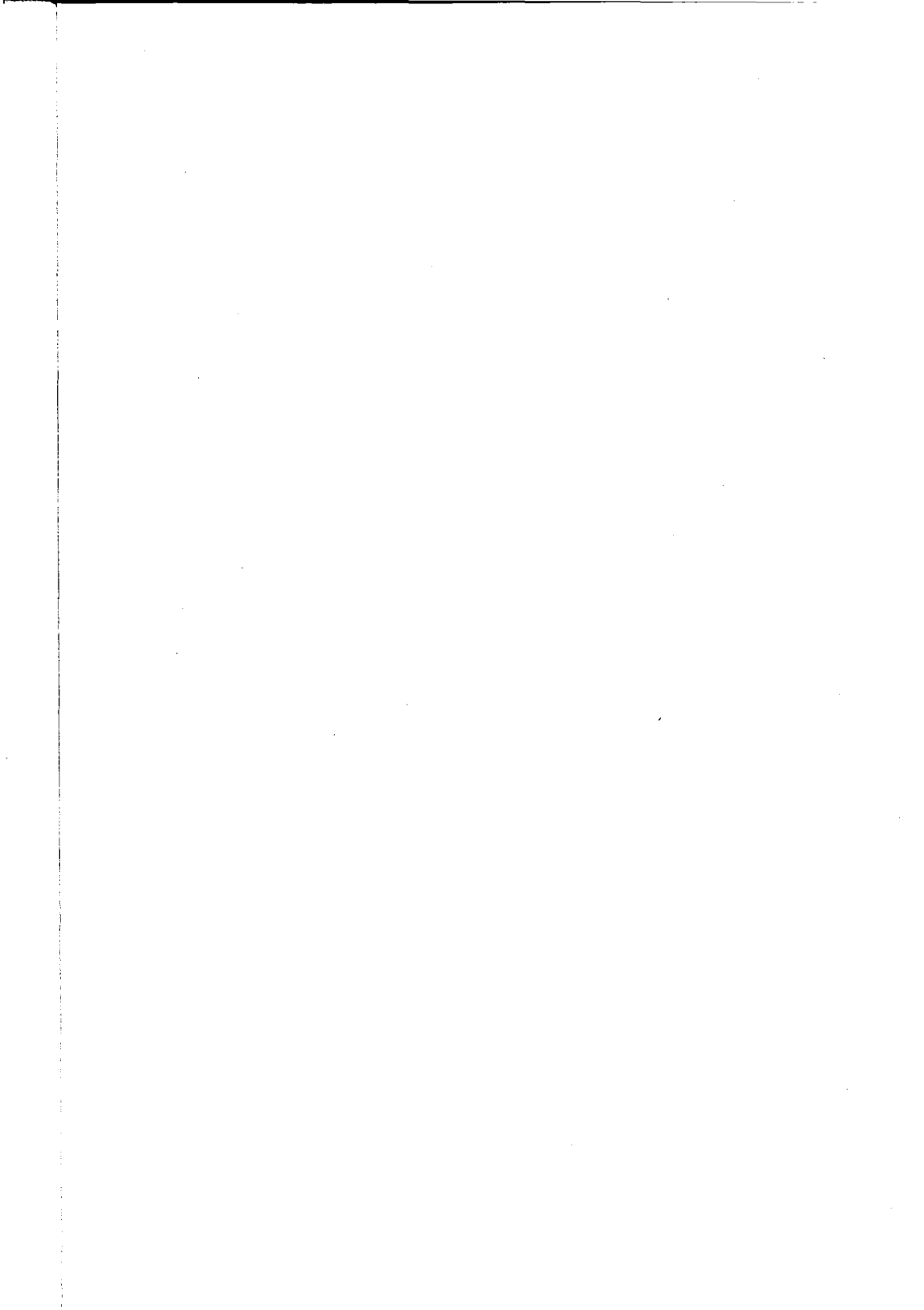


# **RURAL WATER SUPPLY AND HEALTH**

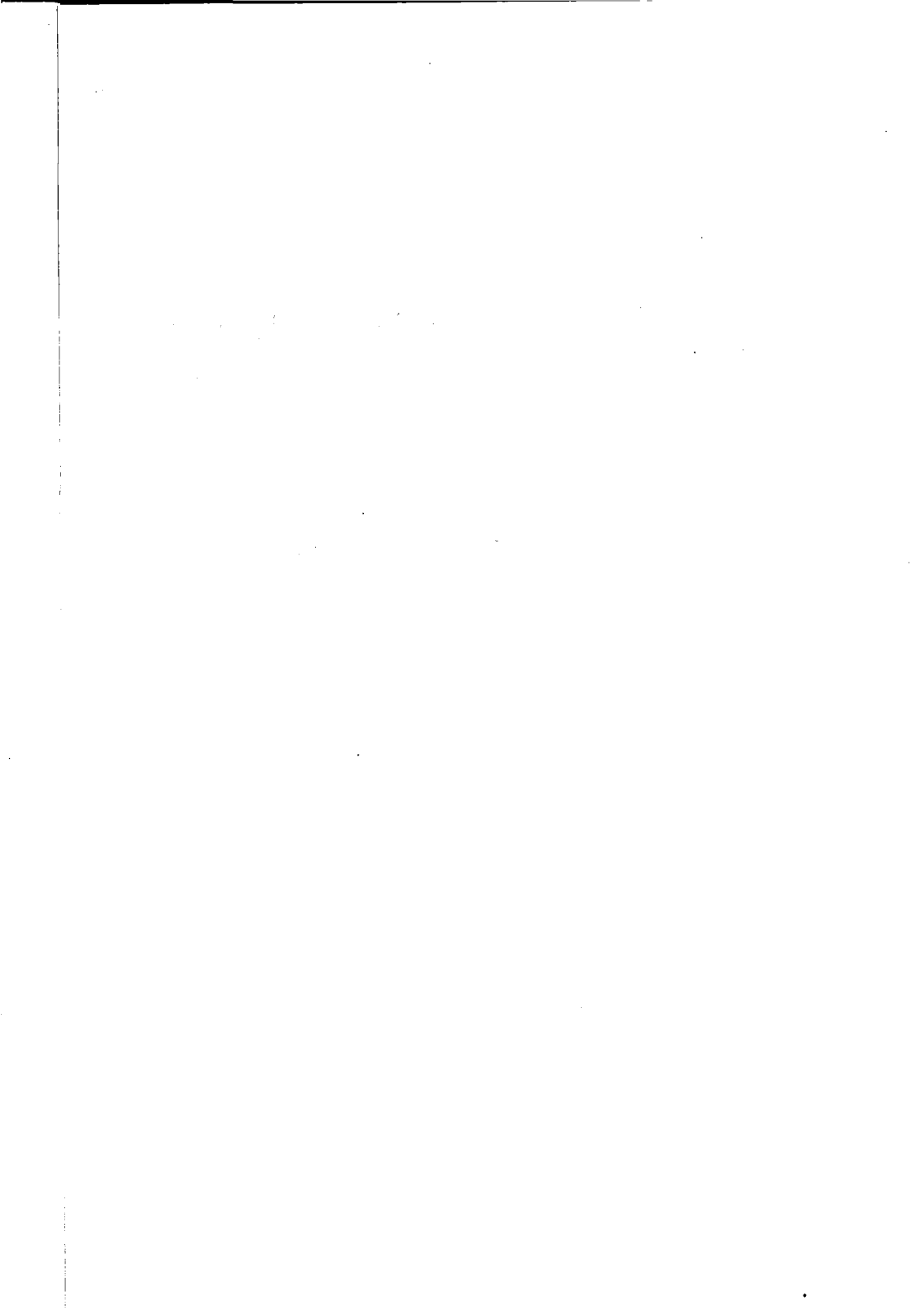
**The need for  
a new strategy**



**Edited by  
Malin Falkenmark**



# Rural Water Supply and Health



# Rural Water Supply and Health

The need for a new strategy

Summary of papers and discussions from the United Nations  
Interregional Seminar on Rural Water Supply  
Uppsala, Sweden, 6–17 October 1980

edited by

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Scandinavian Institute of African Studies  
Uppsala 1982

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# Preface

The International Drinking Water Supply and Sanitation Decade 1981–90 offers the possibility for as great a change in the quality of human life in the world as any program ever launched by the United Nations. Growing out of the World Water Conference in Mar del Plata, Argentina in March 1977, the Decade was created with the general intent of providing safe drinking water and sanitation for all by 1990. If this overall goal is achieved, it would by some estimates reduce infant mortality by half, it would revolutionize the role of women in rural areas throughout the world, and it would have a dramatic impact on the economic status of the world's billion people who live in absolute poverty. Healthy people are productive people, and productivity is the key to economic development.

At the international level the UN system seeks to provide the overall framework, the technical support, the momentum and the visibility and promotion necessary for the program's success. Governments are taking steps to deal with these problems more determinedly and with greater efforts. But, the ambitious goal can only be met if significant levels of financial, technical and manpower resources are made available, and if solid plans for action are urgently prepared and set in motion.

Sweden has long given high priority to water development. Since 1962 about 10 % of the external aid or 1.6 billion Scr, have been devoted to this sector, and two-thirds of these have been used for rural water supplies. The Uppsala Seminar on Rural Water Supply, held in October 1980, was a Swedish contribution to the start of the Decade. It was convened by United Nations Dept. of Technical Cooperation for Development and Uppsala University, and financed by SIDA (Swedish International Development Authority).

Any measures to extract and distribute more water, and to improve the hygienic conditions as well as the awareness of the importance of a hygienic behavior will have radical bearings on social and economic life and on ecological and sanitary conditions. These problems have to be analyzed in detail with all aspects taken into consideration before actions are taken. It was the objective of the Seminar to discuss the factors involved in this complex problem, to try to define the key problems, to identify the bottlenecks, and—if possible—to suggest some solutions and general recommendations.

The participants to the Seminar came from all over the world and represented a wide variety of natural environments as well as different professional backgrounds and administrative systems. The main focus of the deliberations was on the afternoon workshops, aiming at the water supply aspect with less weight on the sanitation problems. The official Seminar Report, issued by the United Nations, concentrated more heavily on the conclusions of the afternoon workshops than on the professional inputs to the workshops and on the country and thematic papers. These formed, however, an important contribution to the Seminar, worth to be covered more at depth.

The purpose of this publication is to amalgamate the professional presentations by invited international and national speakers at the Seminar. The form chosen is a digest, covering both water supply, sanitation and health, items inseparately united within the framework of the Decade. The text and the ideas are mainly extracted from the lecture papers listed at the end of the publication. Thus, the original material has been compiled into a more homogeneous and concise presentation. The text embodies also the conclusions from both country and thematic papers, as well as the discussions.

**Malin Falkenmark**  
Editor



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*Introductory speakers*

- I1. Bi, Jilong
- I2. Bourne, Peter G.
- I3. Sundborg, Åke

*Lectures*

- L1. Åhman, I.
- L2. Arlosoroff, S.
- L3. Beyer, Martin G.
- L4. Beyer, Martin G.
- L5. van Damme, J.M.G.
- L6. Dijon, Robert
- L7. Emmanuel, U.W., ECA
- L8. Falkenmark, Malin
- L9. Fano, Enzo
- L10. Feachem, Richard G.
- L11. Freedman, Joseph
- L12. Gustafsson, Yngve
- L13. Hawerman, Bertil
- L14. Jørgensen, Kirsten

*Lectures*

- L15. Kaul, Inge & Mathiason, John R.
- L16. Law, Frank
- L17. Lee, T.R., ECLA
- L18. Makondiege, S.
- L19. Manalac, A.S., ESCAP
- L20. Mascarenhas, Adolfo C.
- L21. Muslim, F.
- L22. Obeng, Letitia E.
- L23. Steneroth, G.
- L24. Subrahmanyam, D.V.
- L26. Widstrand, C.
- L27. Zarraga, J.C.

*Country paper summary*

- C1. Falkenmark, Malin

# Synthesis

## Water and Sanitation Decade

There is in the developing world a tragic linkage between lack of safe water, high level of infections, and high rates of child mortality. This is why the United Nations has declared the 80's the International Drinking Water Supply and Sanitation Decade with the last century's experience in Europe and North America as a strong incitement. Serious but unsuccessful ambitions in many countries during the 70's to give the population easy access to clean water have created a world-wide call for a new strategy with reassessment of priorities.

Countries have reported a number of different constraints on accelerated development to WHO, the lead agency for Decade activities: scarcity of qualified personnel; limited national and international funding; lack of effective infrastructural coordination; scarcity of water; lack of knowledge on its availability. Besides these constraints, bilateral and multilateral agencies tend to stress some additional ones: necessity of institutional setup; organization of operation and maintenance; crucial implications of community participation; crucial choice of technology; and the essential link between water, sanitation and health. In fact, countries and international agencies partly tend to give the constraints a different order of priority.

