *Models of Management*

Systems for the Operation and Maintenance of Rural Water Supply and Sanitation Facilities). The report is based on case studies in eight developing countries in which the roles of central, regional and local agencies varies enormously.

3.3 Spare parts

One of the most common reasons for prolonged breakdown of rural water systems is missing spare parts. Failure of one key item such as a pump gland or a handpump cylinder seal can disrupt supplies for a whole village. However well trained the local mechanics are, they cannot repair faults unless they have ready access to spare parts.

In the past, lack of standardization and the ready acceptance of tied aid has left agencies with a logistical headache in trying to arrange spares, tools and trained mechanics for a wide range of different pumps, motors, filters, etc, all designed for the same purpose. The problem is aggravated by distribution difficulties and can be made even worse where foreign exchange is needed or import duties make parts very expensive. Retail outlets are not easy to arrange for spare parts which may be needed only very infrequently. Local storage of a wide range of spares is often impractical. The problem can be exacerbated where government attempts (usually unsuccessfully) to play a strong role itself. Private sector initiatives may be discouraged by government intervention.

Since the start of the Decade, water and sanitation specialists have been emphasizing the benefits of local manufacture of any components for which it is practical and use of standardized units for which a reasonable market can be created where local manufacture is not practical. The VLOM (Village-Level Operation and Maintenance) concept was heavily promoted through the UNDP/World Bank Water and Sanitation Programme's Handpump Research Project as long ago as 1981.

However it is organized, a dependable supply of critical spare parts, tools, lubricants and other consumables is a vital element in the planning of a new water system. Technology choice may be dictated by the practicality of ensuring that these items are reliably available.

3.4 A change for the better

As already noted, rural water systems are still failing as a result of poor planning for O&M and/or design inadequacies. Generally, though, there is a widespread recognition of the failings of the past and a strong desire to plan and implement sustainable projects in the future. Community control is at the heart of future strategies and it has to be acknowledged that long preparation times are involved. It would therefore be wrong to expect an immediate impact from the new approaches. On the other hand, it is now possible to demand a halt to the inappropriate approaches that have led to the catalogue of past failures.

Since 1988, an international working group led by WHO has been developing recommendations and guidelines on Operation and Maintenance in water supply and sanitation, covering both urban and rural projects. The O&M Working Group, now functioning under the auspices of the Water Supply and Sanitation Collaborative Council (WSSCC) has produced a series of reports, case studies and tools to help water and sanitation agencies and donors to improve the provision for and the implementation of better O&M procedures.

Of particular relevance to rural water supplies, publications available through WHO or the WSSCC include:

- selected case studies on O&M of WSS systems
- tools for assessment of the O&M status of urban and rural WSS systems
- training course package on leakage control

- ❖ training course package on management of O&M of rural water systems
- ❖ models of management systems for the O&M of rural WSS systems (The WASH publication already referred to in section 3.2)

In a report to the WSSCC Global Forum in Rabat, Morocco, in September 1993, the O&M Working Group noted four "overriding principles" as the basis for effective O&M. They are:

1. The provision of water is a service and requires a service-oriented attitude by the agencies involved. To ensure long-term sustainability, water should be managed as a commodity in the same way as any other resource. Its use and exploitation should be on financially sound and cost-effective bases, subject to the same controls as other resources to ensure its conservation, protection and wise utilization.

2. The supply of water to consumers should normally be based on the principle of effective demand, which can be defined as the standard of service that users are willing to maintain, operate and finance to ensure adequate public health standards and, on occasions, to support economic activity. Effective demand has to satisfy the priorities of the community at large.

3. Water systems should be managed and operated following the principles of good business practices. The form of management will vary depending on the local situation; ie rural, urban, semi-urban, location, demographic structures, etc. To be most effective, the responsible agency should be autonomous from government but manage the system under technical, financial and administrative guidelines set by national governments. The agency should operate in a fully transparent way and be fully accountable to its consumers.

4. Sanitation is an undervalued item in the sector and emphasis is required on sanitation development and on forging closer links between water supply and environmental sanitation (solid and liquid waste management) in the planning of new programmes.

4. O&M implications of rural water supply technologies

To help guide communities and their partners to the right technology choice, all those who may be involved in the subsequent Operation and Maintenance need to be aware from the start of the skills, materials and tools that may be needed to keep systems working reliably. In this section, the O&M implications are related to the different elements of rural water supply systems.

4.1 Intake works

The optimum water supply for a rural community is a high-level spring able to feed the village by gravity. Though the initial capital costs of capping the spring and piping the supply may be comparatively high, subsequent O&M requirements should be minimal. All that is needed at the headworks is vigilance to prevent contamination and periodic inspection of the inlet structure for physical damage.

Unfortunately, mountain springs are rare and most have already been fully exploited. The more common intake is on a river, lake or stream. It has to be designed to draw water in all seasons, must be able to prevent floating debris (logs, leaves, rubbish) from entering the supply system, and must be robust enough to stand up to floods carrying boulders, tree trunks, etc. For the common pumped delivery system, the intake also needs to protect the pumps from damaging grit, silt and such floating hazards as rope or vegetable matter.

Though regular inspection is needed and caretakers need to be sure to clean screens, desludge chambers and clear away encroaching weeds or other vegetation, care of intakes is not a high-skill expensive operation and is well within the capacity of a community-based O&M management system.

4.2 Pumps, engines and motors

Most surface water supply systems involve mechanical lifting of the water into storage tanks before it is distributed via standposts, yardtaps or individual house connections. Except for dug wells and handpump supplies, groundwater-based systems also rely on mechanical pumping. If the village has a dependable electricity supply, electric pumps will generally be the preferable choice, as their O&M needs are the least onerous. In the absence of electricity, diesel-powered pumps are usually favoured. Other options include solar or wind-powered pumps and, in some countries, animal-powered lifting devices.

Pump failure is one of the commonest causes of rural water systems being out of use. Fuel shortages are prevalent in developing countries and, combined with the seasonal transport problems associated with many rural roads, they mean that planners should not underestimate the logistical difficulties of ensuring a secure regular supply of diesel for the water pumps. The right balance of water and fuel storage can ameliorate the problem, but careful consideration of fuel supply risks is a vital part of the planning process.

Coupled with the fuel uncertainties, diesel pumps present their own maintenance challenges for rural communities. Ideally, local caretakers may undertake preventive maintenance (cleaning of intakes, lubrication, monitoring of temperatures and pressures), and nearby mechanics may acquire pump repair skills along with those needed to fix agricultural machinery, motor cycles, etc. There is also a need for spare parts to be readily accessible.

With any pumping system, it is prudent to install enough capacity to cover for at least one pump being out of service, and preferable to install two or more pump units. Repair and maintenance of pumps is a role that may frequently be of interest to private mechanics. In some cases, private operators may be licensed by government to provide the complete water service, including operation of the pumping and distribution system. Before entering into contracts for these services, communities need to be sure that the private firms have guaranteed supplies of fuel and spare parts and that they have the skills for local maintenance.

Wind and solar pumps are alternatives to electric or diesel installations. They have the distinct advantage that their power depends only on nature and, if the site is appropriate, should be reasonably guaranteed for the periods necessary to fill storage tanks or charge batteries. Experience is growing and technology is improving in both wind and solar pumping, with irrigation pumping as the major application of wind-powered pumps so far. In general, wind pumps involve more complex mechanical parts and hence need special skills when anything goes wrong. Solar pumping requires a high initial investment (though this is diminishing as technologies develop) and little routine maintenance (cleaning of the photovoltaic cells), but when anything does go wrong it is almost invariably a case of calling in distant experts and incurring high repair or replacement costs.

4.3 Wells and boreholes

For a number of reasons, groundwater is generally regarded as preferable to surface water as a source for community water supplies. Its quality is likely to be better and more consistent, which usually means that treatment is not necessary (though disinfection is sometimes regarded as a prudent safeguard). The large storage capacity of aquifers also means that seasonal fluctuations in yield are less significant than with surface supplies (though local drawdown of drinking water boreholes by adjacent irrigation pumping is a danger in some areas).

Depending on local hydrogeology, groundwater may be tapped by shallow or deep dug wells or by drilled boreholes equipped with mechanical pumps or handpumps. Maintenance needs relate to both the well/borehole and the means of withdrawing the water.

Sanitary dug wells represent one of the simplest ways of improving on the traditional community water supply of an open well. The main objectives are to protect the water from contamination and to

enable as many people as possible to obtain safe supplies from the source. Dug wells as deep as 50 metres are known to exist but in general such wells make use of confined aquifers at depths of up to 20 metres. Maintenance needs are small, provided that the well has a robust design – concrete linings, either pre-cast or cast *in-situ* are preferred, with the lower sections in open brick or porous concrete to allow water to enter the well. Caretakers need to keep the well surroundings clean and tidy, to avoid contamination, and the well covers sometimes need repair or replacement.

Boreholes or tubewells are the alternative to dug wells for exploiting accessible groundwater. Except in rare geological conditions or for shallow depths, drilling rigs are needed to sink the borehole, which is then lined, with a perforated screen at the appropriate level to tap the right quality of water at the right permissivity. As with mechanical pumps, it is unwise to rely on a single borehole as a village supply. If the casing fails or the screen blocks, or the well needs deepening, specialist equipment and expertise is needed and no water can be provided while the well is out of action.

The choice of water lifting devices is wide-ranging, including for dug wells a bucket/windlass system, rope and bucket pump, and for dug wells or boreholes a big variety of handpumps, and the mechanically powered pumps already discussed. Maintenance needs vary with the sophistication of the devices and the depth of the well. In general, most of the manual systems can be readily maintained at village or district level, though some handpump designs need special lifting gear and costly spares. Suction handpumps (suitable for water tables down to about 6 metres) and direct action handpumps (down to 12-15m) are especially suitable for village maintenance, and there are many examples around the world of minimally trained caretakers achieving high reliabilities with these devices.

For deeper wells too, modern handpump designs can make such tasks as cylinder replacement relatively easy, though experience on pilot schemes is useful where a technology is being introduced for the first time and there are too many examples of inappropriate choices leading to abandonment of handpump-based schemes. Again, provision of spares and special tools needs to be assured from the start. Standardization is highly beneficial both for spares procurement and for caretaker training. Local manufacture of regularly needed items such as piston seals has significant benefits in both cost and effectiveness of O&M.

Handpump materials also need to be selected with groundwater quality in mind. Aggressive groundwater can corrode galvanised iron rising mains and normal steel piston rods. Stainless steel or plastics are sometimes available as options.

4.4 Water treatment

Treatment of groundwater supplies will generally be unnecessary or minimal, particularly if the water is drawn from depths of 15 metres or more. Salinity, fluoride, iron and manganese content are sometimes problems requiring local treatment or blending with other sources. Surface waters on the other hand almost invariably need some treatment to make the quality acceptable for drinking. The choice of water quality in rural areas depends on local conditions and capabilities. Suspended solids and micro-organisms need to be removed, either in a central treatment plant ahead of the distribution system, or at household level once the users have drawn raw water from the system.

Household-level technologies include prolonged sedimentation (eg the three-pot system), gravel and/or sand filtration, chlorination, solar disinfection, or boiling of the water. In practice, sand filtration and chlorination are difficult to operate at household level. Sedimentation and solar disinfection are comparatively straightforward. Boiling all drinking water is a practice used particularly in parts of Asia (eg China, Sri Lanka) but it is expensive on firewood or fuel and correspondingly damaging to the environment, so is not a recommended form of water disinfection, unless it is the only way to protect small children from contaminated supplies..

At community level, water treatment involves a high initial investment to construct the treatment facility and it is therefore vital that the community participates in technology selection and appreciates the

O&M implications from the start. A feasibility study on the technical organizational and financial sustainability of the favoured system is a prerequisite for success. This will include analysis of the dependence on chemicals, the reliability of fuel and power supplies and the need for special spare parts, tools and mechanical skills.

Treatment systems such as coagulation/flocculation, rapid sand filtration and chlorination frequently prove too technologically challenging for satisfactory O&M in rural areas. More sustainable systems include prolonged storage, tilted-plate settlers, roughing filtration, slow sand filtration and disinfection using chlorine generated on site. A sound principle is to introduce a multi-barrier system, in which each element contributes to the removal of pathogens and other contaminants. In that way, if one component breaks down, supplies can be maintained while repairs are carried out. The price for added security, though, is increased O&M, as each element requires its own arrangements for preventive maintenance, materials supplies, skills and repairs, and therefore accumulated costs.

Experience shows that communities able to cope with the comparative sophistication of a pumping system and treatment plant will not be unduly constrained by the addition of extra treatment trains. The multi-barrier system therefore has more advantages than disadvantages.

Iron removal can be achieved through quite simple technology, but desalination and defluoridation present larger problems. There have been some successes with household desalination systems using solar energy, to provide drinking water alone, but in general, high salinity or high fluoride groundwater presents problems, unless it can be blended with treated surface water or other alternative supplies.

4.5 Piped distribution systems

One of the critical decisions the community and its partners will take during the planning phase is the service level or levels to be provided. There are jumps in standards and convenience from traditional sources to dug wells or handpumps, to standposts, to yardtaps and to house connections. Each step adds to the complexity and cost of the scheme and to the maintenance commitments. Most potential users will want the highest service level that they can afford and sustain. In some instances that may mean a range of service levels covering different sections of the community.

Once the system progresses beyond handpumps (or standposts directly linked to a storage tank), the maintenance commitments also extend to a pipe network and to a series of water points and/or house connections. Then metering will also be needed to ensure equitable charging for the different services and to combat wasteful consumption. Now the maintenance system must be able to cope with leaks from pipes, broken taps, valves, connections and meters. Trained plumbers are needed on a regular basis and the scope of work of the village water committee (or scheme committee) and caretakers needs to expand to cover routine maintenance and preventive maintenance of all these extra items. The extra scope is not enormous for a team equipped to handle a water treatment plant, but it does represent a significant extra challenge beyond the capacity to look after point sources such as dug wells or handpumps.

A frequent cause of problems with piped systems is progressively reducing cover to pipes. Erosion may arise from flooding, or ground may be removed or compacted by agricultural operations or by pedestrian or vehicular traffic. Erosion may also result in exposure of structural foundations. Local caretakers need to be made aware of the need to maintain protection for pipes and other structures, and to ensure that adequate cover is provided after repairs or connections have been made.

4.6 Water storage

Elevated storage tanks, once erected do not require significant O&M inputs. Inlet valves need periodic checking; the tanks themselves may need cleaning and desludging; and preventive maintenance is preferable to the risk of catastrophic collapse or major leakage. All these items should be well within the capacity of local caretakers, with external support needed only when tank repairs or major refurbishment is necessary.

4.7 Rainwater harvesting

Rural people have always caught and stored rainwater to supplement their water supplies. Recently, rainwater harvesting has become popular as an integral part of a rural water supply system, particularly in arid and semi-arid areas where surface and groundwater sources are unreliable for parts of the year.

On a household basis, the idea is to improve roofing materials and drainage systems and provide substantial protected storage capacities. Initial investment levels are therefore high and dependent on local credit facilities or subsidies. Routine maintenance is simple – repairs to roofs, drainage systems and storage tanks – and well within the capacity of local tradesmen with some basic skills training.

Larger scale rainwater harvesting, involving the diversion and trapping of floods in large reservoirs, is a major operation involving major capital investment. However, the maintenance demands can be manageable for rural communities, if the planning and design provides for extensive use of local materials and for skills training.

5. Environmental sanitation interface

5.1 Water needs for household sanitation

For improved health, communities need improved water, improved sanitation and improved hygiene behaviour. The sanitation facilities themselves create an additional water demand. As sanitation facilities are upgraded, so that demand rises – pour-flush or full-flush toilets are the obvious example. Sanitation facilities also require maintenance, though that is beyond the scope of this paper. Better hygiene does however also influence the design, use and maintenance of water points. Where aprons around standposts or handpumps are used for clothes washing, there is a need for good drainage, which has to be kept clear of debris and discharged hygienically.

5.2 Pollution effects from point sources

Siting of new sanitation facilities can be important in relation to drinking water quality. There are guidelines on the proximity of latrines, soakpits, septic tanks, etc, to groundwater sources and on the discharge of sewage into rivers and streams upstream of water intakes. Scheme caretakers do need to be extra vigilant to ensure the protection of intakes from discarded solid waste. Treatment processes depend too on the extent of water contamination, so their operation has to be adjusted to match raw water quality trends. Contamination of surface and groundwater sources can arise from a variety of potentially hazardous operations. Leachates from waste dumps may contain toxic chemicals and other harmful compounds. Sewage outfalls and discharge points from sewage treatment plants also add to the contamination load.

5.3 Links with agriculture

Surface water and groundwater are sometimes threatened by agricultural use of fertilisers and pesticides which are then flushed through into the streams and aquifers. High nitrates and organic compounds can mean that an otherwise pure groundwater becomes unsuitable as a drinking water source. Regular monitoring of water quality and sanitary surveys to identify pollution sources need to be part of the routine O&M needs and to be backed by tight regulation of agro-chemical usage in the catchment areas of water sources. The benefiting community itself may also be the main threat to its own supplies. Excessive use of fertiliser and intensive animal husbandry should both be carefully controlled near to strategic water sources.

Water source protection is both a national and a local issue. National legislation and enforcement are essential tools for protecting strategic resources. Locally, communities need to develop their own water source protection strategies including such measures as physical protection of wells, improved sanitation and hygiene behaviour, regular emptying of tanks and pits, organization of sanitary waste disposal,

catchment protection, effective surface drainage and, where appropriate, wastewater treatment.
It is important that water management and land use/agricultural management are planned jointly, so that sustainable water management and sustainable food production become common goals not conflicting ones.

6. Conclusions

6.1 Planning for sustainability

The major conclusion of this discussion is that successful operation and maintenance of rural water supply systems depends critically on proper planning. O&M needs have to be assessed and planned for from the start, with the commitments of communities, agency support staff and any other inputs from the private sector or NGOs established and agreed by all involved parties in advance of project implementation. Planning takes time and both governments and donors have to recognize that time spent in the planning phase is a worthwhile investment as it helps to ensure that the installed facilities can be reliably sustained through affordable O&M.

6.2 Community-led partnership

Local control of water systems has been shown to be an essential ingredient of sustainability. It is not, however, simply a question of the water agency handing over responsibility once a scheme has been completed. The community or local management authority does need to accept responsibility for managing the system and to develop ways of financing its upkeep, but it will almost always depend on some form of external support and backstopping. There is a great deal of documentation on successful community-management approaches. Again, governments and donors need to accept the enabling role as just as important as their previous "providing" one, and to establish the mechanisms for continuing logistical and technical support.

6.3 The enabling environment

This paper deals primarily with the technological aspects of rural water supply O&M. In doing so, it necessarily touches on the institutional arrangements needed to ensure successful community-led O&M. The institutional and financial needs are discussed in companion papers. What is important is that all the parties involved in rural water supply investments commit themselves to the new approaches, universally endorsed by sector professionals, and put a halt to the former practices of supply-driven development with central control.

The UN agencies, in their coordinating and supporting role, can reinforce this critical message in all dialogues, at country level and in international fora. It is fair to say that the approaches currently adopted by UN agencies towards governments and projects are far from uniform. In many cases, agreements readily entered into in global fora are not being translated into policies and actions at country level.

The Influence of Technology on the Operation and Maintenance of Rural Water Projects

Food and Agriculture Organization of the United Nations[1]
Rome, Italy

1. General introduction

1.1 Background to the Consultation

In convening the bi-annual Consultations on Integrated Rural Water Management, the relevant UN Agencies are responding to the recommendations of the UNCED's Agenda 21 in general and its Chapter 18 in particular.

Section F of this Chapter: *Water for Sustainable Food Production and Rural Development,* states *" Achieving food security is a high priority in many countries, and agriculture must not only provide food for rising populations, but also save water for other uses. The challenge is to develop and apply water saving water-saving technology and management methods and, through capacity building, enable communities to introduce institutions and incentives for the rural population to adopt new approaches for both rain-fed and irrigated agriculture. The rural population must also have better access to a portable water supply and to sanitation services."*

The inter-relationship between the ability of rural populations to produce food on a sustainable basis and their health status is abundantly clear. Agricultural development and rural health will need to be pursued concurrently to achieve sustainable development. The 1st Technical Consultation on Integrated Rural Water Management (FAO 1993) reiterated that the very survival of rural communities and the sustainability of agriculture depends on: integrating the planning, implementation of all water related activities in the rural sector; ensuring drinking water supply and sanitation to rural households; improving water use efficiency in rural activities, and especially in agriculture; the conservation of water resources; safeguarding human health with particular reference to water related diseases; and the protection of water quality and the environment.

1.2 Operation and Maintenance of Rural Water Projects

Operation and Maintenance of Rural water Projects is the subject selected for the Second Technical Consultation, with discussion being generated by papers dealing with: (i) technology, (ii) community participation, and (iii) economic and financial aspects. The objective of the Consultation is two fold: (a) to highlight possibilities for greater integration of Operation and Maintenance (O&M) of Irrigation and Rural Water Supply and Sanitation (WSS) projects and the impact of O&M of these projects on water borne diseases; and (b) to recommend approaches and specific areas for inter-agency activities to in the field of O&M of rural water projects.

A few general points, raised at this early stage, may prove subsequently useful. The purpose of Maintenance is twofold: to keep the physical facilities in good operating condition at all times, and to obtain the longest life and greatest use of such facilities. Operation then becomes the routine provision of water to the satisfaction of users. To make this possible, maintenance of the physical facilities is important. In order to ensure sound O&M, good management of the project is essential. Thus by O&M, one really means MOM, Management, Operation and Maintenance.

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[1] Prepared by Janusz Rydzewski, FAO Consultant and Arumugam Kandiah, Senior Officer, FAO, Rome.

Although, for the purpose of this Consultation, the subject is being covered by three papers, they have to be considered together to make any sense of the problem addressed. Choice of technology cannot, for instance, be rational without reference to project economics and finance. Nor can it ignore possible involvement of the user community in its MOM. Doubtless, the papers will overlap to some extent, but this will only serve to illustrate their interdependence.

The Consultation is to deal explicitly with **Rural** water management. Whereas with WSS projects there is a need to distinguish between urban and rural, for irrigation, which is rural by definition, the problem does not arise. Once defined, a rural WSS project will have an upper limit to its size (e.g. for up to 1000 inhabitants). But a self-contained irrigation project could range from one hectare (e.g. based on well and hand pump) to over a million hectares. As a result the diversity of technologies and their O&M implications is very much greater for irrigation projects.

Irrigation projects, except those at village level, generate economic activity which attracts people to the area. In such cases, provision of WSS becomes an integral part of the project and should be reflected in its O&M structure.

1.3 Technology in projects

The technology selected for a particular project is a preferred choice from a number of possible alternatives. It depends heavily on the physical and human environment in which it is to operate and on the economic and financial circumstances for which it is conceived and planned.

The designer has to visualise the facility being created not just at completion (and formal opening), but in the operational mode over its stipulated life-span. This sounds patently obvious, but may not be so easy to achieve in practice, since designers often lack experience of operating and managing the facilities they design. This can be particularly noticeable when the design team comes from outside of the organisation responsible for the operation of the project. Technology does set a limit on what is possible for management to achieve in the operation of a system. There is a temptation to raise the level of technology (and consequent investment) without first ensuring that the existing technology is operating at full potential.

It is now axiomatic to call for the involvement of the users of the facility from the very beginning of the process of project formulation, planning and design. This is particularly useful when the users have some experience with the service the facility provides them, as when an existing project is to be rehabilitated.

In this context, mention should be made that rehabilitation is not to be confused with project modernisation, the latter is a steady process within O&M of improving the functioning of the facility in the light of technical developments and in response to the demands of the users. Rehabilitation, on the other hand, should be seen more as a (desperate) measure to bring the facility back to working order after its decline through poor O&M and/or poor initial conception and execution.

Design of water development projects is, more or less by definition, very site-specific, so comments on its appropriateness cannot be made with global certainty. Yet attention can be drawn to some constraints imposed on the performance of projects by the technology selected for them and on non-technical influences that come into play.

1.4 Technology and economics

Probably the most dominant of the non-technical influences on the choice of technology is that imposed by economic appraisal (in all its forms) of the project proposal. Typically, events in project life are expressed in monetary terms year-by-year over a given study period and then subjected to a discounting process. As is well known, with discount rates of the order of 10-12%, events after some 10 years from base begin to have a low present value.

This purely algebraic phenomenon has an important consequence on the choice of technology, when striving for cost-effectiveness. It tends to favour lower capital cost and higher recurrent cost projects as against higher capital cost and lower operating cost alternatives. This may be appropriate when both elements of finance come from the same basic source. But when capital costs are covered from aid funds or low-interest loans, while recurrent costs are intended to be provided by the state and/or the users, things can go terribly wrong.

Socio-economic considerations, especially in developing countries, confront the designers with choices between capital-intensive and labour-intensive solutions. In an era of high unemployment, job creation can be an important objective.

In many cases the disappointing performance of irrigation projects can be attributed to funds for O&M falling far short of what was stipulated in feasibility studies.In some cases the situation becomes so bad that a 'rehabilitation project' is superimposed on the existing one, bringing in new capital and recurrent expenditure. This can be used as a cynical strategy by substituting rehabilitation for bad O&M. How this can be avoided is one of the key issues for this Consultation.

1.5 Scope and structure of the paper

In discussing technology for rural water projects it has been decided to exclude small-scale hydro-electric schemes, though in some areas of the world these may be of great benefit to the rural communities. Headworks such as large dams (often multi-purpose), barrages or pumping stations, which of necessity involve specialist resident teams for their operation, will also not be included.

Section 2 will deal with irrigation projects, taking them from the source of the water, such as simple diversion, small dam, pumping from river or lake and raising groundwater, through conveyance and distribution to water application on the field and, if necessary to drainage. Where appropriate, reference is made to recent activities of the UN organizations on each of the above areas.

Section 3 indicates where possibilities exist for closer cooperation between various UN agencies and draws some general conclusions.

2. Irrigation Projects

2.1 Special features of irrigation projects

Irrigated agriculture is a special case of intensive agriculture, in which technology intervenes to achieve control of the soil moisture in the crop root zone. Adding water when it is needed, removing excess water and protecting the cropped land from flooding all form part of the process.

But the output of an irrigation project is an agricultural product, against which the success of project management is judged. So what at times may appear as sub-optimal management of water for agriculture, may in fact be the best possible option in the context of the total enterprise.