## Goals and Expectations

*Health.* Attainment of health constitutes the overriding objective of the Decade. The health hazard varies with the type of water source available. Many factors influence a woman's actual choice of water source (water quantity needed, ways of using the water, quality acceptable to the woman, time consumed in queueing up, household size, laundry habits).

Generally, prevention of diseases involves breaking the chains of disease transmission. Such chains may be water-related, excreta-related, or both. Therefore, clean water is seldom enough to realize increased health; it has to go with organized sanitation and hygiene education to make people aware of the link between hygiene and health. The major cause of childhood diseases and death are diarrhoeal diseases, the most important of which are water-related and/or excreta-related. The ones possible to break with Deca-

de activities are those caused by bacteria and protozoa, whereas those caused by viruses need other measures, the key being development of vaccine.

There is a clear dilemma between the intricacy of the transmission routes of diseases, and the oversimplified message often used in water supply campaigns. Other factors influencing the possible impact on health of water supply include pollution from the water source and beyond, as well as extra-home drinking habits. Health education therefore forms a crucial ingredient in any campaign towards better public health.

*Social objectives.* Often a water project implies introduction of new technique and new concepts on the relation between water and health. Besides improved health, the positive impact includes reduced hardship for rural women, settling of nomadic populations, etc. Due to lack of local support many projects have fallen short of stated objectives. Evidently, the intended social objectives are attainable only if the water provided is actually *used*, people find *access* to the water source, and the supply system is properly *maintained*.

Thus, it is essential to create a sense of local ownership, and social aspects have to be considered already at the planning stage. A community survey should cover traditional water use pattern, traditional social beliefs and attitudes, community structure and decision-making, differentiation of sex roles, etc. Great efforts have to be given the education of the public in acceptance, use, maintenance and benefits from the new facilities. It is essential that monitoring and evaluation of the ready project be planned already from the beginning.

*Revolutionalizing the role of women.* Besides the primary health effects, the Decade intends to revolutionalize the role of rural women, at present stressed by an enormous labour burden. It might however fundamentally alter the existing division of labour between men and women. The probable effect of modernisation varies between men and women, and many factors may be ignored that lead to an undesired development. For instance, development measured in GNP change does not include women's subsistence production, and consequently gives a distorted view on women's position and possibilities in the development process.

The Decade may be expected to have benefits for women only if there is a conscious intent to modernize the woman's role in rural water supply, to facilitate her contribution to construction and maintenance and allow more time for other profitable activities such as agriculture, food processing, child care, literacy, participation in self-help activities, etc. The site determina-

tion of the water supply has also to balance hardship reduction with attention to congregation opportunities.

## **Planning and Implementation**

*Planning and implementation.* The political will and commitment are key elements to make a water supply programme succeed. The process of developing adequate water supply and sanitation in rural areas includes three preparatory stages: creating general awareness about the problems related to unsatisfactory water supply and sanitation and its links to health; realisation of the benefits to be reached through a nation-wide effort; and arrival at a determination to establish the facilities needed.

In the past, water supply and sanitation has been looked upon as primarily engineering problems. Experiences, however, indicate the need for an integrated set of policy measures. Old and inefficient methods and strategies should be discarded, and an integrated and multidisciplinary approach embarked upon. This has to include a number of constraint-oriented actions against inadequate administrative authorities, shortage of manpower, inadequate research and development of adaptable technology, lack of health education, lack of public participation, lack of adequate hydrologic data. Many measures rest with the countries themselves, and external financial support might only be a small percentage of the total cost.

The planning and implementation process involves a whole complex of formalized interactions between bodies involved; consideration of policies, laws and regulations; and administrative procedures. Institutional arrangements, operation and maintenance resources, and supply and maintenance operations have to be taken into account. It rests with each country to make its own solutions, as conditions are largely different.

*Three-party dialogue needed.* In planning and implementation of water supply projects, the communication between the three main groups involved is essential: the consumers (local population), the producers (national authorities), and the donors (the groups responsible for external financing). A number of difficulties are involved already in the relation *producer—donor*, and certain principles have to be followed in external aid programs. At the same time, a dialogue between *producers and consumers* is essential and closely related to the question of community involvement, which is a prerequisite for the use of appropriate technology. Tanzania and Thailand offer successful examples in this direction. Valuable inputs from public participation are sense of local ownership, local labor and material, but also financial contribution. An extremely delicate problem is the one related to water payment.



*Water resources assessment.* Water resources assessment forms a crucial part of the planning process. It is a concept under development at present, in accepting that without hydrological data, project planning remains a guesswork. Hydrological conditions may be extremely different in countries in different part of the world: some countries have plenty of water in relation to population size; in others there is extreme scarcity; access to ground-water may be quite different: in some countries it may be found just under the ground surface; in others at 100–200 m depth; in areas with crystalline rocks, even sophisticated technique is necessary to find access to rock groundwater.

Due to the link between hydrological processes and soil and plant cover, there should be a close link between land-use planning and planning of water projects. The low education rate in many developing countries at present involves a dependency on know-how in industrial countries. This raises the question to what degree the present knowledge is in fact applicable under other climatic conditions, and calls for research on hydrological similarities and dissimilarities between regions.

In planning water supply in an area under water scarcity conditions it is essential to consider not only household water, but water for all other activities as well on which the area's *ecological balance* depend: biological production for self-sufficiency, cattle feeding, water for local industry, etc. A distinction should be made between internal and external water requirements, between water availability for plant production and for human needs, and between local and transversal water resources.

*Technology and maintenance.* In the past, western water supply technology has been transferred without serious consideration of its appropriateness. Today, use of low-cost technology is widely accepted as a new strategy to cover basic needs of rural people. If well-drilling and handpump problems are focussed during the first half of the Decade, it is probable that the operation and maintenance problems will be the ones dominating during the second half. Attention should be paid to the organization of maintenance and repair already at the project planning stage, and resources be allocated to such activities through an independent funding. India and Thailand offer interesting field experience in this regard.

In order to reach the Decade target, 2 million wells will have to be dug or drilled before 1990, and related maintenance and repair organizations established. The deterioration processes of equipment are now being examined to find out how to prevent and cure. In open wells lining may deteriorate, water level may go down during prolonged drought periods, and sediment may accumulate. In tubewells, the casing screen may corrode or deform.

Handpumps, although common already 100 years ago, are a major weakness—the ideal handpump still remaining to be designed. In an ongoing UNDP/World Bank global project, laboratory and field testing of handpumps is now being carried out.

The choice of excreta disposal technique is a delicate problem: not only advantages and disadvantages of each type but also habits, soil conditions and funds needed have to be taken into account. The World Bank, in a research project, is identifying and evaluating the sanitation technique that can be afforded by most countries.

*Water pollution and legislation.* Drinking water has to be protected against pollution. Increasing amounts of water for household supply means increased handling of waste water, which may cause serious health problems. Also the industrialization programmes, now developing in many countries as a main ingredient of the economic development, will lead to water quality hazards. Lake Nakuru in Kenya offers an illustrating example. Even where a Water Act exists, it may not be effective in pollution control, as many polluting activities are not connected with water use. Therefore, other legislation is also involved. Usually, each legislation has its own institutions for administration and enforcement. Thus, without an overall water policy for water resources management there is great risk for institutional paralysis and at times obvious conflicts in a country.

What should be strived at is a balance between exploiting and protective forces. Sometimes the two interests coincide (when industrial reuse includes recovery of valuable raw material and reduced pollution). A sensible use and reuse of water must form an integral part of a water management policy. Also, education and field experience form key elements, crucial for the control and monitoring of legislation.

*Manpower and education.* Inventories have clearly shown that lack of trained manpower forms a major constraint to the Decade. The need for skilled and competent people all over the world, from simple skills to more complex ones, is well over 0.5 million people. Training of adequate manpower in fact constitutes a much more essential measure than generally meeting the goals of the Decade, because it will ensure that, ultimately, the country will move towards clean drinking water and sanitation for all.

Three types of education need special stress. The first one is the training of trainers who can then go home and train, bringing with them manuals and job aids developed as part of the training activities. The second is community-based vocational training in rural areas, where few people have grown up in a mechanized environment. Such training has to be village specific and

cover those areas that the villagers themselves feel are in need of attention. One successful example is the community strategy experience in Thailand. Finally, health education (especially hygiene and hygienic behaviour) forms an important and crucial content in sanitation programmes. Especially rural women need a basic knowledge about maintenance of health and causes of illness. Such education has to take into account traditional social beliefs and attitudes.

*Research needs.* Operational research is urgently needed to develop options for national strategies. Out of the massive investments foreseen for the Decade, a small proportion (say 0.01 %) should be allocated to applied research. It is important to remember that the Decade goals are not only an end in themselves, but that they are also a vehicle in the process of reaching self-reliance. It has to be discussed by whom and where research activities should be carried out, and how the results should be communicated to possible users. Among essential areas of research are the following: the problem of appropriate technology; water use in traditional systems (including people's interaction with water and the risks for contamination from the source and beyond); bacteriological surveillance; social and cultural factors of sanitation (including what existing cultural and social structures could be used in diarrhoeal prevention programmes); and methodology in order that not more data are collected than necessary for the solution of a certain problem.



**Part I**  
**INTRODUCTION**

# 1. Water Decade—Constraints and Strategies

... it would be wrong not to take the objective seriously simply because of the enormous size of the problem.

Letitia Obeng, UNEP

## Realistic Goals?

A tragic linkage is inescapable in many developing countries between the lack of safe water on one hand, and on the other the high levels of infection from parasitic diseases and high rates of infant and child mortality.

According to information gathered in 1975 from 75 developing countries (excluding China), an estimated 78 % of rural populations did not have reasonable access to *safe drinking water* (L24). In absolute figures this corresponded to 1106 out of 1419 million rural people without safe water. For *sanitation*, the situation is still worse: 85 % of the rural population were left without more or less adequate facilities.

The world community has therefore set for itself the ambitious goal of ensuring that all people have access to good quality drinking water and sanitation by the year 1990 (I 1). The setting of this goal is a result of the concerns expressed at two United Nations Conferences held in recent years, those of Human Settlements and of Water. In November 1980, the United Nations General Assembly launched the International Drinking Water Supply and Sanitation Decade 1981–90.

During the coming Decade, therefore, a *world-wide awareness* of the importance of clean water and sanitation will emerge as a necessary step for improving public health, reducing the present hardship of rural women, and increasing the number of productive people as a key to economic development. The formidable size of the objective of providing safe water and acceptable sanitation for large populations within one single Decade, in a world where population increase still continues almost unabated, makes it, however, unrealistic to expect that the objective will be fully achieved (L22).

That would, in fact, imply that 500 000 people be given new or improved installations every single day during the whole Decade (L3).

## Awareness and Motivation

*Poor record of the past.* A strong incitement to the Decade efforts is to be found in past experience, in Europe and many parts of America, of *combating diseases* (I2). One hundred and fifty years ago cholera was rampant in

these areas. Life expectancy in the industrialized cities of northern England was seventeen years. What revolutionized the health of people in this part of the world, and banished those diseases that we now see as only something existing in developing countries, was the development of clean water and sanitation systems. The idea is that the same advances can be achieved for the entire world if we have the will to make it so.

In the past decade, experience and knowledge have been acquired globally on the subject within conference rooms and in rural areas (L22). Some water programmes have yielded satisfactory results: the water programmes of UNICEF in Bangladesh are often cited; the effort of the Malawi government is another example. On the other hand, other practices have not been successful with the resultant waste of scarce resources. Although such projects have yielded a wealth of experience, many of the valuable lessons have not yet been reflected in new schemes. The often depressing experiences will have to be taken into account carefully in future work during the Decade.

The overall record of the past decade of accomplishments achieved in this sector in developing countries is rather poor. This may be attributed primarily to the *low priority* assigned to the sector in most national, economic and social development plans. The basic explanation of this is that the investment of scarce resources in the water supply and sanitation sectors, and especially in rural and low-income urban subsectors, is unattractive when compared to similar investments in other sectors of the economy. It should not be overlooked either that there is often little political return from development projects which command little, if any, attention by the media.

The set of recommendations of the Water Conference underscores more than ever the *need for re-assessment of national priorities* (L9), both in regard to the allocation of scarce financial, manpower and institutional resources, among competing water-related sectors of the economy, and in regard to the allocation of such resources to the urban as opposed to the rural community water supply and sanitation subsectors.

*Multi-stage process.* In describing the process leading to the implementation of rural water supply and sanitation facilities in general, three stages can be distinguished (L5): *awareness* that the problem exists and needs urgent attention, *realization* that the availability of services implies substantial benefits, and *determination* to establish those facilities. This process will be gone through by each of those concerned: policy makers and technical managers at the national level, those at the provincial/state/district levels; those responsible at the village level; and finally the future users themselves—but not necessarily in that order, however.

After the third determination stage should follow a stage of *analyses and studies*, mainly by the engineers and their co-workers, of the best means for the implementation of facilities; of which issues need alteration; and of the broader development with which they should be integrated.

## Perceptions and Prospects

*Present situation.* According to what has been reported by the World Health Organization, the lead agency for the Decade activities within the UN system (L1), there is now an awareness of the Decade in many countries, and the process of preparation is accelerating. Achievement of the global goal has required countries to set realistic targets; make more use of community resources; cut costs through the use of appropriate technology; ensure adequate operation and maintenance; integrate programmes with other sectors and provide effective managerial support to the community; and make the attainment of the health components an overriding objective of the Decade. The increasing government commitment to the goals witnessed both at ministerial and even at head of state level, and the manifold activities now embarked upon by UN and donor agencies in planning, training, programming and project preparation, are beginning to have results.

Even if governments are aware of the aims and ambitions of the Decade, many rural people have not heard about it (L24). At the same time, they have, however, very clear perceptions about drinking water, although these perceptions vary considerably between cultures and regions. Their perceptions about water quality depend on their concepts of pollution which are based on religious and aesthetic considerations as well as chemical and biological phenomena. Perceptions about costs are strongly influenced by the concept of water as a free commodity.

*The needs—resources gap.* The size of the populations served in 1975 and 1980 respectively, and the WHO secretariat estimates of the 1990 targets for populations yet to be served (L24), are given in table 1.1. The relative *size of the task* of the Decade is further illustrated in fig. 1.1. which focusses the size, at different times, of the unserved populations. The given information shows that it is expected that improved drinking water and sanitation services will cover the whole population in urban areas. In rural areas, it is considered possible to achieve the availability of drinking water services for the whole population, whereas still about 30 % will have to remain unserved in 1990 in regard to sanitation facilities.



Table 1.1. *People served in 1975 and 1980 and yet to be served 1990. Millions.*

Year	Urban			Rural			Total		
	Whole popul.	Served popul. water supply	sanit.	Whole popul.	Served popul. water supply	sanit.	Whole popul.	Served popul. water supply	sanit.
Population served									
1975	577	450	437	1419	313	209	1996	763	646
1980	741	551	393	1739	503	230	2480	1054	623
Additional population to be served by 1990									
house/ sewer-connections	1129	+477	+377	2054	—	—	3183	+477	+377
standposts/ household systems	+101	+359		+1551	+625		+1652	+984	
unserved		—	—		—	1199			1199

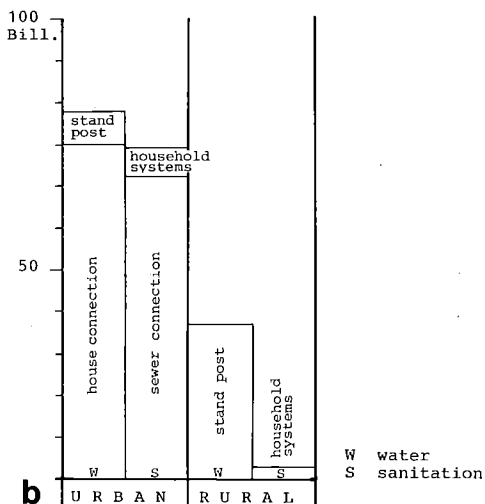
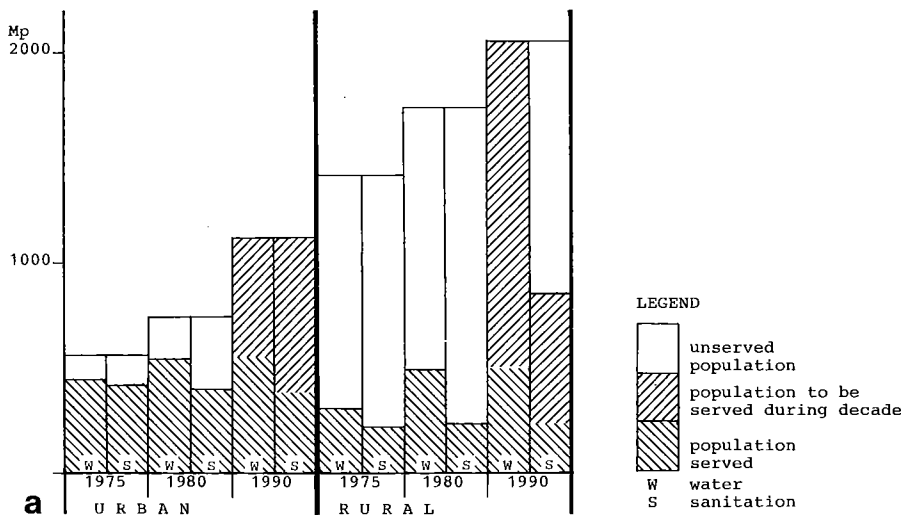
Data from Subrahmanyam (L24).

One should note that the level of ambition for rural areas is considerably lower than for urban areas, and especially that the intended level of sanitation services is quite low in rural areas. Thus, the targets assumed to be achieved by 1990 are the following:

- water supply: urban: 100 % (majority with house connections, rest with standposts\*)  
rural: 100 % (no house connections, only standposts or spot sources\*)
- sanitation: urban: 100 % (sewer connections or household systems\*)  
rural: 30–50 % (only household systems\*)

\*) coverage with different systems varies between regions

Rough estimates have been made by WHO (L24) also of the *investments required* for the Decade (table 1.2).



**Fig. 1.1. Drinking Water Supply and Sanitation Decade 1981–90. Size of the task.**

*Fig. a. Population coverage:* the columns indicate the population coverage for water and sanitation services in years 1975, 1980, and the assumed achievable target for 1990.

*Fig. b. Estimated Decade investments* in billion US \$ (1980 prices) and their division between different levels of service.

Data source: Subrahmanyam (L24) and Åhman (L1).

Table 1.2. *Estimated Investments required for the Decade* (million US \$, 1980 prices).

Service level	Urban		Rural		Total		Grand Total
	Water	Sanit.	Water	Sanit.	Water	Sanit.	
house/sewer connections	80845	70113	—	—	80845	70113	150958
standpost/household systems	7838	9028	37772	2835	45610	11863	57473
	88683	79141	37772	2835	126455	81976	208431

Data from Subrahmanyam (L24)

Estimated investments amount to a grand total of 208 billion US \$. At the same time, a World Bank estimate indicates (L22) that 'in the early 1980's, some US \$ 12 billion might be available for water and sanitation every year. There are good reasons to fear that even this low level of funding may not be reached. But even if it was attained, and then sustained over the Decade, the unserved backlog in 1990 would still be about 1500 million people—the same as it was 1975'. Thus, out of the 208 billion estimated to be required, only about half might be made available during the Decade.

*How to close the gap.* There are, in fact, differing views among different parties on how to close the gap between needs and resources (L24). Figure 1.2 tries to illustrate how different parties involved in the Decade from different aspects might perceive the relative importance of different tools to be used in order to satisfy the needs. There are three parties: within the country itself, within the donor countries, and within the UN system.

Principally, there are two main ways of closing the gap: on one hand to *increase the resources* by increasing allocation to the sector in country development plans, by generating local resources through community participation, and by increasing the external aid. There is also the possibility to *lower the needs* by lowering the service level, by use of appropriate technology and providing what is affordable, by lowering the unit cost through integrated approach with other sectors, and by serving only those groups unserved or less served, i.e., by establishing priorities.

There is a considerable difference as to the weight attributed to external aid by different groups, the two extremes being the political level in the recipient country itself, and the tax payer in the donor country. Although the scenario of viewpoints is fully hypothetical, it illustrates the many different opinions which have to seek a compromise in the large-scale national and international cooperation necessary to reach the goals of the Decade.

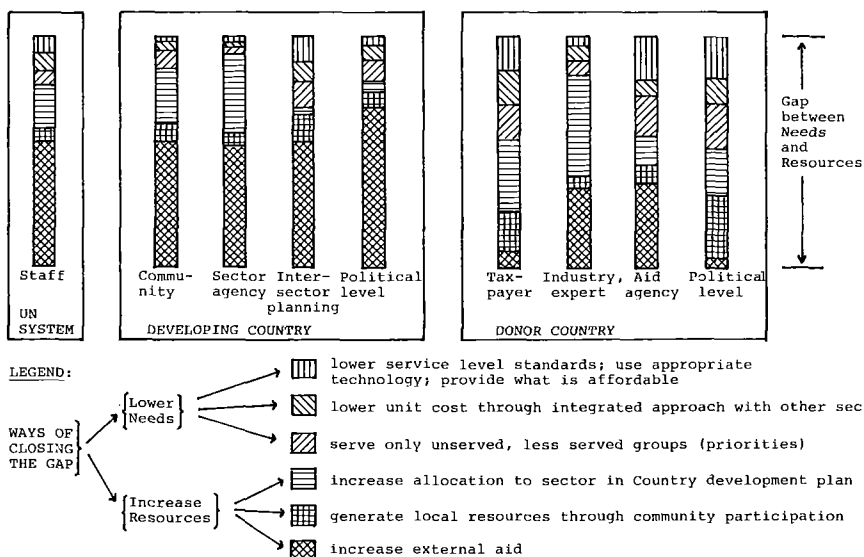


Fig. 1.2. *How to close the need – resources gap: a hypothetical scenario of viewpoints of main groups of actors.*

From Subrahmanyam (L24).

The conclusion of this is that there is a tremendous gap between needs and resources, and that there are quite diverse opinions on the relative importance for fulfilling the Decade of external financial aid. Finding that resources for programmes and the continued increase in population remain major constraints, it is clear that whatever resources can be made available should be utilized efficiently. In addition, the investments needed are put in a relative perspective by the world's spendings on various other activities (L22):

spending <i>per day</i>	cigarettes	240 million dollars
	tranquilizers	10 " "
	global arms bill	1400 " "
needed <i>per day</i>	for Decade	57 " "

It is also interesting to note that, out of the total investments, the main part is in fact related to water supply and sanitation in urban areas, whereas for rural areas the investments needed are considerably lower:

*Investments with different levels of service (million US dollars)*

	Urban	Rural	Total
highest	150958	—	150958
secondary	16866	40607	57473
total	167824	40607	208431

In fact, the calculated investments in rural areas, 40 billion US dollars, correspond to only about 20 % of the total investments required. The part to be covered by external financing is well below the amount estimated to be available.

*Water Decade prospects.* Even if the information given so far invites to some moderate optimism, the prospects for the Water Decade are, in fact, much more fortunate than for the Food Decade endorsed by the UN Food Conference in Rome in 1974 (L24). The targets were similar: no one to go hungry after the Decade, clean water for all by the end of the Decade. The gap between have and have-nots in food is however widening, whereas the rural water supply position has not worsened in the last five years. There are very few 'surplus' food countries, whereas most countries have enough water to drink. Food has to be grown and bought, which creates need for money; the poorest of poor have no purchasing capacity even when food is available. In contrast, water is available 'free' if anyone is ready to walk. This fact creates a reluctance to charge or to pay for water.

## Constraints

*Constraints as seen by countries.* Many countries are at present engaged in a process of developing their strategies to provide a safe water supply and hygienic waste disposal for their populations. The departure point for selecting a suitable Decade approach at the country level has been the study of the different *constraints* to an accelerated development in the sector (L1). An analysis of the constraints reported by governments in their responses to ECOSOC resolution 1979/31 indicates a pattern of three levels of constraints (table 1.3).

In well over half of all cases (80 countries) the scarcity of qualified *personnel* at all levels, ranging from village technicians to overall sector planners, is repeatedly mentioned. This constraint can only be overcome through the establishment of training programmes suited to the various tasks, special attention being given to that of operation and maintenance. Countries face difficult decisions on whether to train staff for the requirements of the entire sector programme or to do it only in a project context.

The second overriding constraint, particularly for poor countries, is the *limited funding* available under the national budget and the difficulty of obtaining more grants or soft loans. One of the objectives of the Decade is to accelerate and facilitate the inflow of external resources to the sector, especially where the needs are greatest. A probably unrealistically high level of expectation of additional external funds has been created in many

Table 1.3. *Constraints to accelerated development of water supply and sanitation reported by 80 countries. Rank order indicated.*

Constraint	Rank order	% cases
Manpower	1	} > 50 } > 25
Finance	2	
Institutional factors	3	
Water availability	4	
Foreign support	5	} > 10
Logistics (materials, spare-parts, transport)	6	
Education	7	
Datebase	8	
Project preparation	9	
Management	} 10	} < 7 } negligible constraints
Operation and Maintenance		
Health systems		
Appropriate technology		
Rehabilitation	} 11	
Housing and planning		
Geographical dispersion	} 12	
Others		

From Åhman (L1).

countries. While those funds may be potentially available, it is at the same time clear that thorough project preparation is the best way to obtain support.