Water use in agriculture is consumptive, and the quantities involved are large. Some 2500 tonnes of water may have to be diverted to produce 1 tonne of cereal. Overall water use efficiencies can be disappointingly low, often falling below 40%. This can not always be blamed on inadequate technology. More pertinent is the lack of awareness on the part of users and management that water is an economic good. Competition from other sectors for a limited water resource will provide a healthy stimulus to more efficient use of water in agriculture.

Agricultural water demand is set, within seasonal climatic variations, by the cropping pattern and associated farming practices (e.g. high water requirements in field preparation for paddy rice). But the crops grown and the manner in which they are grown is likely to change with time, not only because market

conditions can vary, but also because of introduction of new, more drought-resistant plant varieties. The water facility should, therefore, have enough flexibility to cope with this dynamic situation.

The diversity of size and type of irrigation projects has already been touched upon. It is not surprising that projects where good agricultural land is found close to a reliable source of water are the first to be established: this for obvious economic reasons. But as one approaches the limit of available land and water, the projects become increasingly expensive. This creates a problem, not so marked in Water Supply, when setting water tariffs. Should the beneficiaries pay more because their project is more recent and hence more expensive?

The final comment here concerns the user of the irrigation water. Since this is only one, albeit a key, input to agriculture, the skill with which it is handled by the farmer will be reflected in the farm's productivity. In many parts of the world farmers still need training in irrigation water use and this has to be taken on board by management. Obviously no such burden falls on management in Water Supply.

2.2 Elements of an irrigation system

It may be useful to distinguish between three basic elements of the development and management of water resources for irrigation (and other uses). **The first** concerns the creation of a regulated and guaranteed flow of water, to a specified level of acceptable risk. This usually involves catchment protection and creation of storage in reservoirs behind dams. It may, also, involve the management of groundwater within the river basin. As previously mentioned, this part will not be treated here. **The second** element concerns the abstraction of the water and its conveyance to the area where it will be used. **The third** is the facility for distributing the water within the project area, applying it to the land and removing any excess through drainage.

The distinctions made above can be helpful when attempting to compare costs of projects. The first two elements are so site-specific that comparisons become meaningless. The third, however, can and should be subjected to world-wide studies in order to assist technology transfer and to reduce costs.

When technology on irrigation projects is considered in detail, further disaggregation of the system will be made, under the following headings: headworks for gravity supply; pumping of surface water; groundwater lifting; conveyance to project area; distribution within project area; control structures; field application; drainage; roads within project area.

But before embarking on the above, it would not be out of place to take a broad view of possible administrative and management structures for irrigation projects.

2.3 Administration and Management of Irrigation Projects

The very wide range in the size of irrigation projects has a direct impact on how they are administered and managed. One will not dwell on the private owner of a well and plot of land, when all functions are vested in one person. Larger projects, which at present find themselves predominantly in the public sector, will better illustrate what issues are involved.

Public sector ownership of irrigation systems creates some inherent characteristics which have important consequences on the O&M of the systems.

To begin with, public service personnel are trained as administrators and not as managers. They are good at interpreting and following set rules and regulations, but not at responding, without delay, to events (some unforseen) so as to make the irrigated agriculture enterprise a success. In industry, it is axiomatic that remuneration of management bears some relation to its performance with respect to the profitability of the enterprise.

The salary scales in government service give no direct incentive to leave a secure post at national or provincial headquarters for the risks associated with a management post in the field. Being close to the centre, where decisions are made on promotions, is also of advantage. Besides, life in town, with better school, medical and social facilities is more attractive to most, especially to mid-career professionals with families.

The public service salaries themselves, in developing countries, are usually low compared with those in the private sector: the difference can be as much as 450%. So what, one may ask, are the attractions of public service? The main is security of tenure (and sometimes even of food supply), followed by a more leisurely pace and possibilities of study abroad on funds not available to private sector employees.

These are hardly encouraging for the future and leads one to question the extent of government involvement in the O&M of public sector projects in general, and of irrigation systems in particular.

2.4 Issues in Operation and Maintenance (O&M)

Water for agriculture can present a conceptual difficulty when responsibility for it is considered. Should it be the concern of agencies dealing with agriculture or with water resources? It sometimes lands up in 'compromise' locations, like the Ministry of Public Works, or the Ministry of Energy. More frequently several ministries, departments or agencies become involved, without much attention to collaboration in the implementation and operation of projects. Sometimes, one can also discern a marked division of interests between organizations dominated by civil engineers and those staffed by agriculturists.

There are signs of a realisation that what is being provided is a service to the irrigation farmer, a service, which, if efficient, supplies a valuable input. The input can be paid for and the service can then be properly rewarded. Under such conditions good calibre interdisciplinary teams can be recruited without creating wasteful rivalries. Indications are, however, that this scenario is more likely away from the inherent limitations of the civil service. Attention is now increasingly being given to how best to involve the private sector in public sector projects.

The farmer, as the agent of production, has to have confidence in the service providing irrigation water. Nowadays it is often typified by the *vicious circle* : inadequate O&M; reliability of water deliveries deteriorates; farmers reluctant to invest in better inputs dependent on reliable water supply; decline of net returns from irrigated agriculture; increased farmer resistance to pay for maintenance.

Project decline thus initiated can accelerate if it is known by both operators and farmers that, if maintenance fails, there will be funds available for rehabilitation.

So the aim is to set in motion the *virtuous circle* : good O&M; reliable irrigation water delivery; profitable agriculture; good revenue generation.

The O&M of an irrigation system involves the organisation and control of physical, human and financial resources in order to supply water to farm outlets: in adequate quantity (discharge and duration; at the correct time, with respect to the crop growth stage and condition; with reliable and sustainable supply; with equity of distribution.

To satisfy the above objectives, management must be able to:-

- identify and quantify the areas requiring water supplies
- identify areas requiring priority deliveries of water
- control the flow of water in accordance with the resulting irrigation schedule
- maintain safe water levels, to avoid overtopping and possible breaching of canals.

This cannot be achieved without routine collection and processing of data from the field, a responsible and skilled task, made increasingly effective by computer models of the system.

2.5 Operation and Maintenance (O&M) models

Management of irrigated agriculture is beginning to be seen as a commercial enterprise, where resources have to be procured and managed, investment in infrastructure made, quality assured and output marketed. For this it requires structure, systems and skills. Structure defines functions, assigns responsibilities and lines of communication. Systems describe the routine procedures that have to be followed to achieve stated objectives. Skills required to operate the enterprise, if not already available, can be bought in or attained through staff training. Needless to say, the financial incentives must be sufficient to attract and retain such skills. Depending on the size of the enterprise, management should have an in-house research and development programme, or participate in one set up in the area by other enterprises or agencies.

As has already been mentioned, irrigated agriculture inescapably involves a number of agencies. To establish an institutional framework for irrigation development some guiding principles can be put forward:

- organisations should collectively plan and deliver services in a sustainable manner, integrating critical mutually-dependent functions in one management and developing effective coordinating mechanisms for the remainder.
- role and function of individual agencies must be clear and unambiguous, with no conflicts in objectives at the agency level, no overlapping responsibilities and no gaps in a coordinated approach.
- planning and management should involve users in decisions on setting the levels of service.
- service delivery decisions should be devolved to the appropriate level in the community.
- service delivery agencies should be financially autonomous.

It is impossible to be dogmatic on how the ideas presented above should be implemented in any particular situation. So much depends on the cultural background in agriculture as a whole and on the experience and traditions in irrigation.

Broadly speaking, major headworks (dams and barrages) are likely to remain the responsibility of national or river basin agencies, as may larger primary conveyance canals.

At the other end of the system, at the tertiary (distributary) level, encouragement is being given to the formation of autonomous, legally constituted water user groups, who then operate and maintain, and possibly own, the system down to the farm turnout. Here routine O&M tasks are relatively simple and should, with appropriate training, be within the capability of many community-based groups. Repair work could here be contracted out to local firms.

Secondary canals, which convey water from primary canals to the distribution network, demand a reasonable level of technical skills and resources. These could be handled by more broadly based community organisations, such as irrigation districts or co-operatives.

On very large systems, responsibility for primary and/or secondary canals can be vested in an 'irrigation authority' or an 'irrigation company'.

As already intimated, there should be a clear contractual relationship between those providing water and those receiving it, right down to the farm turnout.

2.6 Technology and O&M within the irrigation system

2.6.1 Water allocation and delivery

Policies on water allocation and the consequent methods of delivery influence the design and operation of the whole system. To make subsequent comments on the elements of the system clearer, typical methods will now be briefly described.

Continuous flow. This is by far the easiest for both the designer and the operator. The flow rates are smaller, so the canal capacity and size is smaller too. Once the flow rates are set (down to individual farms), management leaves it alone, except in emergencies. If there is off-canal and/or on-farm storage, this can be a cost-effective solution. If not, especially if irrigation is not practised round the clock, it may result in considerable wastage of water.

Night storage reservoirs (basins) are relevant in this regard. However, they pose a health hazard, particularly by creating an environment for the breeding of disease vectors, if not properly located, designed and managed.

Demand. A true on-demand system can operate only where the delivery, at least at tertiary level, is similar to that for water supply, i.e. it is in pressurised pipes with hydrants (and ideally, meters) at the farm gate. It is used widely in the industrialised world and obviously demands an O&M structure with high technical back-up, again, like in water supply. This is likely to gain popularity in countries where water is scarce and farming is practised on a commercial basis. Water use efficiency is high under this system. Although it has high initial cost, if the farming operation is done as a commercial enterprise, the system is likely to be economically viable. Besides, this system of water delivery is environmentally sustainable.

Semi-demand. This is a much more realistic proposition, in which farmers indent for water a few days before it is needed. Management has to be quick in drawing up schedules and implementing them. For this to be possible the canal system has to contain enough control structures to give the flexibility needed. This system of water supply is now regarded as the standard that should be achieved in most irrigation schemes in developing countries.

Rotation. This can begin at secondary canal level and carry on right down to the farm turnout, where a set quantity of water is delivered over a specified period. Rotation of water supply within a farm unit is normally vested on the farmers themselves who may carry out the function collectively through Water Users Associations. Rotation helps in avoiding standing water in the fields for prolonged periods and there by reducing the risk of vector breeding in agricultural areas. However, in rice paddies, the practice of rotational water application still remains much to be desired.

2.6.2 Headworks for gravity supply

Attention is being confined here to small dams and simple diversion structures. The basic materials for these are embankment fill (earth or rock-fill) and concrete (usually unreinforced).

With dams, small or large (over 30m high), the choice of material and type of structure depend on foundation conditions, valley shape and spillway consideration. The latter are dominated by the flood hydrology of the river or stream. A small concrete dam on a flashy stream can be vulnerable to overturning or sliding, or being breached, if it is an embankment structure. If inadequate spillway capacity has been provided, there is little that management can do in case of dam failure but make speedy arrangements for rehabilitation. When the structures are equipped with gated spillways or crests, advance flood warning gives operators a chance to make adjustments. Passing of silt-laden, early storm waters through the structure as fast as possible is here a sound procedure.

A very important aspect of design and operation of headworks is silt exclusion. With integrated river basin (catchment) development, the prime objective should be the prevention of soil erosion through catchment protection measures, not only to minimise siltation behind structures, but also to safeguard upland agriculture. In the mean time, silt-excluding devices, ranging in sophistication from simple settling basins to vortex tubes, can be introduced at the appropriate cost. On small systems, the simple expedient of clearing silt by hand may still be a viable practice.

Reservoirs are potential breeding sites of aquatic disease vectors, particularly along the fringes where vegetation and stillness of water create an ideal breeding environment. Appropriate design, operation and reservoir management practices can reduce this potential health hazard.

2.6.3 Pumping units in general

To avoid undue repetition, some general comments will be made here on pumping equipment as a whole. The first concerns the choice between electricity and diesel/petrol for the prime mover. In developing countries, where, even where electricity is available, power cuts may make the use of electric energy for pumping unreliable. The extent to which this is critical depends on water storage possible within the system. In irrigation,the soil acts as an additional water reservoir; in water supply this has to be constructed. If, for the above reasons, the diesel option is selected, it should be borne in mind that deliveries of the fuel can also be erratic and sufficient fuel storage is essential.

There is also the key question of maintenance and the related problem of spare parts. In rural areas of developing countries it is more likely to find local mechanics familiar with diesel engines, through work on tractors, trucks or buses, than skilled electricians. Larger projects can, of course, have their own specialist staff.

The second point refers to comments, made in the context of economics, on long-life and short-life capital investment. Mechanical and electrical equipment has to be replaced periodically. If good maintenance is assured, then units can be made to last.

When mechanical and electrical equipment is imported, it is a good policy to strive for a degree of standardisation. Exporters compete for custom, sometimes making it interesting for their products to be specified in designs, thus distorting what at first appears as a free market. The result can be a proliferation of makes and models, with no adequate back-up of spares and service. In this context, tied aid can have similar effects. Shortages of foreign exchange, which are frequent in developing countries, suggest that a locally made or assembled product, may prove a more sustainable solution.

Another distortion may occur as a result on subsidies or taxes on the equipment and on energy. This makes it difficult to make rational decisions, especially at farm level, where they are made in financial and not economic terms.

2.6.4 Pumping of surface water

Since for irrigation the quantities of water pumped are large (it is not unusual to demand some 15 000 tonnes of water per hectare over the growing season), most of such pumping would be classed as low-lift. The energy costs for higher lifts would probably render the project uneconomic. When designing the pump station to handle the required volume of water, there is always the choice between a smaller number of larger units and a larger number of smaller ones. The latter is usually preferred since it gives more flexibility for meeting peak demands and also provides a better stand-by facility in case of breakdown. Experience tends to indicate that breakdowns are less frequent when units operate at lower rpm.

Exclusion of silt from the pump intake is important, especially when the silt particles are highly abrasive. Otherwise, the life of the pump (notably the impellers) is severely shortened. Judicious location of the intake with respect to stream currants is critical.

2.6.5 Groundwater lifting

It is relevant to mention at the outset that capacity of wells is much more limited than that of surface water. If one takes and indicative hydromodule of 1 litre per second per hectare, then even a large tubewell yielding 100 l/s will irrigate no more than some 100 ha. The community of irrigators will therefore be small and able to exercise control over the system from water source to the field.

Division is usually made between shallow wells, of a depth less than 10 metres and medium to deep wells of over 10m.

Shallow wells are usually hand-dug or bored, using simple devices which may not require mechanical power. From the maintenance point of view, wells that are lined (with concrete, sheet metal or plastic) present fewer problems. If, as is most likely, water from the well is also used for domestic purposes, then the well-head should be raised above ground and covered to prevent pollution from the farmstead.

Water from shallow wells can be raised using a great many devices, some going back to antiquity. The simple, traditional units are, through familiarity, the easiest for the local community to maintain. Considerable effort has recently been directed to design of hand-pumps which can be installed and dismantled by the users.

Simple, often portable, pumping sets are introduced when they can be afforded. Here it is not always recognised that farmers need good, impartial advice on what equipment to purchase. Standardisation of equipment, and hence of spares, as well as co-operative bulk buying, reduce the costs and problems of maintenance.

When considering village-level installations, it is now prudent to include solar-power in the list of options. Technology here is moving apace, so the price of units is coming down, and maintenance costs are very low.

Deep wells, commonly referred to as tubewells or boreholes, demand a skilled team to construct. The well has to be drilled, the liner and filter placed in position, the pump set installed and the well developed before being commissioned. Decisions on whether or not to invest initially in better quality equipment for longer life and easier maintenance depend to some extent on who owns the well. For at least a generation, debate has been rife on the relative merits of public and of private tubewell development. The greater attention to good maintenance that the private owner is prepared to give, is now recognised as a distinct advantage. Here, too, careful selection of equipment is crucial.

When deep wells are used for irrigation, the use of such wells to supply drinking domestic needs to farm workers and rural families should be considered. The major criteria will be the quality of the water for such purposes. Often, water from deep aquifers meet the required standards. If water quality meets the required standard, certain wells should be reserved to meet human water needs and appropriate water supply and treatment systems should be incorporated into the irrigation scheme.

2.6.6 Conveyance to project area

Depending on the size of the project, one is here referring to the primary and secondary system, comprising the conveyer itself and associated control structures. On smaller projects conveyance may not necessarily be in excavated canals, but in pipes or precast flumes (canalets). For simplicity, conveyance systems can be divided into three types: (i) unlined canals, (ii) lined canals and flumes and (iii) closed conduits (pipes).

Unlined canals are the simplest to build: even large ones can be constructed with manual labour. Their lower capital cost is offset by higher maintenance costs. Well constructed and well maintained they can perform very satisfactorily. Maintenance, too, can be done manually, but usually draglines and graders are used. The major maintenance programmes require canal closure and have therefore to be fitted into the farmers' cropping calendar. When in fill, overtopping must be avoided as it can cause great damage.

In general, unlined canals present a high degree of health risk for the following reasons: schistosomiasis can breed under low velocity of water flow; weeds that grow both on the bunds of the canals and inside the canal create an ideal environment for vector breeding; and seepage from unlined canals may create permanent water spots on lower areas and create additional vector breeding sites.

Canal lining can be achieved with a variety of materials. Unlined canals with excessive seepage losses can be sealed using buried plastic sheet. But this measure does not alter their other characteristics - in fact, mechanical cleaning is more difficult as the plastic liner can be easily damaged. Where materials

and skills exist, canals can be lined with brickwork (southern Asia) or flagstones (China, Peru). The advantage here is, apart from giving employment to the local population, that repair work can be done easily using the same local skills.

But the most common canal lining is that of unreinforced concrete. The quality of construction is crucial to its subsequent behaviour. Cracks can easily develop where concrete has been laid on a poorly consolidated base. These and badly formed construction joints can result in as much leakage as from an unlined canal. Repair of the concrete requires considerable skill, especially when long canal closures are to be avoided. If silt is deposited in the canal, its removal usually involves manual labour, since mechanical equipment could damage the lining.

Canal lining is a good solution to reduce vector-borne disease problems in many irrigation schemes. It is particularly effective in reducing schistosomiasis infection.

Precast concrete flumes (canalets), supported above ground on precast concrete piers, have become a feature of the Mediterranean landscape since the 1950s. A weakness of their concept is that it approached single-mindedly the irrigation part of agriculture, ignoring the problems they created for mechanised agriculture. When constructed with due care they perform well hydraulically. But the not uncommon leaks at joints can weaken the pier foundations, causing collapse. Replacing canalet units requires access for drainage.

Open conduits as a whole have two negative features: they and their access roads occupy valuable commanded land and they also tempt illicit abstractions of water. Buried pipes with outlets at the farm gate do not present these problems. If silt is excluded at the inlet and/or flow is fast enough to move the silt pipe networks require little maintenance. Manufacture of concrete pipes is easier than of canalets, which are now being replaced by pipes in a number of countries (e.g. Spain). In some more advanced economies national (Israel) or district (France) pressurised irrigation water grids have been established, allowing direct use of mechanised application methods on farms.

2.6.7 Distribution within the project area

From the engineering point of view the distribution system at tertiary level can easily be of the same kind as upstream. But as it is increasingly likely that the O&M will here be entrusted to a locally-based organisation, the technology should aim to make O&M as trouble-free as possible, especially when the community is new to irrigation. By the simple geometry of the wetted perimeter, seepage losses increase as one goes down the system. So lined canals, or, better still, concrete pipes should be encouraged in this reach. These could easily be made locally. This is the level at which tube wells deliver to the system their more expensive water, which should be distributed with minimum loss.

2.6.8 Control structures

Control points, such as regulators, distributors, valves or metres, have to be established within the system to enable management to operate it. A great deal depends here on what the contractual arrangements are, or should be, between agencies responsible for water deliveries within the system. Broadly speaking,two basic methods of operation can be distinguished: Upstream control and downstream control.In general, the upstream control method is used for continuous or rotational deliveries, while downstream control is normally chosen for on-demand practice. Microcomputers have now made it possible to model the hydraulics of an irrigation network, so that hydraulic and crop data received from key locations can be used for decision-making on water releases. This is especially useful in times of water shortages, when an efficient and equitable distribution of a limited resource is important.

Control structures and measuring devices can be operated manually, or with any degree of automation, depending on management's wish to substitute capital for labour, especially when the latter is not too

reliable. There is, in fact, a body of opinion advocating a reduction of the level of skills required by using simple control devices not requiring careful adjustment (e.g. proportional distributors). This may be correct in the short run, but, looking ahead, planners should feel an obligation to create skilled jobs in the rural sector. To describe what technologies are available would take volumes. Suffice it to say that at our stage of science and technology pretty nearly everything is possible, but at a price.

2.6.9 Field application

This is an area of greatest diversity, which ranges from the watering-can to climate controlled, automatically irrigated greenhouses. This is also where the greatest losses of water can occur, application efficiencies varying from as low as 20% for wild flooding of fields to as high as 75% - 85% for mechanised methods, such as sprinkler, micro-jet or drip, and also for the humble watering-can, where efficiency is the result of human energy conservation.

With O&M at this level of the system being in the hands of the farmer or estate manager, decisions on investment in technology are largely made from the commercial standpoint. In more advanced economies the dominant factor may even be the tax laws and/or subsidies, when a good (creative) accountant is more useful than an agricultural economist.

Technologies here can be roughly grouped into three categories:-

- surface methods not requiring mechanical equipment (e.g. flood or spate spreading, basin, border check,furrow)
- surface methods assisted by mechanical equipment (e.g. siphons with furrow, gated pipe, surge)
- micro-irrigation (sometimes called localized irrigation, e.g. drips, bubblers, micro-jets)
- overhead irrigation (from hand-move to fully automatic linear-move or centre-pivot sprinklers).

The last requires water under pressure and hence pumping equipment, comments on which have already been made.

When mechanisation of irrigation is discussed, it is useful to bear in mind that other parts of the farming system are quite likely to be mechanised already. Advice on the appropriate water application method and on the most suitable equipment for it, as well as for other farming activities, is very important. An official seal of approval for equipment would be a
safeguard against unscrupulous selling practices.

A number of improved irrigation technologies have been developed and tested recently. An example is the Low Energy Precision Application (LEPA), which consists of a low pressure moving irrigation system, such as modified center pivot system or linear-move system, where sprinkler heads are replaced by drop tubes which deliver water close to the soil surface. Water application efficiency under such a system is very high. The system also has minimum environmental and health impacts.

2.6.9 Drainage

The drainage network can be seen as a mirror image of the irrigation system. Infield drainage is nowadays achieved through horizontal pipes (ceramic, concrete or plastic) laid in trenches and surrounded by suitable filter material. Their maintenance is the responsibility of the owner of the field. If the drains are properly laid, all that is basically required is regular clearing by rodding or jetting.

The main problems are encountered on the network of collector drain, into which the field drains discharge. Such collectors are normally open, unlined channels, the hydraulic characteristics of which can be greatly affected by siltation and weed growth. The latter is greatly enhanced by nitrates leached out

from fields where excessive applications of excessively subsidised fertilizers have been made. The resulting retarded flow can often drown the field drain outlets and turn the field drainage into unwanted sub-irrigation. In flat, alluvial areas, where gradients are insufficient to carry the discharge by gravity, the main drainage system may have to include pump stations. These, though low-lift, have the same O&M problems as previously discussed.

Lack of drainage and or poor drainage maintenance have contributed to significant environmental and health problems in farming areas. Drainage is considered a manor environmental modification measure in vector control.

2.6.10 Roads

This item can easily be forgotten in this context, on the assumption that it will be seen to by the Roads Department, or equivalent. Intensive agriculture needs a viable road network within the project and it falls on the management to maintain it. However, equipment for road maintenance could easily be shared at local level with the district Roads Department, or the latter could be sub-contracted to carry out such work.

3. Areas for inter-agency collaboration

Inter-agency collaboration on technological aspects on O&M of irrigation projects can be achieved by two parallel and concurrent approaches. The division is based on the primary objectives of the two approaches.

approach 1: O&M technology to improve water use efficiency, local adaptability and cost-effectiveness;

approach 2: Evaluation of and improvements to O&M technology from the point of view of health and environmental safety.

3.1 O&M Technology to improve water use efficiency, local adaptability and cost effectiveness

Within the UN System, FAO, UNDP and the World Bank would be the logical partners to pursue activities under this approach. The partnership is further strengthened by the fact the FAO's International Action Programme on Water and Sustainable Agricultural Development (IAP-WASAD) and the World Bank-UNDP joint International Programme for Technology Research in Irrigation and Drainage (IPTRID) have common goals in this regard. IPTRID had identified the following areas for technological research and development in O&M:

- aquatic weed control - evaluation of mechanical, chemical and biological controls;
- testing and evaluating weed cutting and desilting machinery for channels;
- guidelines for cost effective operation and maintenance of drainage systems;
- developing an understanding of the irrigation system aging process;
- developing techniques to remove sediment from channels;
- design of low maintenance control and measurement structures; and
- operational research study for optimal maintenance of scheme structures, pumps, roads, drains and canals.

The National Action Programmes formulated under the FAO's International Action Programme have identified the following areas for research and development in O&M:

- **in Egypt:** Control of seepage losses in the Nubaria and Ismalliah canals through appropriate O&M and other measures;

- **in Indonesia:** Farmer participation and cost recovery for sustainable O&M in irrigation.
- **in Turkey:** Computerized systems for scheduling and organizing O&M activities.
- **in Zimbabwe:** Improving O&M of irrigation projects through assessing irrigation system performance.

In addition, FAO's regular programme in water resources development and management includes a priority area, namely improving water use efficiency, which encompasses research and development in O&M.

3.2 O&M technology from the point of view of health and environmental safety.

FAO, WHO and UNICEF are ideal partners for inter-agency collaboration in this area of O&M. Inter-agency collaboration on agricultural water development and water-borne diseases is already pursued under the Joint WHO/FAO/UNEP/UNCHS Panel of Experts on Environmental Management (PEEM). Although O&M were not specifically studied and or evaluated by PEEM, the impact of irrigation water management on the incidence of vector-borne diseases has been extensively dealt with.

UNICEF has particular interest on rural water supply and sanitation and there is ample opportunity to link agricultural water supply with rural drinking and domestic water supply during planning, implementation, operation and maintenance phases.