The description of the institutional set-ups given by the countries confirms that the *lack of effective coordination* among the various ministries, agencies and other entities with responsibilities in the sector is an important constraint which normally becomes more serious as the size of the country and the decentralization increase. Another serious observation is that, although water and sanitation coverage is central to the global objective of 'Health for All by 2000', little reference is made in the reports to links of the water supply sector with primary health care. Intersectoral coordination could help overcome these constraints.

Two other constraints often mentioned in country reports (more than 25 % of cases) are the *scarcity of water resources* and the *lack of knowledge of underground waters*. The first of these constraints needs special study. The second constraint which leads to the preferential utilization of surface water, though this may be costly and difficult to treat, could be offset by intensified groundwater exploration efforts.

The constraint pattern varies between regions. In African and Asian



## Three Party Dialogue

In conclusion, one could say that the ECOSOC material proves the general validity of the model presented in fig. 1.2 on possible ways of closing the need-resources gap. However, scaled down to its most crucial components, the model comprises three parties which set the aims, means and other criteria of development of rural water supply (L1):

- the *consumer*, i.e., present and prospective consumers of rural water supply and sanitation services
- the *producer*, i.e., the parastatal organization or the department of water development in charge of construction, operation, maintenance and rehabilitation
- the *sponsor*, i.e., on one hand the *national* authority in the country concerned, deciding upon the budget contribution to the sector, and on the other, *external* donors and financing agencies involved.

The outcome of the whole sector depends on the extent to which the dialogue and actions between the parties are successful in coordination and conflict reduction. Looked upon from this point of view it could be questioned to what extent the three differ in aims, approaches and means. The proceedings from a Nordic meeting give a rough characteristic, perhaps overexaggerated but serving the purpose of identifying problem areas and differences between the three groups (L1):

'Usually the *consumer* represents the weakest link in the chain of events. The prime target for the whole exercise is in the worst of cases characterized as excluded from adequate information, frustrated and lacking possibilities of participating and influencing the decisions concerning the water supply system to be built and is later on a victim of unreliable provision of water. The one who carries the water to the household is in most cases a woman with as little say as the child on her side and with far less influence than the pump attendant, who always is a man, and who probably never had to fetch water in his life.

The *producer* on the other hand could be characterized to act under political pressure and stress to favour certain village schemes. Many times the producer will plan and work under the overtone of national and international targets demanding a nearly immediate solution to a complex problem. The latter undoubtedly will force the producer to favour new construction at any price, avoid time-consuming considerations on maintenance and the need to build up a consumer-producer relationship.

However, the producer will soon find it frustrating to realize that more consumers are lost per time unit due to breakdown of installations than the number gained through the newly constructed schemes. The reason for this is mostly lack of an adequate operation and maintenance system. At a certain point the frustration will increase when the vast experimental ground for splendid engineering endeavours will have to be changed for a less glorious technology level in order to satisfy the activity targets of providing rural water by 1991.



Thirdly, the *donor* (also in this case characterized through employing a caricature) relies only on the imported overseas-made, stamped and sealed component with attached instructor and spare parts. Splendid short-term results are achieved which satisfy the donor's home-market and leave very little consideration for long-term effects. Frustration arises when ingenious 'appropriate technology experiments' fail to show anything but an adaptation to the 'appropriate technology' level of the inventor. Others again reside in the grandeur of the unofficial praise of the producers. The autoperceived perfection can lead to a self-complacency that renounces all advice or cooperation with the outside. At the same time the producer has developed a keen knowledge on how to present a memorandum to make it attractive to the donor. Of special interest are the cases where requests are 'redressed' because of sudden shifts of prospective donor.

Donor tactics can also be one of tossing the burden of responsibility and decision completely on to the producer by referring to the nobility of the 'lee-way approach' vis-a-vis the producer. Unconcerned and uncommitted participation in the development process is an easy way out where the donor always could save face because after all the decision was not his'.

There is also a difference in relative strength between the three to take into account. The matter brings up the question of who in reality is setting the goals: the consumer, the producer or the sponsor/donor. The three groups differ in their preferences as to what aspects of water development are of highest priority.



**Part II**  
**GOALS AND EXPECTATIONS**

## 2. Improving Health Conditions

Half of the infants that die in the world each year die from water-borne diseases. Eighty percent of all diseases in the world are water related. Half of all the hospital beds in the world are occupied by people with water-borne diseases.

Peter Bourne, UNDP

If one reads the WHO statements on the Decade, one finds that WHO has urged governments 'to make the attainment of health components an overriding objective in the Decade', and that 'the strategy for the Decade should be part of the national strategies for health 2000' (L26).

In other words, the primary reason that during the Decade governments and development agencies throughout the world will be exhorted to make domestic water supply and hygienic excreta disposal a major development priority is health (L10). Improved water supply and sanitation may improve the aesthetic quality of life, they may facilitate other development activity, they may save the time spent carrying water over long distances; but the foremost benefit anticipated is improved health. A clean water supply close to the home and a hygienic toilet are believed to be among the cornerstones of those environmental and social changes which produced the dramatic decline in infectious diseases in Europe and North America over the last 130 years. Although infectious disease mortality can be reduced by curative services alone, morbidity can only be significantly reduced by preventive measures, and improved water and sanitation are central to our concepts of preventive medicine and public health.

### **Settlements and Health Hazards**

*Differences in access to safe water.* People on the lower end of the income scale in developing countries reside for the most part in rural areas, either in clustered communities or in scattered residences, or in city peripheries where urban services are scarce or completely lacking (L14). In all these settlements, water for domestic use is often costly in terms of cash, time and energy expenditure, and its quality varies from safe to extremely hazardous.

Patterns of water supply and health hazard and the cost of obtaining water may be seen as varying according to the settlement pattern of people in rural areas of developing countries along the lines indicated in table 2.1 (L14).

The woman who goes to the nearby village tank may have a low cost for her water in terms of energy and time, but when the tank is used for washing clothes, people, cattle, and cooking pots the health hazards are high. An Ethiopian woman may object to the 5 kilometres she has to walk to a

Table 2.1. *Characteristics of settlement and water supply.*

Pattern of settlement	Types of water sources available	Health hazard from water	Cost (in energy or cash)
Urban peripheries	Taps	low	high
	Standpipes	medium	medium
	Vendors	high	high
	Surface ponds, streams	high	low
	Underground springs, wells	high	low
	Rain-barrels	high	low
Rural clustered	Taps	low	high
	Standpipes	low	medium
	Vendors	high	high
	Surface ponds, streams	high	low
	Underground springs and shallow wells,	high	low-high*
	Deep wells	low	low-high*
	Rain-barrels	medium	low
Rural scattered	Surface ponds, streams	high	low-high*
	Underground springs, wells	low	low-high*
	Rain-barrels	low	low

\* Depends on area—tends to be low in humid areas and high in arid areas, especially in the dry season

From Jørgensen (L14) (Source: White 1974)

borehole in the dry season, but the water she gets is not likely to be polluted. However, water carried substantial distances may well become contaminated by the time it reaches the home. Settlement patterns also affect very much the cost of possible improvements so it is important to try to estimate how the population is distributed.

Rural regions differ considerably in the availability of safe water (people having reasonable access to safe water). This term is defined by WHO as implying 'that the housewife or members of the family do not have to spend a disproportionate part of the day in fetching the family's water needs'.

In most of the *concentrated settlements* water seems to be available within about half an hour's walk. The sources are varied, and frequently there is some choice of sources. In some places the public fountain is usually the first step in the improvement of water supplies. Other sources include various kinds of surface water such as ponds, streams, and canals, or underground water springs, hand-dug shallow wells, and deep tubewells. In some communities rainwater is collected from the roof into containers, in others this is not even considered a potential supply. Except for the tubewell or the rain-barrel in sparsely populated areas, the sources tend to be

hazardous to health, unless they are protected or their water treated. They may be used for washing clothes, people and animals, as well as for drinking purposes.

*Scattered settlements* are frequent in many of the rural areas of Africa. In humid areas water may be readily available at short distances from the house, and even in the drier areas there may be springs, wells, sometimes boreholes, and the variety of potential sources associated with a river, the stream itself or holes dug nearby the main channel. In addition, there is rainwater collected from roofs, or in dug ponds or tanks which last at least into the dry season. The household that is remote from neighbours may even have its own well or spring, and consequently little contamination except from its own wastes. Such areas may also have households at the extreme limits of distance from a water source, and in the dry season people have to go 5 kilometres or more to the only available source.

*Water supply choice.* One common characteristic of low-income communities is that there is much more necessity for choice of source than in higher income areas, where piped water serves almost everyone (L14). Recently, there have been some studies seeking to determine what factors affect the choice of source, the quantity of water used, and the ways in which it is used. These studies are still few in number, but there appear to be some general findings emerging.

There is considerable evidence that a woman in selecting her source picks the one she considers the best quality for her family. A user's criterion may here be more likely to include taste, temperature, odour and appearance than considerations of bacteriological quality, but they are nonetheless real for her. Costs, in terms of the distance walked, cash payments, or time spent waiting in a queue, seem to be important factors in the choice of source of water in all areas. However, cost does not seem to determine the amount of water carried home, and there is no entirely satisfactory explanation of why one woman will struggle home with 40 kilograms of water on her head while another is content with much less.

The volume of water used by people who carry it home seems to be associated with the number of people in the household. Thus, the larger the household, the smaller the per capita use daily. This may have something to do with the composition of the household and who carries the water, and it also seems to hold true for the low-income families with piped water supplies in a city. One of the major factors affecting the quantity of water used in a household is whether the washing is done at home or not. Where rural water schemes have been introduced there may be clothes-washing facilities associated with them, although in urban low-income areas of Africa this is

seldom the case. People often carry clothes to the source to wash them, or to a special spring, as in Nandi country in Kenya. The closer they are to the source, the more they tend to use it for washing clothes.

A model of domestic water choice and use might appear as shown in fig. 2.1 (L14), where the user considers water quality, technical feasibility and costs in a broad sense, including time, cash and energy, and the social relationships involved in getting the water, and selects a source.

Water that is carried home is used in the household in a variety of ways: for drinking, cooking, bathing, washing, cleaning, etc.

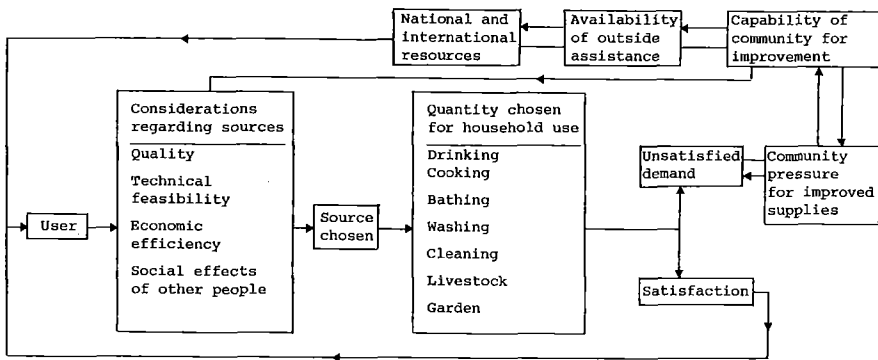


Fig. 2.1. A model of water supply choice and use in low-income communities in developing countries.

From White et al. (in L14).

## Transmission of Diseases

In recent years a conceptual system for understanding diseases related to water has been developed and is now fairly widely used. More recently a similar conceptual system for diseases related to excreta has been proposed. The main elements of these two systems might well be integrated for the present purpose.

*Water-related diseases.* A water-related disease is one which is in some gross way related to water in the environment or to impurities within water (L10). Water-related diseases may be divided in *infections*, caused by a biological agent (a pathogen) and including some of the greatest causes of disease and death in the developing countries, and *water-chemistry-related* diseases such as fluorosis linked to high fluoride levels in drinking water, which are only of major public health importance in certain areas of some countries, and, in developing countries, totally over-shadowed by the infections.

The water-related infections are characterized by four different transmission mechanisms which are water-related:

*Water-borne transmission*

Transmission occurring when the pathogen is contained in water which is drunk

*Water-scarce or water-washed transmission*

Transmission from person to person in the domestic environment which might be reduced if water was more available and was used to improve personal and domestic cleanliness

*Water-based transmission*

Transmission of a pathogen with an obligatory aquatic intermediate host or hosts

*Water-related insect vector transmission*

Transmission by insects which breed in water or which live and bite near water

All water-related infections transmitted by the water-borne mechanism may however also be transmitted by more direct person-to-person routes, in other words by the water-scarce or water-washed mechanism. Understanding the transmissions is necessary as a basis for an understanding of prevention, and in particular, to a knowledge of what modifications in water supply are necessary to have the best impact on a particular infection.