3.3 General conclusions

Well established methods of harnessing the water resource, taking it to the farm and applying it to the land, can result in efficient and cost-effective projects. Much can be gained from such experience, but although transfer of information is becoming increasingly simple, mechanisms often do not exist for it to reach the people who can benefit from it. Inter-agency programmes could do a lot to help in this respect. Hands-on training of nationals from one country in another, similar country, where O&M problems have been successfully tackled, should be promoted through field level inter-agency activities.

Mention has been made above on more than one occasion of the need of good, impartial advice on procurement of mechanical and electrical equipment for O&M. This could be done on a regional basis, if more appropriate. UN agencies, could well act as a catalyst in this activity, taking into account the possibility of local production and regional trade.

Collection and analysis of data, setting-up of data bases and transfering the data and information through appropriate networks are relevant areas for inter-agency collaboration. Comparisons of technology and costs of irrigation application methods across the world are a case in point. Another could be the evaluation of the O&M structure in various countries (e.g. Mexico, the Philippines, Iran, Nigeria).

Much has been said and written about coordinating and promoting research in irrigation and water resources development in general. What is needed is adequate funding of proposals for research, after their careful scrutiny. The UN may not be to undertake the funding itself, but it could act as a clearing house for such proposals, directing them to international, national or private sector funding possibilities. But even today it is not appreciated how much serious research goes on in this subject. Would it be too much to ask for summaries of all reports and doctorate theses to be deposited centrally with the appropriate UN agency, so as to join the traffic on the information super highway of the future? It would be good to know what is already known.

Co-operation and Co-ordination between External Support Agencies in Namibia

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1. Introduction

The purpose of this consultation, the 2nd Technical Consultation on Integrated Rural Development is to discuss United Nations Interagency Co-operation in the water sector with respect to integrated rural development.

The various UN agencies involved (WHO, FAO, UNDP, UNICEF, and the World Bank) all have their distinct goals and objectives and regularly undertake evaluations to discover how effective their programmes and projects are to the benefiting country.

The objective of this case study is to give the perspective of UN assistance from the viewpoint of the recipient country, in this case Namibia. The paper will discuss how the Department of Water Affairs in Namibia which has the sole mandate for water resources in the country perceives the assistance and performance of the UN agencies. As such the viewpoint is very self-centred and may only reflect the particular circumstances in the water sector of Namibia.

2. Donor assistance

Namibia gained its independence from South Africa in 1990. Since independence the country has undergone profound social changes as the government seeks to correct the social and economic imbalances of South Africa's 75 years of rule. Namibia is a semi-arid country and water is the key to economic development and to the existence of the rural people and their livestock. In Namibia, management of the scarce water resources in a sustainable and environmentally sound manner is a priority. Recognition of the importance of water to the country and its vital role in economic and social development has been given by external support agencies. Table 1 depicts donor assistance to the Department of Water Affairs since 1991 through to 1997. The amounts provided until 1997 reflect the firm commitments which are in place at present. However additional resources may be forthcoming in the next 2 years or so.

As can be seen the bilateral agencies provided significant amounts of assistance to the sector. The UN system has contributed a little over 2 million Namibian dollars out of an overall grant and loan, balance of about 300 million. The major donor have been Germany, the Netherlands, Japan, the European Union and France. Germany alone has given over 200 million dollars.

3. Local perception of United Nations assistance

With such a relatively small programme in place in the water sector it is perhaps not very realistic to draw many conclusions from the Namibia case. However, some comments can be made based on the perceptions of the Department of Water Affairs. These fall under the broad headings of:

1.Commitment and interest

2.Staffing levels and bureaucracy

3.Development approach

4.Co-operation and co-ordination between UN Agencies

Table 1. Donor Assistance to Department of Water Affairs (grants, loans and pledges)1991-1997

Country	Grant (N$)	Loan (N$)
Germany	183,15 million	17,8 million
France	23,40 million	
Netherlands	64,29 million	
European Union	6,32 million	22,8 million
Finland	20,37 million	
Sweden	611,800	
Japan	24,00 million	
India	2,30 million	
Luxembourg	1,43 million	
Belgium	20,000	
UNDP	100,000	
UNICEF	2,14 million	
African Development Bank	8,30 million	
USA	2,59 million	
International Red Cross	1,11 million	
Canada	800,000	
TOTAL	**240 million**	**40,64 million**

Table 1 does not include contributions in form of volunteers from Germany, USA, UK and Belgium.

3.1 Commitment and interest

The water supply and sanitation sector receives assistance from various government and non-government institutions. In order to streamline this assistance the Water and Sanitation (WatSan) Forum was established to coordinate activities of non-government organizations and a number of bilateral donor agencies. This committee meets on a regular basis to discuss common issues in the sector and to give advice to government. Although the United Nations Agencies are members of the WatSan Forum, the only agency which regularly attends and participates is UNICEF. WHO and UNDP rarely participate and when they do they are usually represented by junior members. Why the agencies with the exception of UNICEF choose to accord a low priority to this important committee is not readily apparent. A Water Supply and Sanitation Policy (WASP) approved by the Namibian Government in 1993 calls for the establishment of the Water Supply and Sanitation Co-ordinating Committee (WASCO) whose Water Supply and Sanitation Co-ordinating Committee functions overlap somewhat with those of the WatSan Forum. Policy implementation will be more effective if UN Agencies contribute and participate in the future. The general impression given to the host country at present is of a lack of interest and commitment by UN Agencies to providing long term solutions to the problems of the water and sanitation sector.

3.2 Staffing and bureaucracy

Relative to the amount of funds being committed the United Nations Agencies seem to have a disproportionate number of staff. Their levels of staffing as contrasted with the major bilateral donors appears high when equated with the amounts of money being managed. KFW for example which give support in terms of tens of millions of Namibia dollars each year has no personnel based in Namibia.

3.3 Development approach

In the water sector the perception is that the approach is fragmented with small amounts of money being given to a variety of disparate activities. It is difficult to see how these activities fit into an overall development programme.

One reality is that small programmes can often involve almost as much management effort as large ones. The result of having many small efforts is that there is disproportionately high level of staff to manage projects.

3.4 Co-operation and co-ordination between United Nations agencies

In Namibia the United Nations Agencies are geographically located very close to one another. The major agencies co-exist in the same office building. From an outsider's view however it does not appear that there is close co-operation and co-ordination or support between the various agencies. For example last year the DWA organized with INSTRAW a training workshop on Women, Water Supply and Sanitation. The various United Nations donors were invited to the opening and the seminar but were conspicuous by their absence. The UNDP office which acted as the contact point between INSTRAW and DWA was helpful but did not appear to be enthusiastic about this very significant workshop.

To summarize the overall impression which the various United Nations Agencies give is of a fragmented approach to development, little co-ordination and collaboration, a high staff involvement and a concern with managing their own specific activities.

The Experience of Turkey

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1. Introduction

Agenda 21, Chapter 18, states that " *All states, according to their capacity and available resources, and through bilateral or multilateral cooperation, including the United Nations and other relevant organizations as appropriate, could implement certain activities to improve integrated water resources management.*" Turkey has made progress in some of the activities of this field in accordance with its capacity and its available resources.

The institutional and managerial progress made in the field of irrigation in Turkey will be explained in this paper after an overall picture of the irrigation sector is presented. It may provide a good model for other countries, ut it should be kept in mind that every country should find its own model, taking into account all national resources and their interdependencies as well, after studying tested models.

Turkey is located in the semi-arid zone. It is subjected to a continental climate with varietions in different parts of the country. Distribution of precipitation is quite uneven, ranging from less than 250 mm in inland areas to over 3000 mm in eastern Black Sea region; the average annual precipitation which is 643 mm.

Turkey covers a total area of 77.95 billion hectares, out of which are 28.05 million hectares agricultural, 21.5 million hectares pasture, 23.2 million hectares forestry, 1.2 million hectares water surface, 0.8 million hectares residential and 3.2 million hectares are non-agricultural areas. The country's population is 60 million (1990 census) with an average growth rate of 2.2 percent.

Economic planning in Turkey is carried out in the framework of Five Year Development Plans and public investments made according to annual programmes. Both plans and programmes are mandated by law and prepared by the State Planning Organisation. The VI Five Year Development Plan (1990-1994) was completed and after a one year transition period the VII Five Year Development Plan is underway. Ever since the cycles of development plans started in 1963, the agricultural sector has been subsidised and guided by the government.Development planning gives priority to the country's industrialization and progress in the agricultural sector has, therefore, been less than in the industrial sector. Cereals production doubled, pulses and oil seed production increased by 3.5 times, industrial crops production increased by 2 - 4 times and fruits and vegetable production increased by 10 times. The share of the agriculture sector inthe GNP dropped from 41 % in 1960 to 14 % in 1993.

Five-year development plans aim at ensuring the optimum distribution of resources among various sectors of the economy. As an important element of the country's development activities, agricultural development projects should be consistent with the overall development plans. It is important to integrate programmes at national level and to evaluate all projects from a national viewpoint.

In water resources planning, whole river basins are studied in reconnaissance and/or master plan level and feasibility studies are carried out for each separate project within the basin. Water resources plans must cover requirements considering sectoral and inter-sectoral balances, socially and economically, as well as balances between all users within each sector.

The average annual run off in Turkey is 186 billion cubic meters and the safe yield of ground water is 12 billion cubic meters per annum. Half of the safe yield of ground water is consumed. Although total water resources of the country amount to 198 billion cubic meters,because of technical and economical

reasons only 107 billion cubic meters may be considered for utilization by development projects. An evaluation of the country's water resources along with the soil resources and the population clearly demonstrates that , in comparison with other countries, Turkey is not a water rich country.

Irrigation projects are developed and implemented by two public organizations, consistent with annual programmes. It is important to develop, finance and construct an irrigation project, but it is even more important to operate and maintain the irrigation scheme properly to reach the goals of the project.

2. Policies and strategies

Although industrialization is given priority over agricultural development, government policy encourages the development of large-scale irrigation schemes and small-scale schemes in marginal areas. Irrigation is still considered a good instrument to reduce unemployment and increase income levels of the rural people. Irrigation development alsohelps balancing the income levels between regions. Since the income in rural areas is not enough, unskilled people migrate to large cities and as a result social and infrastructural problems occur. Self sufficiency in food at local, regional and national levels is another factor in support of agricultural development.

Limited financial resources for the development of both soil and water resources and for the operation and maintenance of existing schemes force the government to find solutions, using modelsof self financing. Inadequacy of water resources where they have been developed to their full extent, or drought or insufficient management at all levels also forces the country to review and, if necessary, improve the existing system.

A number of agencies have a direct or indirect interest in land and water resources development and conservation. The agencies responsible for irrigation are mainly the General Directorate of State Hydraulic Works (DSI), the General Directorate of Rural Services (GDRS), and the Ministry of Agriculture and Rural Affairs (MARA) and they will be introduced in Section 3. Existing and improved strategies and policies in development and operation and maintenance of irrigation schemes are given below.

2.1. Water resources management

In the recent years all countries of the world have started to realise the importance of water resources management for their sustainable development. It is well understood that water is a finite resource which is becoming scarce and more expensive to develop.Population increase and rising living standardslead to a greater water demand. Contamination of water resources by industrial effluents, chemicals, untreated sewage disposals etc. detoriates water quality.The environmental impact of water resources development projects either increase unit cost of water or even prevents projects from being implemented; this clearly indicates the importance of water resources management including quality management.

On the other hand, integration of environmental issues into water resources development projects also depends on the economic capacity of the country. Introducing standards applicable for developed countries will impose a burden on developing countries that have newly stepped into the structural transformation and industrialization. So, comprehensive water resources management should be integrated with economical, social and environmental issues to reach the optimum goal.

Studies for the development of water and soil resources started in Turkey in the early 1930s in parts where technical and economical capacities were limited. Water resources management was demand-oriented from the start, has been parallel to national development targets.Technical and scientific approaches and basin-wide studies started in the late 1940s and accelerated with the establishment of relevant institutes such as DSI and GDRS. DSI is the main institute responsible for water resources. Allocation of water to sectors and ground water licensing are under the responsibility of DSI. Water uses and requirement for different sectors are given below in Table 1.

Table 1. Water use in Turkey

Year	Total Water Use (km^3)	Development Percentage (%)	SECTORS Irrigation (km^3)	(%)	Water Supply (km^3)	(%)	Industry (km^3)	(%)
1990	30.6	28	22.0	72	5.1	17	3.4	11
1995	40.2	37	29.5	74	6.4	16	4.3	10
2000	46.5	43	34.9	75	6.9	15	4.7	10

Following the transportation and energy sectors the water sector is the third largest in terms of public investments. The size and capital intensive characteristics of water resources development projects, especially in a climate of of financial constraints, emphasise the importance of water sector in the national economy. The development of irrigation projects is very important from water allocation point of view since irrigation consumes 74 percent of total water use in the country. Irrigation development in Turkey is presented in table 2, below.

2.2. Irrigation Development

Uneven distribution of rainfall within the year and between years necessitates water application to crops to increase the yield. Since the cultivated area reached to the total cultivable area of the country in the year 1970s and the area for rain-fed agriculture is limited, the development of irrigation projects is crucial to increase the agricultural production.

The total irrigable land in Turkey is 25.85 million hectares and one third of it (8.5 million hectares) can be irrigated by technically and economically feasible projects. There are 26 main river basins in Turkey and basin-wide master plans for development of water and soil resources are prepared for all major rivers. All large scale irrigation projects have been studied at reconnaissance, master-plan or feasibility levels, or at all levels if necessary.

Irrigation development is carried out by the public sector and the private sector (farmers and farmer groups). The public organisations are The General Directorate of State Hydraulic Works (DSI) and the The General Directorate of Rural Services (GDRS). DSI is responsible for large-scale projects and GDRS for small-scale projects and on farm development of all projects including DSI projects.

By the end of the 1994 the total gross area under irrigation is 4.27 million hectares which is half of economically irrigable (see Table 2, below). Approximately 10 percent of total irrigated area, 0.45 million hectares irrigated by ground water by the projects jointly developed by DSI and GDRS. The areas irrigated by the projects developed by DSI during the period 1950-1994 are given in Figure 1.

It is evident that Turkey is halfway in the development of irrigation projects. There is a high demand for irrigation projects from people who live in rural area since irrigation projects increase their income and living standard. Farmers are convinced it is the only way. Since 1960, there is a rapid increase in irrigated area.

Table 2. Irrigation development (By the end of 1994)

Organisation	Net Irrigated Area (hectares)
DSI	1 562 000 00
GDRS	902 000 00
DSI & GDRS jointly	270 000 00
Public	1 000 000 00
Total	3 734 000 00

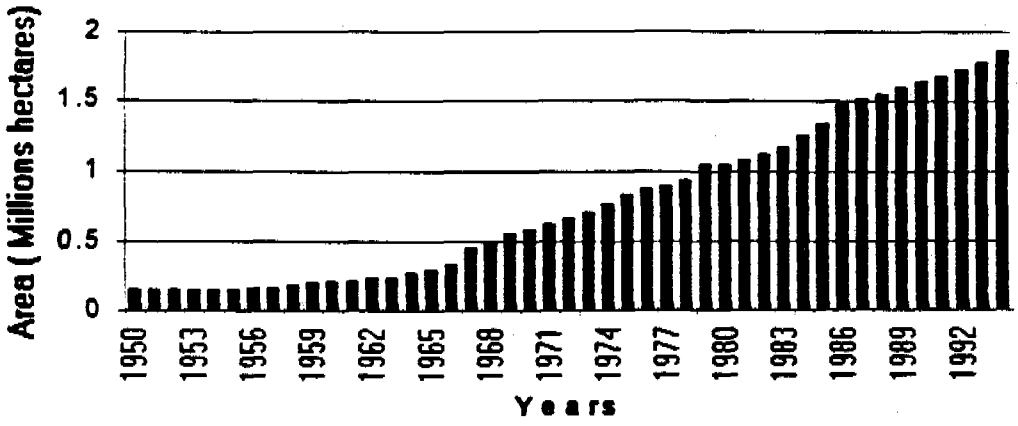


Fig.1 Development of area irrigated by DSI's projects

Irrigation projects are mainly financed from public funds. The average unit cost of irrigation projects increased from 3 200 $/ha to 4 300 $/ha in period of 1982-1992. The unit costs have risen as a result of heavy investments in the large-scale Southern Anatolian Project (SAP) and other projects selected for development. Future unit costs will not drop since remaining projects have a lower IRR because of technical difficulties and environmental concerns.

2.3. Operation and Maintenance

The purpose of operation is to distribute water for irrigation in an equitable way to users through a distribution system and various outlets. The purpose of maintenance is to let irrigation water flow in the system optimally for the smoothest possible operation.

As stated before DSI and GDRS are responsible for development of irrigation projects. DSI is also responsible for operation and maintenance of the irrigation schemes developed by it according to establishment law, but GDRS has notbeen given the legal responsibility for operation and maintenance. Operation and maintenance activities of DSI are explained below.

By the end of 1994 net 1 832 006 hectares were under irrigation in projects developed by DSI. Out of that area net 345 290 hectares are irrigated by 283 irrigation cooperatives with ground water; the rest by 1 320 irrigation schemes with surface water. DSI operates net 1 188 534 hectares with the remainder transferred to the users. The irrigation area operated by DSI will decrease rapidly in the near future as a result of its successful transfer programme.

The operation and maintenance of irrigation schemes is performed either directly or under contract by the Department of Operation and Maintenance at DSI Headquarters in Ankara and by the units under 23 regional directorates all over the country. The number of permanent staff for operation and maintenance is about 3 850 and seasonal staff about 5 200. The operation and maintenance activities are carried out with machinery, equipment and vehicles of DSI and in some cases are tendered to local contractors. DSI also has workshop facilities for the maintenance of machinery.

DSI is increasing the area under irrigation annually by 60-70 000 hectares. This puts the Operation and Maintenance Department under pressure to maintain a satisfactory level services in the future years with declining staff, equipment and budget. The cost of operation and maintenance for the year 1994 was 1 141 billion, or 961 000 TL per hectare. The total budget allocated for operation and maintenance for the period 1985 - 1994 is given in Table 3. During that period the percentage of coverage (allocation) of the required budget decreased from 65 percent to 49 percent. The share of maintenance expenditures in allocated budget decreased from 50 percent to 25 percent, mainly because of the rapid increase in staff cost. In general, the budget allocated for operation and maintenance activities is insufficient for adequate operation and maintenance activities and insufficiency is increasing every year.

Table 3. Operation and maintenance expenditures for irrigation schemes operated by DSI

Year	Net Area Irrigated (hectares)	Operational expenditures (million TL)	Maintenance expenditures (million TL)	Total O&M expenditures (million TL)
1985	1 060 440	10 426	9 374	19 800
1986	1 115 240	14 563	12 675	27 238
1987	1 156 990	14 690	17 347	32 087
1988	1 201 340	19 345	21 890	41 235
1989	1 231 100	53 626	25 174	78 800
1990	1 251 251	85 171	41 328	126 499
1991	1 269 571	160 395	66 217	226 612
1992	1 300 561	237 009	97 439	334 448
1993	1 341 495	503 504	184 536	688 040
1994	1 188 534	853 299	288 309	1 141 608

Note :Energy costs are included

2.3.1. Operational activities

The net area of irrigation schemes and the area irrigated are given in Table 4 for the period of 1950-1992. The irrigation ratio increased from 34 to 70 percent. There is a considerable improvement in the operation of the schemes since 1950s. Users are very well aware of benefit of irrigation for increasing their welfare. Users participation and the transfer of operation and maintenance of irrigation schemes to users will also help in increasing irrigated area and irrigation efficiency.

Table 4. Irrigation ratios of irrigation schemes developed and operated by DSI

Year	Net area of irrigation schemes (hectares)	Total area irrigated (hectares)	Irrigation ratio (%)
1950	122 585	41 939	34
1960	184 750	89 283	48
1970	521 482	284 775	55
1980	755 459	493 604	65
1990	1 251 251	857 499	69
1992	1 300 561	906 802	70

The irrigation ratio varies from one region to the other and from project to project. The reasons for low irrigation ratio are the following:

because of variations in climatic conditions and cropping patterns there may not bethe same irrigation water demand every year. The size of land may not be suitable for irrigated agriculture if there is no land consolidation. There may be improper irrigation scheme design. There may not be proper drainage system and land levelling. There may be improper management. The project is not a good investment if there is not enough demand by the users for the project, and also the output of the project is not satisfactory. The reasons and their percentages for low irrigation ratios in irrigated areas developed and operated by DSI for the year 1992 are given in Table 5.

Table 5. Non-irrigated areas in irrigation schemes for the year 1992 (Reasons and their percentage)

Reason	Non-irrigated areas (hectares)	Irrigation ratio (%)
Lack of water	32 250	6.8
Insufficiency iof the scheme	36 133	7.7
Drainage and salinity problems	31 969	6.8
Land levelling problems	24 121	5.1
Sufficient rainfall	120 026	25.4
Uncultivated areas	75 671	16.0
Pasture (non-irrigated)	23 951	5.1
Irrigated by Other Water Resources	86 307	18.3
Others	41 239	8.8
TOTAL	471 667	100

Basically two methods, "demand" and "supply", are available for water distribution. The supply method is applied in most projects in Turkey. In large schemes, where the conveyance system requires considerable travelling and filling time, water is spilled to drainage canals.

The past 7-8 years have been a draught period in Turkey especially for central Anatolia and the shore region.This draught has helped create an awareness among all parties involved in irrigation (DSI, farmers, municipalities, etc.) about the scarcity and value of water.

The operation of open canals and flumes have some problems such as high evaporation and seepage losses compared to close conduits, difficulty in distribution and measurement of water delivered to users, high maintenance costs in cold areas where cracks occur in concrete especially at flumes and loss of energy if available between reservoir and irrigation. Taking past experience into consideration, irrigation schemes are being designed as closed conduits depending on size of irrigation, topography, cost, location of scheme and users demand.

Since water is scarce and valuable, supply management is being shifted to demand management to save water. In the recent years, regulation of consumption through demand management tools such as appropriate pricing policies, training consumers in efficient water use and conservation, and technical and operational improvements have received great attention. DSI is planning to introduce automatic discharge control devices in some existing and planned irrigation schemes to reduce water loss and to improve operation of the schemes. More sophisticat systems like remote control devices can also be used. In this respect, the study for operation of Harran main canal (capacity 84 m^3/sec) in the southern Anatolian Project (GAP) has been already done by a consultant company for DSI.

The experience in Turkey is very valuable and it helped to find correct and timely solutions suitable and acceptable for the users. Inappropriate or untimely solutions are not accepted by the users and have very low chance of success.

The existing operational activities for the irrigation schemes which are operated by DSI are given below in brief.

2.3.1.1. Water distribution activities

General Irrigation Plans are prepared by considering irrigation water requirements based on expected cropping patterns, available water supply and the capacity of the scheme. The information for preparing irrigation plans are obtained from questionaire forms. The farmers are asked to fill "irrigation information questionaires" to give information about the size of the area that they are planning to irrigate,

type(s) of crop(s) they are planning to irrigate, location of their field and name of the canal that they demand water from. Monthly water requirements and flow rates based on 24 hour flow are calculated by using the information obtained. The total water requirements are compared with the available water supply and any deficiencies and limitations in the irrigation area are discussed in the general irrigation plans which are prepared by regional directorates. The plans are controlled and amendments are made, if needed, by the Operation and Maintenance Department at Headquarters and sent to Operation and Maintenance Units in Regional Directorates.

Water Distribution Programmes are prepared on a weekly, ten day, monthly or seasonal basis depending on the climatic conditions, cropping patterns, soil characteristics and farmers habits. The programme shows the flow in the main canals during that period.

Daily Water Allocation Tables are prepared according to the data obtained from **Water Demand Cards** filled by users three days before demanding water and handed over to the Operation Engineer. The tables are prepared for tertiary canals, taking into consideration water losses in canals.

The measured flow rates and water used are recorded daily on **Monthly Water Measurement Forms** and sent at the end of every month to the Operation and Maintenance Department for evaluation at the end of irrigation season.

At the end of each irrigation season, evaluation reports are prepared by Operation Engineers for each scheme and submitted to the Operation and Maintenance Department. The evaluation reports cover applied general irrigation plan, irrigated area, crop pattern, water allocated and water used, problems encountered, impacts of users and discussion of all items covered in the report and recommendations for the next irrigation season. The reports are sent to the Operation and Maintenance Department for overall evaluation.

2.3.1.2. Water table monitoring

The water tables and ground water quality in the irrigation schemes are periodically monitored to determine the performance of drainage systems. For this purpose one monitoring well is installed for each 100 hectares irrigation area. The water table and salinity (EC) of the well water are observed once a month. By using the data collected and water table contour maps, sground water salinity maps for each month are developed for evaluation. The results obtained by monitoring and evaluation, the problems identified and recommended solutions are given in a report published every year.

In 1993, water table levels were monitored in 107 irrigation schemes covering 1 016 606 hectares and sground water salinity analyses were conducted in 104 irrigation schemes. The evaluation shows that the area with a water table depth of 0 - 1 meter, in the month that maximum irrigation water was applied, was 102 045 hectares (10 percent) and the area with ground water salinity of over 5 000 micromhos/ cm, during the same period, was 45 565 hectares (4 percent). The area having both conditions was 9 045 hectares (1 percent) only.

2.3.2. Maintenance activities

Maintenance of canals and drains includes silt removal, weed control and canal repair, flumes and structures.

The canals receive silt from irrigation water and storm water run off entering the irrigation system from adjoining areas because of improper construction and management. Silt deposits, however, in drains more than in canals. That is because of high erosion rate in Turkey, erosion of spoil banks, lack of or destruction of vegetation on banks, steep side slopes, lack of silt traps etc.

Weeds are removed by using herbicides which have no adverse impact in environment and by mechanical means in drainage canals for smooth water flow. The herbicides used by DSI are not forbidden in

most of European countries. On the other hand removal of weeds in drains may cause bank erosion and siltation. Use of chemicals for weed control is being reduced for environmental reasons.

In order to reach the goals of the project, it is necessary, among others, to operate the irrigation scheme properly. For proper operation of a scheme, successful maintenance service is essential. So successful operation and maintenance service will increase the benefit to users. Farmers are well aware of it and they are ready to share in operation and maintenance activities and to pay for them.

The weed problem in canals in coastal areas is more severe than in inland areas and the maintenance problem of flumes in the cold areas is more severe than coastal areas due to climatic conditions. The siltation problem is more severe in the drainage canals which has weak vegetation and in canals which have no proper embankment.