*Excreta-related diseases.* An excreta-related infection is one related to human excreta (urine and faeces). There are two different transmission mechanisms (L10):

*Transmission via infected excreta*

The pathogen is released into the environment in the faeces or urine of an infected individual

*Transmission by an excreta-related insect vector*

An insect which visits excreta to breed or feed may mechanically carry excreted pathogens to food or an insect vector of a non-excreted pathogen may preferentially breed in faecally polluted sites.

All excreta-related infections except Bancroftian filariasis are excreted infections, shed in the urine or faeces of an infected individual. The exception is transmitted by a certain mosquito which breeds in sewage or other heavily polluted waters.

All excreta-related infections are also water-related, except for two types of helminth which are excreted and reinfect through the skin without requiring an intermediate host. By contrast, there are many water-related infections which are not excreta-related (for instance skin infections, trachoma, guinea worm and malaria).

If an excreted infection is to spread, an infective dose of the relevant agent has to pass from the excreta of a case, carrier or reservoir of infection to the mouth of a susceptible person or some other portal of entry. Three key factors govern the probability that, for a certain transmission route, the excreted pathogen from one host will form an infective dose for another: latency, persistence and multiplication. There is a wide variation in the concentration of pathogens passed by an infected person. Latency is the



interval between the excretion of a pathogen and its becoming infective to a new host. The persistence or survival of the pathogen in the environment is a measure of how quickly it dies after it has been passed in the faeces. Under some conditions certain pathogens will multiply in the environment, so that originally low numbers can be multiplied to produce a potentially infective dose. While the minimal infective dose for some diseases may be a single organism, or a very few, the doses required in most bacterial infections are much higher. Host response is important in determining the result of an individual receiving a given dose of an infectious agent. In particular, acquired immunity, and the relation of age to pathology, are important for predicting the effects of sanitation.

The balance between exposure to infection and host response to it will determine the pattern of excreta-related disease. If transmission, creating exposure to a particular infection, is low most people will not have been exposed and are thus susceptible if a sudden increase in transmission occurs. It will then affect all age groups in *epidemic* form. Improvements in sanitation will have a big effect under these circumstances by reducing the likelihood and/or magnitude of an epidemic.

By contrast, if transmission is very high, all the people will be repeatedly exposed to infection and first acquire it in childhood and immunity will develop. The infection will always be present and is described as *endemic*. Under these conditions much transmission is ineffective because of immunity, and reduced transmission as through improved sanitation will only delay the date of infection somewhat so that older children are seen infected. Very large sanitary improvements will either render the infection very rare, or if the disease was originally very highly transmitted, make it an adult disease.

Some excreted diseases are infections exclusively or almost exclusively of man. Others involve animals either as alternatives to man as host, or as hosts of other stages in the life cycle. In the first case control of human excreta is likely not to suffice for complete prevention of the infection. In the second case, some excreted infections with intermediate hosts will be controlled if excreta are prevented from reaching this host, if these hosts are controlled, if people do not eat the intermediate host uncooked, or do not have contact with water where the host lives.

## **Breaking the Chains of Transmission**

*Preventive strategies.* In order to highlight the amenability of the different water-related and excreta-related infections to prevention through interventions in water supply, excreta disposal or hygienic behaviour, the two groups of infections could be brought together to form what might be called

Table 2.2. *Decade-related infections.*

INFECTIONS	Importance of alternate control measures							Public health importance	Importance for Decade policy
	Water quality	Water availability	Excreta disposal	Excreta treatment	Personal and domestic cleanliness	Drainage and sullage disposal	Food hygiene		
1 Diarrhoeal diseases and enteric fevers									
1.1 Viral agents	2	3	2	2	3	0	2	3	3
1.2 Bacterial agents	3	3	2	2	3	0	3	3	3
1.3 Protozoal agents	1	3	2	2	3	0	2	2	3
2 Poliomyelitis and hepatitis A	1	3	2	2	3	0	1	3	1
3 Worms with no intermediate host									
3.1 <i>Ascaris</i> and <i>Trichuris</i>	1	1	3	3	1	1	2	2	3
3.2 Hookworms	1	1	3	3	1	0	0	3	3
3.3 <i>Enterobius</i> and <i>Hymenolepis</i>	1	3	2	2	3	0	1	1	1
4 Beef and pork tapeworms	0	1	3	3	1	0	3	2	2
5 Worms with intermediate aquatic stages									
5.1 Schistosomiasis	1	1	3	2	1	0	0	3	2
5.2 Guinea worm	3	0	0	0	0	0	0	2	2
5.3 Worms with two aquatic intermediate stages	0	0	2	2	0	0	3	1	1
6 Skin, eye and louse-borne infections	0	3	0	0	3	0	0	2	2
7 Infections spread by water-related insects									
7.1 Malaria	0	0	0	0	0	1	0	3	2
7.2 Yellow fever and dengue	0	0	0	0	0	1	0	3	1
7.3 Bancroftian filariasis	0	0	3	0	0	3	0	3	3

0 = no importance

1 = little importance

2 = moderate importance

3 = great importance

From Feachem (L10).

the 'Decade-related infections', i.e., in groups having similar epidemiological features (L10). The groupings considered are presented in table 2.2, indicating also the relative importance of alternative preventive strategies concerning water supply, sanitation and health education.

A summation of the scores of each column gives a rough guide to the overall relative importance of the preventive measures considered:

● water quality	14
● water availability	22
● excreta disposal	27
● excreta treatment	23
● personal and domestic cleanliness	22
● drainage and sullage disposal	6
● food hygiene	17

The important conclusion to be drawn from this is that the health impact of the Decade will not be achieved by a simplistic policy of supplying just *clean* water. Only carefully designed programs which integrate water quality improvements with improvements in water availability, sanitation and *hygiene education* will bear fruit.

The diarrhoeal diseases are, when combined with malnutrition, a major cause of childhood disease and death throughout the developing world. They are therefore the most important group of water- and excreta-related diseases, and are caused by a variety of excreted viruses, bacteria and protozoa. However, viral diarrhoea will probably not be much affected by water supply, sewerage and hygiene. In this case, therefore, vaccine development may be the only reasonable prospect for control. There are many areas of uncertainty and ignorance, and diarrhoeal research is a fast moving field at the present time.

*Does clean water make people healthier?* The documentation given in table 2.2 clearly indicates the intricacy of transmission routes and importance of different control measures that supplement each other in breaking the chains of disease transmissions. This intricacy heavily contrasts with the oversimplification of the Decade slogans and exhortations, which aim at creating the political will necessary to reach the goals of the Decade (L26). Exhortation is probably politically necessary, the sloganeering probably useful in the sense that it brings a problem to the surface, mobilizes politicians and governments and generates interest.

The whole complex of issues may however lead to a problem: in order to

sell the message—e.g., piped water in every household—reality has to be deformed, simplified or adapted to single operationalism: for example, that one single action will promote development. Clean water alone will not make people healthier. There are many paradoxes in the relation between water development and health: people get sick from dirty or infected water, but they do not necessarily get healthier from clean water. Much water development has been founded and funded on the simple belief that clean water will make people healthier.

However, several attempts to measure the impact of interventions on rural health have been inconclusive. This may have several reasons:

- there are problems of measuring health. Disease is easier to measure, but health and well-being is not the mere absence of disease—there is a methodological problem of measuring which has to be solved
- something happens to the clean water and there are many ways for it to get dirty. Even if the drinking water is safe at the source it may be contaminated from the source and beyond
- even if the drinking water in the home is safe, there are many instances when people drink: at the market, when travelling, etc. Sanitation, hygiene and hygienic behaviour are as important for health as clean water so that the achievements of health benefits certainly do not come automatically when safe water is provided.

## **Creation of Awareness**

*Regard to cultural and social conditions.* In the prevention of water- and excreta-related diseases, it might be wise to investigate which existing cultural and social structures could be used, especially in diarrhoeal prevention programmes (L26). There are, for instance, occasions when concepts of ritual purity coincide with hygienic measures. Whatever the intended religious or magical purposes, some means of sanitation may in fact function to protect health and ward off disease: left-right hand practices, ritual cleansing, anal cleansing with water, notion of personal cleanliness, in short what has been called the positive elements in folk hygiene. Such elements should be included as parts of a system of public health.

Many consider the sanitation programmes as perhaps more difficult than the water supply projects (L11), because of the greater number of families that must be dealt with and of the task of motivating the people to improve their hygiene habits.

*Health education and the crucial role of women.* The importance of health education cannot be overstressed. It is required to secure the understand-

ing, support and participation of the rural population. Effective education on domestic hygiene for communities needs to be made part of social development programmes in order to motivate and involve communities in the provision of basic sanitary facilities (L19).

Attention must be paid also to the important environmental impacts arising from the provision of drinking water supply and sanitation, since the provision of such facilities may in fact lead to serious health problems due to the improper handling and disposal of waste water, particularly in areas where there were no such facilities before.

Health problems affect rural women in many special ways, because as mothers and caretakers, the health of the members of their families are primarily their responsibility, and because they must use and be in constant contact with contaminated water for various household purposes, including washing, preparing food, and bathing children (L14).

The difficulties faced by most health education programmes are linked to their lack of supportive appropriate technology in these basic areas, especially regarding safe water supply. Many years of preaching prophylactic measures on an individual basis would in many cases be ineffective if not wasted when undertaken alone. In fact, rural women would probably continue not to boil contaminated water, even when they were aware of the need to do so for the safety of their children, if access to water supply and firewood were difficult and exhausting. It is unreasonable for a health programme to exhort people to use purer water if women without water supply in or near the home must carry more water. In order to boil it afterwards, they must also find and carry a supply of increasingly scarce firewood.

Advice on better nutrition and health practices is wasted unless women are assured of the resources for following such advice, and will not be prevented from doing so by their husbands and families. And if health education programmes are undertaken in a vacuum without adequate means to improve water supply for the rural population, the continuing gap between preached practices and the reality will lead to disillusionment. As a result, it might be difficult to obtain community involvement in the implementation of these and other development programmes.

The relationship of health to safe water supplies should be stressed, for health educators have constantly pointed out that community action involvement depends mainly on people's perception of the multiple causes of health problems. Due to the high degree of emotional involvement concerning disease and death, the effects of health education programmes in combatting water-related diseases can be maximized when health educators gear the initial emotional involvement of the community around health

issues, especially of women, to a more rational perception of structural causes such as water supply, conservation and nutrition. When women are aware that high infant mortality rates are mainly due to the lack of safe water supply and malnutrition, they are motivated to become more involved in action-oriented programmes.

### 3. Reaching Social Objectives

... Decade goals become not only an end in themselves, but also a vehicle in the process of self-reliance.

J.M.G. van Damme, International Reference Center, Haag

#### **Water Supply and Social Development**

*Many projects fall short of objectives.* Since water supply systems may affect, positively or negatively, the development process in various sectors of the village economy and society (L15), it has sometimes been argued that although water by itself is unlikely to have a significant development effect, 'its absence will prevent, or at least greatly hinder development'.

Although water supply would be expected to contribute to improve well-being of people, many projects fall short of their stated objectives because of technical or institutional problems, such as equipment failure, poor maintenance, or lack of trained personnel. Not seldom the failure is basically due to lack of local support. For example, the community may dislike the taste of 'clean' water, consider the supply unsafe, or believe that the water be taken from a sacred site (C1).

The message conveyed by past experience (L15) is that in 'bringing a rural water project to an area, we not only introduce new techniques, but also new concepts about the relation of water to health and disease, and new forms of organizing the community'. The success of rural water projects might therefore be a function of, among other things, the extent to which it will be possible

- for the project to adapt itself to prevailing socio-economic conditions
- for the local community to absorb the changes resulting from the project.

*Function of water in society.* Abel Wolman once expressed his view on the function of water in society in stating that 'Water is at once the servant and the master of Man' (I3). Water is the master of Man as it indicates the limits of human settlement and growth. No water at all means no life. Periodical

lack of water means droughts and famines. Too much water means flood catastrophes, water-borne diseases and deaths. But water is also the servant of Man. The old riverine cultures prospered because of the construction of intricate systems for water distribution. Development and improvement in our days is possible only with the access to safe water in sufficient quantity and of satisfactory quality.

*Seminar conclusions on social impact.* Social impacts of rural water supply projects may be positive as well as negative. The seminar, during its discussion of social impact assessment, which was chosen as the main topic in one of the two workshops devoted to social and economic aspects of rural water supply, identified

*positive impacts as:*

- improvement of health and hygienic conditions
- a growing number of women no longer have to waste time on the road to fetch water. They may be engaged in more productive activities such as weaving, gardening, working in small industries. Children may go to school instead of for water
- nomadic populations have settled and enjoy social benefits such as schools and hospitals; and

*negative impacts as:*

- overgrazing as the result of concentration of livestock and of multiplication of wells in grasslands
- water supplies not being used because water is 'cold' or has 'no taste' or 'bad taste'
- the water supply 'does not belong' to the village: its maintenance is considered to be a government responsibility. It may break down frequently and, if not repaired, the government will lose credibility. It will also be more difficult for the population to believe in the benefits of new technology, and in development in general.

The seminar further concluded that one lesson of past experience therefore is the need to consider social aspects already at the planning stage, both by planners and engineers. Some awareness of the effect of a rural water supply project on social conditions is needed at the level of the construction engineers, and social studies are needed at the planning level to ensure the success of the project. Shortage of time and financial resources do not always make it possible to have detailed social surveys, but a minimum level of social considerations is needed in project conception, design and evaluation. It is essential that water agencies have at least some in-house capacity to assess the social impact of projects, especially as regards the daily life of women.

## Social Benefits

*Early identification of benefits and beneficiaries.* Since, during the period of project design or early implementation, it is necessary for project engineers to visit project sites in order to make technical surveys, this time can also be used to obtain rough information on the social factors (L15). As a minimum, the probable benefits and beneficiaries, as well as gross socio-structural and organizational factors, can be identified through discussions with the local people. This can be done through the preparation of an interview guide or checklist which is to be filled out by project engineers as part of their other information-gathering efforts. Such information would provide a rough guide about possible social factors and help assure that the project design, at least to some extent, takes these factors into account.

*Criteria for social benefits.* As a general rule, it is useful to distinguish between the use of water for production and for consumption (L15). The social benefits of projects which provide water primarily for *production purposes*, tend to be derivative of their economic effects in terms, for example, of increased agricultural production, employment and income. For the provision of water for *consumption purposes*, however, direct social benefits may be derived such as improved health, which is the most commonly used justification for drinking water projects. Greater convenience is less frequently, or only secondarily, a stated objective in the sense of reducing the time and effort traditionally spent on fetching water for household purposes. These direct effects are expected to contribute ultimately to providing well-being of the population living in the project area, particularly via increased productivity and income.

It is quite clear that 'improved public health', 'greater convenience' or any other of the commonly stated objectives of drinking water projects will be attainable only if

- local people actually *use* the potable water provided
- they are able to find *access* to the water source
- the *maintenance* of the installed water supply system is ensured.

The question is then how to obtain these conditions. Development studies have consistently shown that socio-economic change will be more organic and self-sustaining if it is indigenous to the social system, which, for water supply, would be the village or community. This would suggest that adapting the project as far as possible to both its natural and socio-economic environment would greatly enhance the probability of its absorption into the village economy and society.



*Community survey.* It might, therefore, prove worthwhile to undertake a community survey or diagnosis early in the process of project planning focusing on two problem aspects (L15):

- possible alternative ways and means of adapting the project to the given economic, social, cultural and political conditions under which it will need to operate
- whether the project activities needed to attain its stated objectives would require the local people to change certain aspects of their life or environment and, if so, which ones.

The variables to be studied in order to gain the necessary insights into the structure and functioning of the target community or area will, of course, vary from case to case. The following sets of variables illustrate the type of information which must usually be obtained:

*Traditional water-use patterns.* In some countries people tend to use different water sources for different purposes, such as drinking, bathing or washing of clothes. Thus, 'it may sometimes be better to design a project in which the aim is to improve the water supply from several different traditional sources instead of concentrating on the provision of a single, larger alternative source' (Whyte in L15).

The natural water points, such as springs or river banks, have traditionally, in rural society, been a focus of social interaction and communication, particularly for women, since in many countries, the fetching of water is a task primarily assigned to them. The introduction of new water sources, especially the provision of house connections, may therefore have repercussions on the existing patterns of communal activities.

*Traditional social beliefs and attitudes.* Most if not all societies, whether tribal, peasant, rural or urban, have their 'own' beliefs and practices concerning health and curing of diseases. To a greater or lesser extent these may reflect what is considered to constitute the 'scientific knowledge' in this area. The importance of incorporating these beliefs in a modernized view on health has already been discussed in Chapter 2.

*Community structure, organization and decision-making.* Unless 'community or village enthusiasm is present at the time the system is being constructed, there is a much greater probability that the system will not be widely used, or that it will fall into disrepair in a short time' (Saunders & Warford in L15). The villagers' interest depends among others, on the factors discussed above. An additional factor will be the priority assigned to water, i.e., the overall structure of the villagers' preference system. It may be that the local

people may perceive a need for better water, but feel other needs more urgent.

Whether a project meets the perceived needs of the local population will furthermore depend on who had been able to make his/her views and interests known to the project staff. Evidently, community participation cannot be achieved simply by listening to a few community leaders.

The villagers with greater economic power and social status may be able to influence the designing of the project, for example, by siting the water source. It is obvious that the persons living close to watering projects are more likely to benefit than those who are distant. Moreover, when the watering points are located on private lands the respective owners are given the opportunity to exercise control of access. The locational aspects become even more important in cases where the project allows irrigation of garden plots, watering of cattle, etc.

Also the institutional aspect of maintaining a water supply system has great relevance. Shifting from natural water sources to systems that require maintenance makes demands on communities where provision must first be made in the public sector to provide the necessary services. This in turn requires that recurrent revenues must be made available either through central funding, or from local generation, or that some means of voluntary local maintenance system must be worked out. Experience however indicates that the two alternatives are mutually exclusive: provision of government responsibility usually precludes any voluntary maintenance by removing the incentive from the people themselves. At the same time, maintenance of a water system through local action requires that an organizational capacity exists in the community. Furthermore, the degree to which a community would be able to mobilize the maintenance support depends, in part, on the complexity of the system itself. A highly technological system or systems requiring mechanical maintenance may be difficult to maintain in primitive rural societies.

*Differentiation of sex roles.* Women being, as earlier mentioned, the traditional carriers of water to the household implies that the bringing of water to rural communities might fundamentally alter the existing division of labour between men and women. If water supply projects be designed 'to modernize women's role in rural water supply, preserving the importance of their contribution while reducing hardships' (United Nations in L15), it would be necessary to involve women actively in the construction and maintenance of the new water system.

## Social Impact Assessment

*Seminar conclusions.* When discussing social impact assessment, the seminar concluded that it is essential that much greater effort has to be made to educate the public in the acceptance, use, maintenance, and benefit of rural water supply projects. These efforts could be facilitated by a greater understanding of the views of the rural people themselves. Major approaches taken by countries today to overcome constraints are integration of health education programmes in the project; the mobilization of community participation; increased attention to rural population; and accelerated manpower development.

*Importance of local conditions.* There are numerous methodological problems encountered in the assessment of the social impact of rural water supply projects (L15). Principally, there is evidently need to obtain information on three sets of variables:

- the existing level of people's well-being including such components as food and nutrition, health, income, and employment
- the locally available social attitudes and patterns of behaviour relating to water
- the socio-structural characteristics of the community into which the project will be placed, including the distribution of socio-economic power and prestige, local-level organizations and decision-making processes.

The difficulty in obtaining such information is that most of the factors in water delivery are of technical and engineering nature, and the bulk of the decisions concerning the project design must be made using those criteria. Moreover, if water systems are to be developed for a maximum impact they must be reasonably cost-effective. The means for collecting information on social variables must therefore be sufficiently inexpensive in order not to add unduly to the cost of the water system.

There is a range of options available for obtaining the desired information in a generally acceptable way, ranging from comprehensive base line studies through systematic observation. Clearly, the shorter the time available between assessing the feasibility of a project and its final design and implementation, the more quickly the information will have to be obtained and the less complexity will be possible. Whether one is able to use sophisticated methods of information collection will depend on the level of preparation of project resources which can reasonably be devoted to it. The more complex a project, the more important may be the assessment of its components to assure complementarity. And the larger the investment in the project, the more information it may be feasible and desirable to collect.

Regardless of these factors, however, the general type of information to be obtained would be similar in all cases.

*Base-line study.* Assessment of project impact should seek to facilitate and support rational decision-making on the project, including decisions on the project design (L15). The assessment process will thus have to start before the commencement of project implementation with a so-called base-line study.

Base-line studies are intended to provide the data and information required for the project design, and to represent a preproject evaluation of the given situation: the problems to be resolved, the existing potential for change, and the factors to be modified. They would also provide a bench-mark against which to assess future change, and hence serve as the basis for subsequent monitoring and evaluation studies.

At the same time, base-line studies can also be a first occasion for community involvement in the project. If organized appropriately, the 'questioning' of the local people will not only be a means of obtaining the required data but also of helping them to gain a better understanding of their present situation and the way in which they could benefit from the proposed project.

The questions which might be asked are as follows:

- what are the benefits expected from the project and who will benefit (health, work, siting of the water source)
- what attitudinal or behavioural factors are likely to affect the project process (water-use patterns, health, work, participation)
- what organizational and structural characteristics of the community are of relevance to the project process (socio-economic structures, community organization, role differentiations).

*Methods of data acquisition.* In an examination of national experience in this field, the United Nations has proposed a set of procedures for designing monitoring and evaluation into the programme planning and implementation process (L15). The suggested procedure is to design information collection simultaneously with the formulation of the projects, and to make the evaluation in close consideration of project objectives. Special emphasis is placed on designing the data acquisition in terms of both immediate assessment needs and future monitoring and evaluation.

Three methods are suggested for obtaining information:

- community level studies through interviews with local influentials
- group interviews with local residents
- interviews of individual families.

Extensive use of sampling, both at community and individual levels is proposed, with the size of each sample being determined by the precision required from the data.

In order to assure that the information is collected systematically, it is preferable to have structured forms for each type of information collection. In addition, the completed forms will permit future monitoring and evaluation by direct comparisons.

*Monitoring and evaluation.* The project monitoring and evaluation may be one of the most important follow-up activities to water projects (L15). Once the system is installed, official interest can fade. It is important to realize that impact will be achieved only if the installed systems are being used because people have developed new water-use habits. Monitoring and evaluation of water projects must especially be focused on the control and assessment of this 'habitualization process'. The design of water projects *must* therefore include provisions for post-project monitoring and evaluation: the assessment of people's access to water, the actual use of the water system, and its maintenance. We will return to this issue in greater detail in Chapter 5.

## 4. Revolutionize the Role of Women

She lives in a hut  
She cannot read or write  
Her energy is sapped by disease  
She walks miles for water that is not safe  
She works in the burning sun on a land she does not own  
She and her family are always hungry  
She will die young.

In van Damme (L5).

### **Water Fetching is Part of the Domestic Burden**

*Present labour burden on women.* While many people might see the Decade as primarily a health initiative, and certainly its potential impact can most visibly be seen in altering the health of the people in the developing world, its impact is really much broader, touching every aspect of development (I2).

Each day women throughout the developing world walk miles to carry the water necessary for the barest survival. "That the situation continues to exist generation after generation is really a crime of humanity against

women and children' (Obeng, L23). Therefore, the provision of clean and accessible water would do no more than revolutionize the role of women in the world. At the recent Mid-Decade Conference on Women in Copenhagen, a strong resolution was passed endorsing the Water Decade and calling on member states to participate to the fullest extent.

Women, being the traditional carriers of water, may spend as long as four hours or more for a single journey to fetch water. Thus, the bringing of water to rural communities could in some cases fundamentally alter the existing division of labour between men and women (L15).

The labour burden on the women food producer is enormous, and low in productivity, whether the husband is involved or not (L14). She has numerous off-farm duties, including the portage of water and fuel. The women take care of the daily tasks in the family and in the production, while the men do the tasks that appear periodically. A male worker laying a water pipe to a house in the city is considered 'economically active', a woman carrying a 40 kilogram water jar daily for one or two hours is 'just doing a household task'. But obviously that daily hour might be used for more productive activities.

UNECA (in L14) has estimated that in Africa women provide 60–80 % of the agricultural work. The work performed by women relates to both agriculture and non-agriculture activities, with domestic work being carried out almost exclusively by the women.

*Patterns of water collection.* Table 4.1 shows the time spent for water collection in Africa (L14). The physical efforts and waste of energy, and also the special difficulties of transporting water in countries with mountainous regions should be considered.

Table 4.1. *Time spent for water collection in Africa.*

Distance between water source and consumer (miles)	Time spent in collecting water (hr)	% of average daily working time spent in collecting water
0.25	0.166	2.8
0.50	0.333	5.5
1.00	0.667	11.1
2.00	1.333	22.2
3.00	2.000	33.3
4.00	2.667	44.4
5.00	3.333	55.5
6.00	4.000	66.6
7.00	4.667	77.7
8.00	5.333	88.8
9.00	6.000	100.0

From Jørgensen (L14). (Source: Biswas 1978)

It has been calculated that it takes up to 12 % of daytime caloric needs of most women in non-dry areas. In dryer areas and in mountainous areas the energy spent fetching water and carrying firewood may take up to 25 % or more of the daytime calory consumption.

However, water collection is but one of several tasks making demands upon a woman's energy. 30 % of the daily intake is used solely for night--time metabolism, and breastfeeding may use another 35 %. In conclusion, the breastfeeding, water-drawing mother has to use the main part of her energy already for these basic tasks (Isely 1980).