Maintenance and repair activities in the irrigation schemes operated by DSI are conducted following the "Maintenance and Repair Manual" developed by the Operation and Maintenance Department of DSI by adapting the USBR annual. At the end of the irrigation season (September to December) irrigation and drainage facilities in each scheme are inspected by a team and annual inspection reports are prepared by regional directorates to be sent to the Operation and Maintenance Department for evaluation. The maintenance and repair requirements and the cost of these activities are given in the report. The budget for next year 's required maintenance activities is estimated on the basis of the evaluation of inspection reports. The budget is prepared by the Department of Operation and Maintenance considering the proposal of regional directorates.

The majority of maintenance works is performed by DSI's own machinery and personnel. However, large-scale repair works are tendered to big contractors and small-scale works tendered to local contractors in some cases.

The cost of maintenance works is increasing every year with the irrigated area and the aging of irrigation schemes. As a result the increasing cost of operation and maintenance is becoming a burden to DSI and the national economy. In the case required budget is not allocated, the quality of operation and maintenance works decreases and consequently the output of the scheme also decreases and farmers are not satisfied. The share of maintenance works in whole operation and maintenance budget is given in Table 3. The decrease in the share of maintenance works is mainly because of increase in labour cost which is higher in operation works.

For **the training of operation and maintenancestaff** seminars, courses and workshops are organised by the Department of Operation and Maintenance in coordination of The Department of Technology in Ankara and in the regional directories for different levels of staff in different subjects every year. New recruits get on-the-job training also. The seasonal workers get brief introductory courses at the onset of the irrigation season. Although there is not a systematic programme at present, training courses for users in the irrigation scheme where operation and maintenance activities have been handed over are organised. In near future such courses will be organised systematically.

2.3.3. Users participation through transfer of Operation and Maintenance activities

Public participation contributes importantly to the success of development projects.It is perhaps even more important in the case of irrigation projects since farmers are living with the project. Public participation should involve all steps of an irrigation project, at planning, construction and operation and maintenance stages.

The experience of Turkey in public participation in operation and maintenance of irrigation projects is worth mentioning, both DSI's activities to transfer O&M to users as well as the informal transfer by GDRS.

The transfer of O&M activities to irrigation scheme users started in the early 1950s in Turkey at a slow pace. Until 1993 small schemes were gradually transferred to users: by then the total area transferred had reached about 62 000 hectares. Before 1993 the policy of DSI was mainly focused on transferring small and isolated schemes since they weres difficult and uneconomical to manage. In addition to full transfers DSI also encouraged users to participate in O&M activities through establishing irrigation groups with limited responsibility. By the end of 1993 about 600 000 hectares were managed by such irrigation groups jointly with DSI. The irrigation ratio on these schemes has reached 81 % compared to 67 % on the schemes run entirely by DSI.

The difficultiesencountered by DSI and the Government in the implementation of this transfer programme are the following:

- Since the 1950s farmers are experienced in irrigation and aware of benefits of irrigation. They know that a good operation and maintenance service will increase their income. Farmers have gained experience in maintenance services through irrigation groups. They also gained experience in operation service over the last 7-8 years drought period. Thus, farmers are ready to deliver operation and maintenance activities.

- The cost of routine annual maintenance activities which consist of maintenance and repair of canals, flumes, sediment removal and weed control in canals and grading of roads has been increasing and it is becoming an unbearable, unsustainable burden to DSI and the national budget. O&M cost is also increasing every year as the area under irrigation is increasing.

- Operation of irrigation schemes is also becoming a burden to DSI socially, since there is no public participation but unreasonable over dependence on DSI to coordinate everything. This has become a morepressing issue during the drought period.

- Because of the bureaucracy, DSI is under pressure to keep a satisfactory level of operation and maintenance service in the near future with declining staff, equipment and budget.

- The existing system for collection of water charges to cover operation and maintenance activities is not sufficient to cover next year's operation and maintenance budget. The collection rate of water charges is very low (37 percent). The high inflation rate also effects the collection rate negatively.

DSI is authorised by Act of its establishment to transfer any facility constructed by it to any legal entity (village legal entity, water use group, cooperatives, municipality) and person. No legal action is necessary for the transfer of operation and maintenance activities to users. The transfer policy is guided primarily by the concern that it was difficult and uneconomical for DSI to continue management. By mid 1993 with World Bank's persuasion and encouragement DSI accelerated the programme of transferring irrigation schemes. The transfer program was also supported by the government as a part of its privatization policy. Another factor for accelerating the transfer programme in Turkey was the exposure of DSI's high level staff to the transfer of irrigation districts in USA and particularly in Mexico. Considerable internal training including seminars and workshops also contributed to the process.

By the end of 1994 net 267 362 hectares have been transferred to users and it reached to 667 834 hectares in June 1995. DSI's transfer plan, its achievements and the distribution of the transferred area between users organisations are given in Tables 6 and 7. It is planned to transfer about 250 000 hectares to users before the end of 1995. At present, the transfer agreements for 115 573 hectares are at the Ministry of Public Works and Settlement and the statutes for 133 800 hectares are at the Ministers' Council waiting for approval.

Before transferring, information about the irrigation scheme and the transfer procedures is given to farmers through workshops. The users are asked for their decision concerning system transfer and they are enlightened on the procedure to be followed should they agree. The information about the types of users organizations is given in Section 3.

Table 6. DSI's transfer plan and achievement

Years	Planned		Achieved	
	Annual (hectares)	Cumulative (hectares)	Annual (hectares)	Cumulative (hectares)
1988			1 789	55 034
1989			3 386	58 420
1990			2 391	60 811
1991			257	61 068
1992			1 552	62 620
1993			9 422	72 042
1994	103 958	176 000	195 320	267 362
1 Jan-1 June 1995			400 472	667 834
1995	140 000	316 000		
16 May-31 Dec 1995			382 345*	1 000 000*
1996 - 2000	600 000	916 000		

* Estimated

Table 7. Distribution of transferred area between users

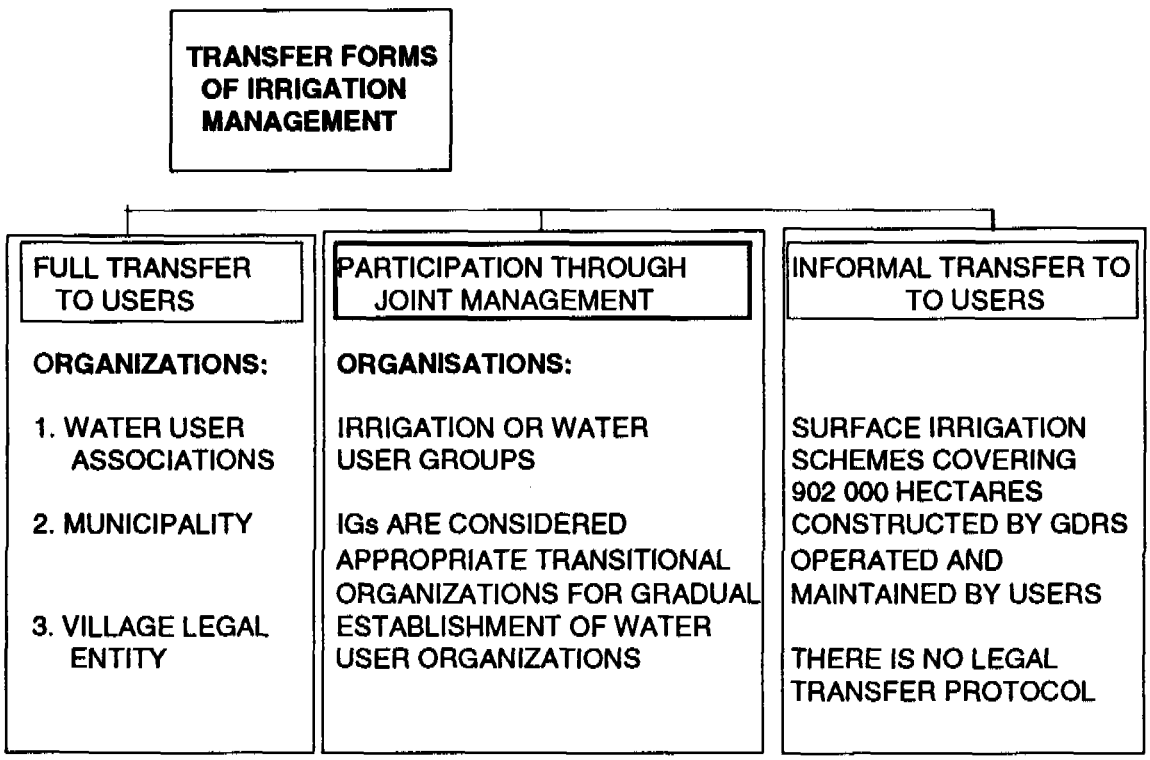
Water Users Organisations	Number	Net area (hectares)
Village Legal Entity	173	24 373
Cooperative	14	4 555
Municipality	112	43 733
Water Users Association	120	594 486
Others (University etc.)	2	687
TOTAL	421	667 834

A competition among the various regional directorates in promoting transfer and willingness of farmers are principal contributing factors to the success of the programme. DSI engineers interact directly with the local authorities, including governors, mayors and municipality councils to inform and encourage the users for transfer. But in general the transfer programme is largely demand-driven by the farmers.

Almost all associations which delivered operation and maintenance activities have elected their boards and presidents, appointed secretaries and office staff. They have established a permanent office and some acquired computers. A number of them employed an Agricultural Engineer and a lawyer and few of them purchased equipment for operation and maintenance. Personnel expenses are generally limited to 30 percent of the total budget, with the balance allocated forb other activities. In addition to water charges, the farmers are requested to pay a one-time membership fee covering the initiation of operations of the association. Most of the farmers become members of the associations.

Despite the visible success in the transferred irrigation schemes, DSI is keen to promote the need for a continuous monitoring and providing assistance to users in all related aspects. Technical, legal, procedural, and organisational assistance to users organisations is given by the DSI. At present the transfer of machinery to user organisations cannot be legally done by DSI. But some mayor maintenance works were done in the early stages by DSI as well as some other maintenance works on the basis of reasonable payment by user associations. DSI is well aware of the need and importance of the programme of transfer.

The ground water irrigation schemes developed jointly by DSI and GDRS are handed over the irrigation cooperatives. But surface irrigation schemes developed by GDRS have been transferred to users in an informal manner. The reason for **informal transfer to users** is that GDRS has no legal authority. GDRS has no operation and maintenance units within its organization. Actually it is very hard to manage the operation and maintenance activities of about 13 000 small-scale irrigation schemes. The schemes which transferred informally are operated and maintained by users under the coordination of the head of the village. But it is very hard to determine whether they are successful. The transfer form of management of irrigation schemes is given below.



Turkey's experience in transfer of operation and maintenance activities of large irrigation systems with participatory management, various types of user organisations and accelerated transfer may be a useful example and information for those countries that interested in public participation. The next step for Turkey and DSI should be to enhance the user organisations and to have larger organisations for transfer of whole irrigation projects.

3. Organization and Institutional Framework

A large number of Turkish agencies have a direct or indirect interest in the aspects of land and water resources development and conservation. These are the General Directorate of State Hydraulic Works (DSI), the General Directorate of Rural Services (GDRS), the Ministry of Agriculture and Rural Affairs (MARA), the Ministry of Environment, the Ministry of Forestry, the Bank of Provinces, the General Directorate of Electric Power Resources Administration, municipalities, Farmers Cooperatives, and Users Associations. Some of these organizations are responsible for developing projects only, others are responsible for operation only and yet others are responsible for both development and operation. The organisations responsible for irrigation projects are given below under two headings as governmental organisations and users organisations.

3.1 Governmental Organizations

There are two main organizations responsible for the development of irrigation projects, namely DSI and GDRS.

The General Directorate of State Hydraulic Works (DSI) under the Ministry of Public Works and Settlement is the largest organisation responsible for planning, design, implementation and operation of water resources developments for various purposes including large-scale irrigation, hydroelectric power generation, domestic and industrial water supply , river training and flood control. DSI is also responsible for allocation of surface water to different sectors of the economy and licensing the ground water.

DSI was established in 1954 under an Act and its responsibilities enlarged by the 1967 Ground Water Law and by the 1968 Drinking Water Supply Law. DSI has a headquarters in Ankara and 25 Regional Directorates, 56 Sub-directorates and 14 Project Directorates. There are 15 departments in the general directorate and one of them is the Operation and Maintenance Department responsible for O&M activities of all irrigation schemes through the regional directorates.

Operation and maintenance activities are being carried out in 23 regional directorates under the supervision of the **Operation and Maintenance Department** at Headquarters in Ankara. At each regional directorate there is an **O&M Section**, which is responsible for operation and maintenance of irrigation and drainage systems operated by the Regional Directorate. They are directly responsible to the Regional Director. **The District O&M Office**, headed by the chief engineer is responsible for operation and management of the irrigation and drainage systems operated by DSI in the District concerned. The District Operation and Maintenance Office is a part of the District Head Office and directly responsible to the Director of the District Office. **The Operation and Maintenance Engineering Office**, headed by operation and maintenance engineer is responsible for O&M in certain area and is directly responsible to the Head of the District Operation and Maintenance Office. In addition to above operation and maintenance units, there are two more offices on project basis. **The Operation and Maintenance Chief Engineer Office** headed by a chief engineer was established to carry out the O&M activities in medium size irrigation schemes and directly responsible to the Director of the District Office. **The Operation and Maintenance Head Office**, headed by the chief engineer was established to carry out the O&M activities in large irrigation schemes and is directly responsible to the Regional Director. It is similar to the District Operation and Maintenance Office.