Water fetching does much to determine the structure of the day for the woman in the household (L14). Usually she has to go far for water first thing in the morning, and again during the day. The diagram in fig. 4.1 sows water use at two sites in East Africa (White et al, 1972. in L14). At Alemi in the Lango district of Uganda near the River Nile, the land appears swampy, but for three months of the year the women have to dig holes in the edges of the swamp, or walk to a government borehole. The household illustrated contains six people, with only the mother and daughter carrying water. The mother made three trips this day to the borehole, one in the morning and two in the afternoon, and the daughter one. Each trip takes her only ten minutes and she uses a large tin container holding about 40 kilograms of water. The largest volume of water is used for bathing, although people bathe also in streams and ponds. Cooking claims the next largest volume, with enough left for dishwashing and drinking. Water is stored in a covered pot in the house.

In the second household at Mkuu, a farming community on the green slopes of Kilimanjaro in Tanzania, another family of six people uses a much smaller total volume of water. Here the mother sends her children several times a day to fetch water from the rural standpipe. The water originates in a high mountain stream. They walk about one kilometer to this source, as she feels the little stream running near their house is not safe to use. Outside her house she keeps a 200 litres cask in which she stores water, and into this goes water from the roof when it rains. Her husband's bath and that of a male visitor use up the rest of the water in the cask, so she makes two trips to replenish the supply. In the afternoon she sends the children off again to the standpipe. Her drinking water is kept in a small clay pot and she feels it is safe to drink without boiling. Had there been laundry to do she would have carried more water.

Both of these women are responsible for most of the food-growing for their family, and have to fit their water carrying in with the rest of their daily tasks.

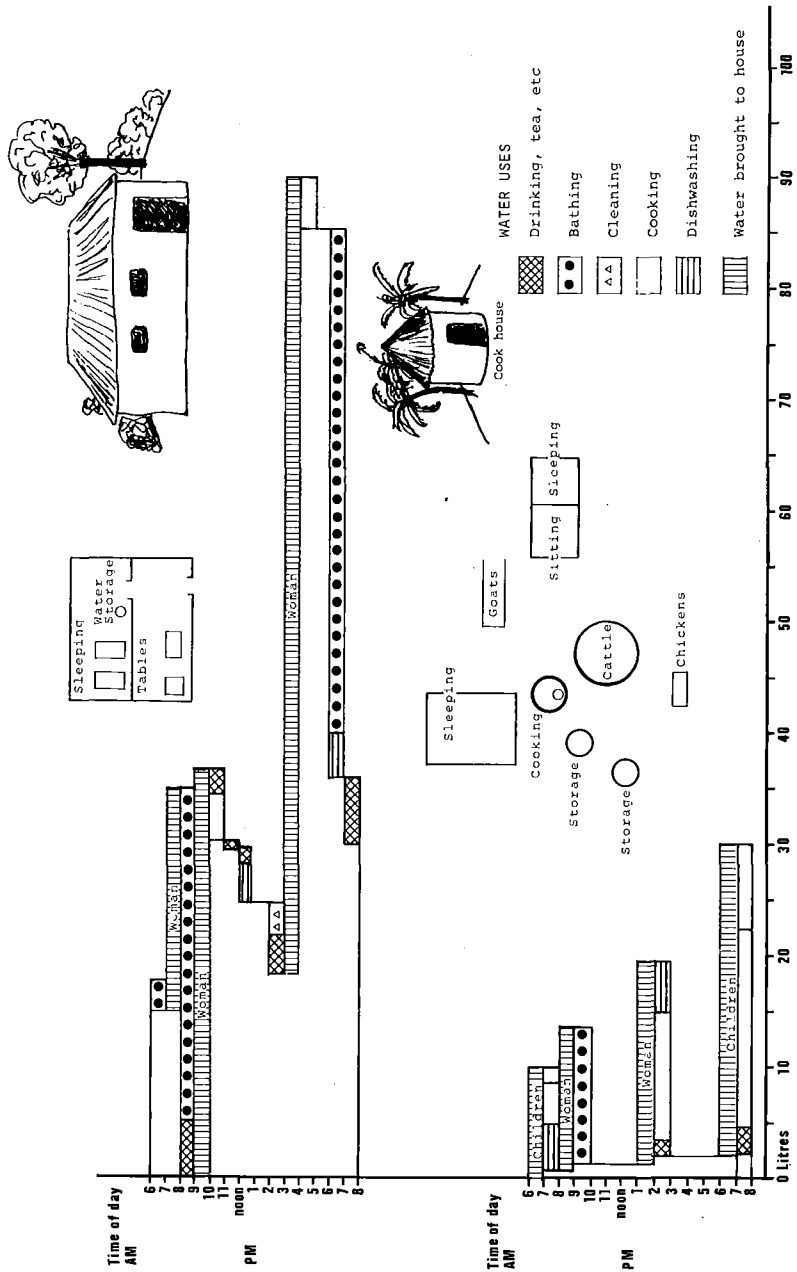


Fig. 4.1. Diagram of one day's water use at two African sites. Above: an Alemi household. Below: a Mkuu household.

From White et al. (in L14).



## **Effect of Modernization on Women**

*Reducing women's hardship.* On one hand the depletion of a woman's energy by carrying water reduces her capacity for other activities (L14). On the other, as has been showed by a study in Kenya on the impact of improved water supplies on women, women received less assistance from other family members in fetching it when water was made more accessible. Therefore, improved access to water may hold no benefits for women unless supported by other programmes, such as improving the efficiency of the water carrying system.

Modernizing water supply systems should not aim only at relieving women from traditional tasks, as this might be detrimental to the social status they enjoy in rural communities. The aim instead should be to modernize women's role in rural water supply, preserving the importance of their contribution, but reducing hardships. Such a course of action is also supported by evidence that village involvement in the construction and maintenance of rural water systems is crucial for their success.

Some people hold the attitude that relieving the burdens of women will leave them idle. With water nearby, the woman might, however spend the newly available hours working in agriculture, learning new methods of agriculture and food processing, or studying nutrition, child-care or literacy, or participating in self-help activities, which improve production and raise community levels of living. What should be kept in mind is the objective of allowing time for more profitable activities, and the consequent need to introduce these activities. Real progress is first expected when – in the planning process – women are properly recognized as an essential target group of rural population.

*Women's subordinate role in development.* In the planning of the development of a country attempts have been made to encircle the factors preventing women's full participation in the development process (L14). It is generally recognized that the effects of modernization vary as between men and women. In contrast to 'traditional development theory', exemplified by liberal modernization theory, it can be maintained that society can hardly be considered as an organic whole, implying that development in one sector necessarily generates the same kind of development in other sectors. The social transformation process is not free from contradictions: thus, a policy aiming at increasing women's employment possibilities may lead to pauperization of women if at the same time, the general wage and labour conditions are not adjusted.

Considering women as independent social and economic individuals. and

not only as appendices to men kept out from development, recent development research on women has proved that many ignored factors may lead to an undesired development. The basic theoretical ideas of the development strategies in the 50's and 60's, including the statistical surveys of the Gross National Product (GNP) made until now, have been criticized from the viewpoint that they do not include the value of women's subsistence production, the value of women's work in the household, and women's work in various services. Measuring development from the annual growth in percentages of GNP, therefore, provides a completely distorted view of women's position and possibilities in the development process.

In the new theory of women's subordinate role in development, women are considered a reserve labour force, to be directed from the household to the labour market.

This view-point is, however, hardly relevant to many African countries. A precondition is that there is a demand for female labour power which is hardly the case. Another is that women's work in the household and the subsistence production can be dispensed with. In the African countries the unequal distribution of investments in the various sectors (traditional and modern) can be taken as an indication of women being marginal to the modern sectors, as they have been 'left behind' within the traditional fields of activity with inferior productivity. Because economic value is not attributed to women's work in the household or in the production of food crops for the family, investments will mainly be canalized into the modern sectors, where returns are higher and can be measured in the usual economic sense.

As with other 'discriminated' groups of the population who can be rather effectively controlled, women lose their possibilities of taking part in the decision-making. The inferior value attached to women's work generally can also cause a change in the earlier complementary division of labour between the sexes, making women dependent on men: when the family is dependent on one income, i.e., that of the man, he will be the central person in the family.

*Conservation of women's status.* In conclusion, improved access to water may hold no benefit for women unless there is the conscious intent to modernize women's role in developing rural water supplies, preserving the importance of their contribution while reducing hardships (L14). The building of water supplies can serve as a catalyst for incorporating women in agro-industries and semi-rural industries brought about by the improved availability of water. There is however a need for bringing women into the decision-making process in the planning of water projects and the importance of such aspects as time, education and hygiene.

In fact, the lack of proper housing, sanitation and safe rural water supply may build up a scepticism on the part of rural populations regarding the willingness of decision-makers to bring about a significant change in their situation. This is in part due to the fact that many national plans seem to invest more in urban areas and wealthier villages than in remote rural areas, although the vast majority of the population is poor and lives in the latter. Therefore, the constraints for improving rural water supply are not only confined to political, administrative and technological inadequacies. On the administrative side, the problems are not only located at national levels, but also in the villages themselves as local leadership is delegated almost only to men.

In these cases, if rural women were to have more power in local and national decisions regarding rural water supply, since they are more directly affected, a village's representation regarding water demands could become stronger. As a result of an effective participation of rural women in water supply developments, the involvement of the communities regarding their contribution both in the form of labour and/or money for construction and maintenance of rural water supplies could also become more feasible. Participation of women in grass-root organizations and women's groups might be encouraged to provide them with legitimate basis for their demands, thereby bringing about their participation also in the local and national decision-making process.

Even if the provision of more convenient water sources, no doubt, will have the positive effect of freeing women from the time-consuming and tiring drudgery of carrying water over long distances, it at the same time could also mean that women lose the opportunity to congregate, a form of non-material activity which they may, for various reasons, enjoy and consider important and valuable (L15). The delivery of water directly to the house may thus improve convenience but at the same time produce alienation, whereas the delivery of water to a central point in a community can fail to relieve the problem of water carrying.

It would seem important to determine the site of the watering point so as to achieve, under given local circumstances, a balance between the two. If the project failed to do this, the result might be, for example, a rejection of the project by women, and hence the non-use of the water source provided. Such a reaction might be experienced especially in societies where the prevailing social norms restrict women's sphere of life primarily to the house and where women must have a socially-acceptable reason for being seen in public, such as fetching water.



**Part III**  
**IMPLEMENTATION**

## 5. Planning and Implementation

... water is one of the location factors in urban and rural planning, a particularly relevant factor in the developing countries, where scarcity of capital does not permit transportation of water from distant sources.

Enzo Fano, United Nations

### Needs for Integrated Strategies

*Discard ineffective methods.* It is evident from the country reports to WHO that the Decade has generated interest in many developing countries. Since so much has been spent in recent years on the rural water supply and the situation still continues to change only slowly, there is evidently a need for the freshness of new thoughts and approaches and purposeful action (L22). There should be sufficient courage by implementers of programmes, and hindsight and foresight from donors to *discard old and ineffective methods* and strategies.

An integrated approach to water supply logically implies that the provision of water facilities should be seen as *multidisciplinary activities with a multipurpose objective*, including contribution to the improvement of rural health and life and sound management of water sources (L22). The integrated water supply strategy has incorporated into the domestic supply programme several other component activities which make it a multipurpose strategy.

*Command political attention.* One approach to reversing the sombre trend of past experience in the field of rural water supply consists of including community water supply projects for low-income consumers within plans and programmes of larger scope and breadth, capable of commanding political attention and a flow of resources (L9). Plans and programmes for integrated rural development, and for integrated river basin development would appear to be capable of accommodating the provision of water supplies to low-income consumers on terms which are economically, financially and politically acceptable.

The integrated strategy is particularly useful as a strategy for providing water supply in large irrigation schemes. Quite often, for example, when water is planned for crops on irrigation schemes, supply of water for the workers is hardly considered, in endemic areas forcing them to constant water contact, increasing the incidence of bilharzia. With some adaptations, domestic water could evidently be provided if an integrated strategy were to be followed.

The identity of the community water supply, in this approach, might

however be subsumed with other well-defined development sectors such as agriculture, manufacturing and housing, and might be especially vulnerable according to the vagaries in the flow of resources channelled to the larger sectors of which it would be a component.

An alternative approach consists in channelling whatever resources are made available to selected water supply projects and areas, thus preserving the sector identity and having some assurance of continuity.

Underlying either approach are a number of sector-specific problems pertaining to improving the administrative authority responsible for planning and implementation of water supply programmes, shortage of trained manpower to carry such programmes through the operation and maintenance phase, inadequacy of research and development of technologies adaptable to local needs and conditions, lack of public participation and health education programmes, and lack of an adequate hydrologic and socio-economic data base.