Already 164 large dams and 250 small dams have been constructed and 78 large dams and 172 small dams are under construction. As explained before net 1 930 000 hectares area as 1 420 irrigation schemes is in operation and 84 irrigation schemes having total gross 662 280 hectares are under construction by the end of the 1994. DSI has totally 25 400 staff out of which 4 300 technical staff. During summer time the number of personnel, increases approximately to 40 000 by employing seasonal personnel. The total budget of DSI for the year 1995 is 1 165 million US $ and 765 million US $ of it is for investment.

The General Directorate of Rural Affairs (GDRS) which formerly was under the Ministry of Agriculture and Rural Affairs, is now under the Prime Minister's Office and responsible for rural roads, drinking water supply in rural area, communal buildings, small reservoirs and small scale irrigation schemes. GDRS is also responsible for land consolidation and on-farm development of all irrigation projects including the projects developed by DSI. GDRS can only develop the water resources less then 500 l/sec and has to get approval from DSI for larger water resources.

Small-scale irrigation projects developed by GDRS are not officially handed over to farmers and are not operated and maintained by GDRS. A total net 902 000 hectares of area is under irrigation by about 16 000 small-scale schemes developed by GDRS. GDRS has also developed irrigation networks for about 270 000 hectares area which received water from about 750 ground water wells developed by DSI, GDRS has completed a large quantity of on-farm development works. The area of small-scale irrigation schemes constructed by GDRS ranges between 30-100 hectares . Each irrigation scheme belongs to a village or a municipality and operated by farmers living in the area. The organisation for O&M of the schemes will be explained in Section 6.

GDRS has its headquarters in Ankara and regional directorates to carry out the works. Although it has regional directorates it is mainly administrated on a provincial basis. Since GDRS is not responsible for operation and maintenance it has no operation and maintenance units with its administrative framework.

3.2. User organisations

There is not a single type of user organisation. There are five different user organisation models and one of these may be used by farmers depending on the size of irrigation area, number of and administration type of settlements in the irrigations scheme and the preference of farmers. The five models are a) Irrigation Groups, b) Irrigation Cooperatives, c) Water User Associations, d) Village Legal Entities, e) Municipalities.

In general, user organisations are responsible for O&M of irrigation schemes handed over to them according to the agreement signed by the parties.

The smallest of the user organisations, **Irrigation Groups**, have been offered incentives for undertaking some of operation and maintenance responsibility to improve the efficiency. If an irrigation group agrees to organise water distribution at the tertiary level, farmers get a 20 percent reduction on their water charges; farmers get a 25 percent reduction on their water charge if they also agree to organize canal cleaning and maintenance. Reduction may be increased up to 40 percent by DSI. They have limited responsibility and as a result of it their commitment for the management of systems is limited also. If the operation and maintenance effort organised by irrigation group costs less than the reduction in water charges collected from the users, the balance of funds can be relocated for some other social projects by farmers. Establishment of irrigation groups helped to develop the skills of farms for cooperation and organized management. The irrigation groups have a tendency to change their form to water user associations after the programme of transfer.

At present there are 990 irrigation groups in irrigation schemes developed by DSI. They have no official statute. For 910 irrigation groups the Muhtar (head of the village) is leader of the group without election and for the rest the leader is elected by the users with 2/3 majority. DSI is not satisfied with the last group since they are not successful in management and collecting the water charge.

Irrigation Cooperatives are established under the Cooperatives Law and related regulations. Cooperatives are formed mainly for operation and maintenance of ground water irrigation schemes. For a legal cooperative to be formed at least 15 farmers have to make a formal request. A new ground water irrigation scheme is only undertaken after establishment of a legal cooperative. Existing surface water irrigation schemes are also transferred to cooperatives established for irrigation purpose, if asked by users.

If farmers wish to form ground water irrigation cooperative first they have to apply to GDRS. At least 24 farmer families should benefit from the cooperative. GDRS gives assistance to farms for forming a cooperative legally after receiving a positive view of DSI about developing a project. After approval of the project by the DSI-GDRS coordinating council the ground water wells and pumping stations are designed and constructed by DSI and the irrigation scheme is designed and constructed by GDRS. The ground water wells and pumping stations are transferred by DSI to the cooperative with a transfer agreement but the irrigation scheme is not legally transferred by GDRS since it is not authorised to do so. The cost of ground water wells and pumping stations is paid back by the cooperative over a 30 years period with a 5 year grace period. At the end of the period facilities are owned by the cooperative. Operation and maintenance activities of irrigation scheme wells and pumping stations are undertaken by the cooperative, but replacement of wells and pumping stations are undertaken by DSI.

Every year members of cooperative have a general assembly meeting for electing the steering committee having a president, an assistant president, an accountant and two members. Members of the steering committee are elected by the majority for a year and do not receive a remuneration. Cooperative announces water charge every year before irrigation season. There is a friendly competition between the cooperatives for lower water charge. They employ agricultural engineers or technicians and labourers for O&M activities.

If there is more than one local administrative units (village legal entities, municipalities) within one irrigation scheme **Water User Associations** (WUA) are established. They are established under the laws

and regulations of Ministry of Interior and their statute has to be approved by the Council of Ministers. Water user associations are the most appropriate organisations for large irrigation schemes.

Before the transfer of the irrigation schemes, farmers are informed about the scheme and the transfer and they are asked, if they wish to establish a water user association. They use a standard type of statute prepared by the Ministry of Interior for the establishment of WUAs. This statute is prepared under the guidance of DSI, signed by the heads of administrative units participating in the WUA and approved by the Governor of the province, if the WUA takes place in a province. If the WUA takes place in more than one province the statute is approved by the Ministry of Interior. The approved statute is sent to the Ministry of Interior for Ministers Council's approval, which completes the establishment of a WUA. The next step is to organize a first meeting to choose the members of WUA Assembly and to decide to receive operation and maintenance activities of the scheme. The first meeting takes place under the chairmanship of the Governor. A transfer agreement between DSI and WUA is signed by the authorised persons and approved by the Minister of Public Works and Settlement. Then the transfer of the scheme is completed officially.

Representation of farmers in the WUA Assembly is decided in the statute of WUA. The head of each administrative unit (Muhtar, Mayor) is an *ex-officio* member of the assembly. The rest of the members are elected in the assembly with the majority according to the statute of WUA. The number of representatives for each administrative unit is either fixed depending on irrigated area or calculated depending on a representation per certain hectares of irrigated area. The members of the assembly are elected with majority for five years. They elect a president for five years and four members for one year for the administration of the WUA. A general secretary (technical person) and accountant are employed for administration. Totally there are minimum of seven staff in the administrative unit of WUA. The president is paid a very low salary and four members of administration get a fee for each meeting. Decisions are made by majority.

If an irrigation scheme serves only a single village and if **village legal entity** decides formally to undertake operation and maintenance of the scheme, an agreement is made between DSI and the entity and proposed to the Minister of Public Works and Settlement for approval. The head of the village legal entity is also responsible for the irrigation.

If an irrigation scheme serves only a single municipality and if **municipality** decides formally to undertake operation and maintenance of the scheme, an agreement is made between DSI and municipality and purposed to the Ministry of Public Works and Settlement for approval . The mayor of the municipality is also reposnsible for the organization of O&M.

4. Financial Aspects

The irrigation projects are financed by the government and under today's system, tax revenues and government borrowings are the predominant source for funding. Some projects are financed by the Public Participation Fund which is a national organization and controlled by Under Secretary of Treasury and some others by international organizations such as World Bank and European Development Bank.

The total public investment budget of Government and DSI's investment budget for last ten years are given in Table 8. DSI's investment budget is about 40% of the total public investment budget of the Government. During that period increase in DSI's investment budget had been below the inflation rate and in 1995 DSI's investment budget was decreased. The budget allocated for DSI's investments has always been far from covering the need. That is because the government has been bearing almost all of the burden of investment of projects, which is than it can reasonably be expected to manage.

Especially large-scale projects create problems for financing. Build-operate-turnover (BOT) system seems not to be an appropriate way of financing irrigation projects because of heavy investment cost. Moving from today's heavy dependence on public financing for irrigation projects is very hard and long way. The move to a more open and transparent system need scrutiny and coordination of many interests.

Table 8. Investment budget of DSI

YEAR	Total Public Investment of the Government (million TL)	DSI's Investment Budget (million TL)	Ratio of DSI/Government Investment Budget	Increase in DSI's Investment Budget (%)
1985	1 004 891	427 740	42.6	84.5
1986	1 303 100	701 844	53.9	64.1
1987	1 854 100	881 206	47.5	25.6
1988	3 471 000	1 571 457	45.3	78.3
1989	5 287 600	2 422 221	45.8	54.1
1990	9 814 400	3 237 147	33.0	33.6
1991	14 650 000	6 048 392	41.3	86.8
1992	27 000 000	10 029 724	37.1	65.8
1993	47 000 000	17 691 798	37.6	76.4
1994	86 000 000	32 285 984	37.5	82.5

The water charges collected to recover the cost of investment and operation and maintenance activities directly go to the Treasury and budget for DSI activities allocated by the Government. Every year an estimated operation and maintenance budget for next year is prepared by the Operation and Maintenance Department of DSI in detail. The estimated budget is first discussed within DSI, studied by the State Planning Organisation within the total DSI budget and after the presentation of the Government approved by the Turkish National Assembly after presentation of whole budget by the Government. The budget allocated for operation and maintenance activities of DSI is given in Table 3.

5. Pricing and Cost Recovery

Water resources projects developed by DSI have reimbursable andnon-reimbursable purposes. Non-reimbursable projects are navigation, flood control, recreation and land improvement. Reimbursable ones are energy, water supply and irrigation. Because of political reasons and inflation it is very hard to say that they are fully reimbursable especially for reimbursment of investment costs.

The investment costs and operation and maintenance expenditures of irrigation projects incurred by DSI are subjected to repayment in accordance with its establishment law. Water charges are prepared by DSI and discussed by an inter ministerial commission and presented to the Government for approval. It has to be announced before the end of April every year. The inter ministerial commission is formed by the representations of the Ministry of Finance, The Ministry of Agriculture & Rural Affairs, The Ministry of Public Works & Settlement.

The water charges cover the actual cost of operation and maintenance activities of last year and the investment cost of the irrigation scheme. The investment cost of the irrigation scheme is amortized over a period not exceeding fifty years with a certain interest rate which is fixed by the Government. But in practise no interest is charged for the investment cost and once amortization charges are fixed they are not adopted to inflation. Only when amortization charges are very low because of inflation, are they adjusted by the approval of the Government. The amortisation charges are not fixed separately for every project but fixed for four regions which defined by considering the repayment capacity of farmers, geographical location and the amount of investment costs. Under high inflation rate, very low percentage of the investment costs reimbursed (about 10 percent).

The farmers repayment capacity is based on incremental net income less a certain allowance which should ensure a reasonable improvement in living standards of the farmers. In other words, only a part of the increase in income of the farmers due to the project can be charged as repayment.

Annually, operation and maintenance charges are set and announced by DSI to recover the actual operation and maintenance costs incurred in the previous year as calculated by DSI. Basically an adjustment percentage is applied to the previous year's rates so as to meet new cost collection targets. The operation and maintenance rates are being charged on cropped-area base with different rates for different crops to reflect different water consumption. Cropped-area base water charges do not reflect real water consumption and do not lead farmers to more efficient water use.

The operation and maintenance costs and collection rate of water charge for a period are show in Table 9. The collection rate decreased form 54 percent to 30 percent . This is due to inadequate penalty for the late payment. Farmers who are not paying on time are liable to a 10 percent penalty. With the current high rates of inflation a penalty of only 10 percent is very law.

Table 9. Recovery of O&M expenditures

YEAR	O&M Cost of Previous Year (million TL)	Receipts Collected (million TL)	Collection Rate (%)
1984	3 215	1 734	54
1985	6 512	3 248	49
1986	13 692	6 485	47
1987	27 047	11 425	42
1988	35 071	13 214	38
1989	53 444	20 051	38
1990	176 090	27 417	36
1991	120 151	38 904	32
1992	185 607	61 635	33

6. Comparison of Operation and Maintenance activities in traditional and modern irrigation projects

The historical heritage of civilization in Anatolia has a long past which goes to BC VIII. The oldest known water works belong to Hittite civilization. There are many water works constructed by different civilizations which took place in Anatolia and some of them still serve to supply water. There is not enough information about these structures and their operation and maintenance.

At present there are about one billion hectares of public irrigation in Turkey. That area is decreasing every year as modern irrigation schemes are developed by DSI and GDRS. Public irrigations are developed by farmers by using minimum discharges in rivers and springs in general. And there is not enough and correct inventory about these irrigation systems and their operation and maintenance.

In general, public irrigation systems, if not operated signally by the farmer himself, operated by the coordination of Muhtar who is the head of the village legal entity. The maintenance of the system done by the united efforts of users. In case of conflict in allocation of water, users go to the court to solve the problem.

Since there is not enough inventory and information about public irrigation systems, it is very hard to evaluate them and compare traditional and modern irrigation systems.

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