*Endorse constraint-oriented actions.* No matter how great the support from donor countries, from the UN system or other multilateral financing institutions, the success or failure of the Decade rests primarily with the countries themselves. Even if the costs are high, the external financial support represents only a small percentage of the total cost compared to what the countries themselves must contribute. The political commitment and will must therefore be generated to give water and sanitation programmes adequate attention and priority. Thus the key element in the entire Decade is the necessary political will to make the programme succeed.

According to the ECOSOC material referred to earlier, many countries are now in the process either of reaffirming previous policies which are in tune with the objectives of the Decade, or of considering appropriate shifts in that direction (L1). In principle all areas identified as constraints have their corresponding approaches and action programmes established to reduce them. In descending rank order, the Decade-oriented actions most often endorsed by countries are 1) integration of health education in rural water supply sector; 2) mobilization of community involvement; 3) increased attention to the rural population; 4) accelerated manpower development. All these actions are endorsed by more than half of the countries.

In four areas *international support* will probably be of significant importance:

- in supporting institutional coordination and Decade planning
- in reducing the obstacles to smooth running of foreign supported projects and programmes

- in supporting the establishment of an adequate data base and monitoring system for the sector
- in increasing the flow of requests from countries for financial support for projects to donors and financing agencies.

*Compose integrated sets of policy measures.* In past day-to-day practice, water supply and sanitation tend to be regarded as an isolated engineering problem (L5). Unfortunately, it has not been possible so far to bring about a major change for the better in this tendency. Yet there is a common understanding that water supply and sanitation, especially in rural areas, can neither be developed in isolation, nor also as an end in itself. First it is an important factor for satisfying basic human needs; second, crucial to survival in arid areas; third, a necessary—though by itself insufficient—condition for improving health; and fourth, a frequent prerequisite for social and economic development.

To change this isolated viewpoint, an integrated set of policy measures is called for, including integration of development of water supplies and sanitation within the broader framework of an overall development strategy; a human settlement policy based on people's motivation and participation; water resources development, consistent with ecological principles, including conservation of available water resources and measures against environmental abuse; and health and sanitation education programmes. Other issues with which alignment should be sought are: stimulation of private enterprise, the labour issue and the role of women.

Despite repeated rhetoric in favour of the aforementioned principles, not much consolidated work has been undertaken this far to arrive at strategies for integrated approaches. Each of the above points provide examples to bear witness to this fact. Although no uniform solutions should be strived for, it would seem that evaluation of past experiences, and the planning of new strategies could be beneficial for the process as a whole.

## **Planning Process**

*General structure.* The implementation of the integrated strategies has to be taken care of in a well structured planning process, where the actions of all parties involved are efficiently channeled through well defined organizational arrangements and administrative procedures (L23). The whole system of activities should be backed up by an adequate set of policies, laws and regulations.

In principle, the planning process contains a long series of activity steps as illustrated in fig. 5.1. Starting from the general objectives, development



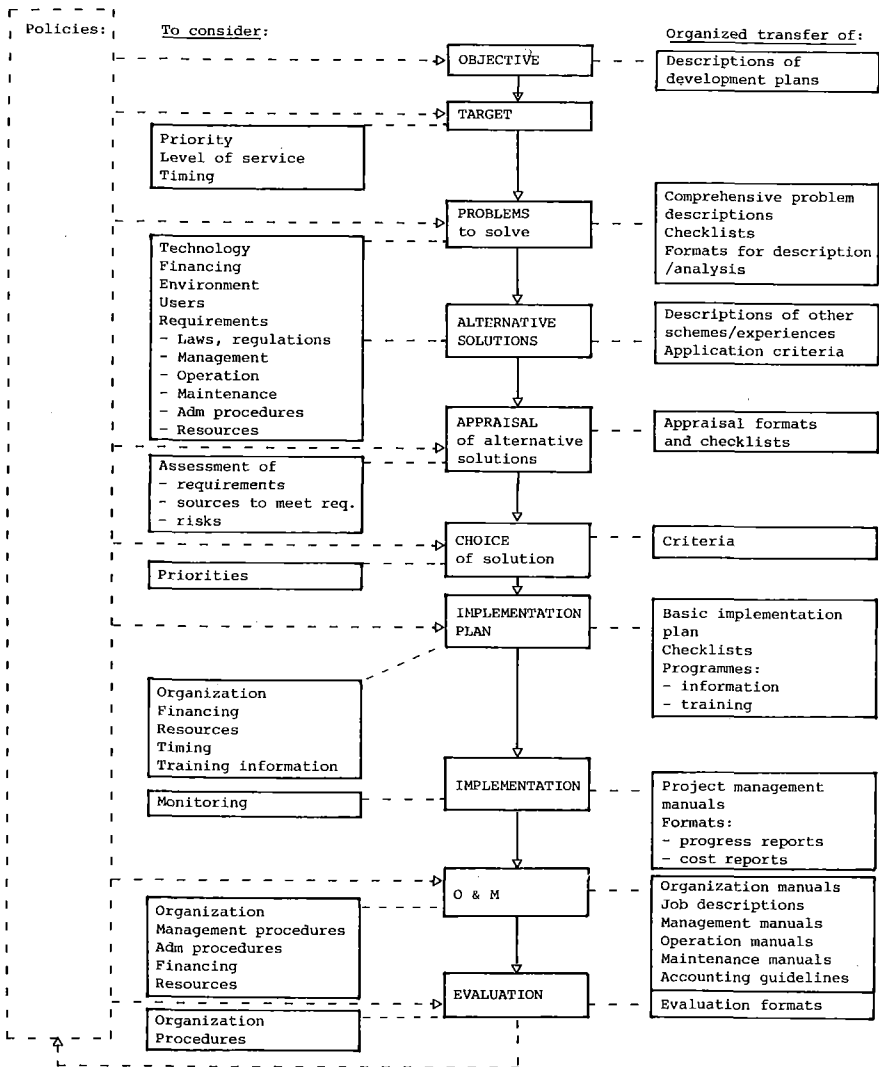


Fig. 5.1. *The process of planning.*

From Steneroth (L23).

plans are generated. These are translated into sectoral targets that are to be achieved concerning the water supply and sanitation. The problems involved are analyzed in detail and described, by the help of checklists and formats for description and analysis. When analyzing the problems to be solved a number of factors have to be considered: technology available, possibilities of financing, environmental constraints, user characteristics as

well as requirements stipulated in laws and regulations, or addressed in management, operation, maintenance, administrative procedures to be followed, etc. A number of alternative solutions are then formulated to solve the problems defined, and these alternatives are evaluated from a number of different aspects using checklists and formats as a support in the work. Based on the comparison made possible by these assessments, a choice of the best solution is made by application of a number of priorities and specified criteria which have to be met.

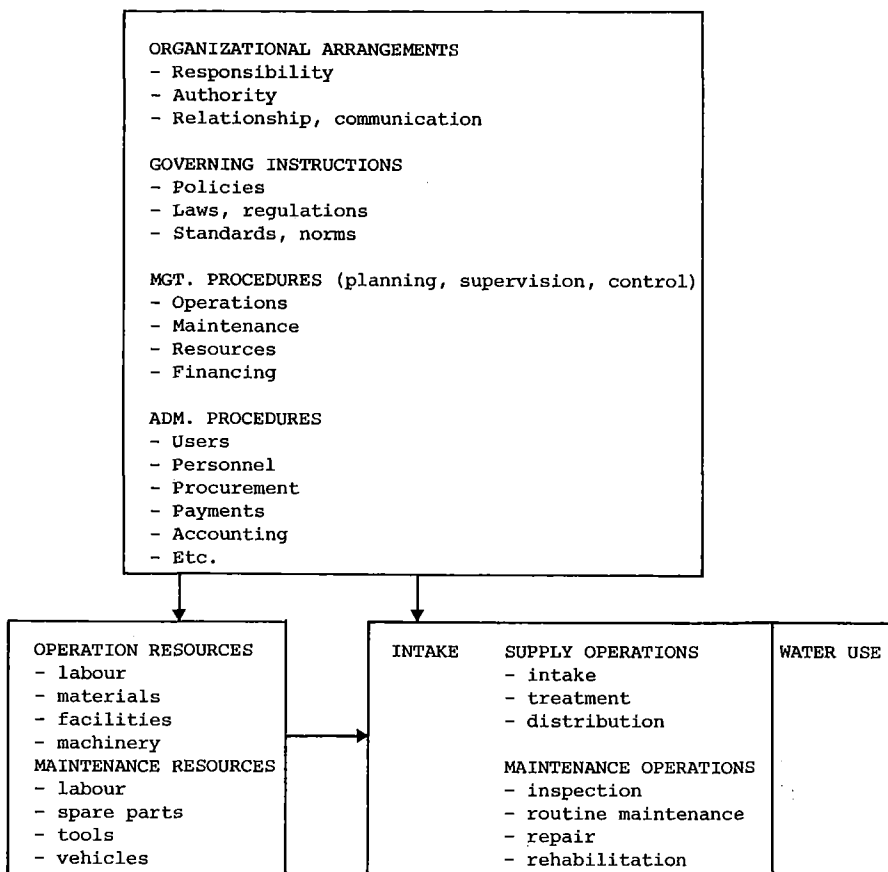
The plan chosen is then ready to implement and a specific plan has to be made up for this implementation. This plan has to include programmes for the information necessary and the training that has to follow the realization of the scheme and guarantee its use for the benefit of the intended consumers. The implementation plan has to take into consideration organizational, financing and timing aspects. The implementation is then ready to start and has to be monitored and controlled, as well as having to involve also an organized transfer of progress and cost reports. Project management manuals have to be worked out. When the project has been implemented the operation and maintenance has to be organized, organizational manuals and job descriptions worked out together with manuals for operation and maintenance. Also accounting guidelines have to be worked out. Once the project is running it has to be evaluated to monitor the effects of the water supply and sanitation system, the habituation process of the consumers, etc.

*Institutional arrangements.* The whole process of planning and implementation involves a whole complex of formalized interactions between bodies involved, consideration of policies, laws and regulations and administrative procedures (L23). These different factors could be covered by the general concept of *institutional arrangements*.

Fig. 5.2 shows the principal structure of a rural water supply scheme with its three main groups of components: institutional arrangements, operation and maintenance resources, and operations involved.

The organizational arrangements can be seen as tools required to perform specific tasks. When the tasks change in nature, magnitude, or priority, changes might be required to ensure effectiveness. Questions involved might be: How to distribute responsibility and delegate authority for water and sanitation affairs? What bodies/units should be established and what functions should be carried out at different levels? What organizational setups and what managerial procedures should be implemented for planning coordination and control of multidiscipline projects?

Analysis of past experience with rural projects reveals that the organizational structure of the programme influences its capacity to provide the



SCHEME EFFECTIVENESS	Needs/Water supply Resources consumed
SCHEME EFFICIENCY	Targets/Achievements (production) Resources utilization
SCHEME PRODUCTIVITY	Production/Resources engaged
PROGRAMME EFFECTIVENESS	Needs/Operating schemes Total resources consumed
PROGRAMME PROGRAMME EFFICIENCY	Programme targets/Achievements Resources utilization
PROGRAMME PRODUCTIVITY	Progress/Costs

Fig. 5.2. Rural water supply components.

From Steneroth (L23).

intended service and to maintain the system efficiently. Experiences also indicate that water systems cannot rely on external (non-local) services and funds for their effective functioning. Participation by the local people—the users or consumers—is normally necessary. But what measures are appropriate, or inevitable, to ensure success? Measures might be required at a national level, at a regional level, and at the local level.

As regards policies, laws and regulations, there is a difference between the case of a small organization and a bigger one. In a small organization the consistency required in decisions and actions can be secured by frequent contacts and information exchange between the members of the organization. The bigger the organization, and the more complex the issues to be managed, the more indispensable are such administrative means as policies, laws and regulations.

Policies are usually based on values, which might change by experience. Administrative procedures are required to ensure a systematic feed-back of information for evaluation of the policies established. The more laws and regulations are established from 'above', the more difficult it might be to implement new regulations.

Norms usually direct precisely on action, for example a decision or an evaluation. But what is acceptable or not in the particular case? Is the performance just acceptable, good or even excellent? Norms usually have to be based on local conditions, experiences and values.

The administrative procedures established to secure the collection, processing and transmittance of information play an important role. Different administrative systems and procedures might affect the effectiveness of a scheme significantly.

In the planning stage of a scheme, specific competence might be required, for example, special technical, health or environmental aspects. The specific competence required might be located at a central or regional level, maybe within another ministry. Adequate administrative procedures are required to ensure that the specific competence is added to the project.

Many water projects have been suffering from lack of funds enough to maintain the intended standard of services. There are sometimes conflicting interests between the project planners and the budgeting officials. It seems to be a general experience that when funds for recurrent expenditure are allocated centrally, the approving authority often makes considerable reductions of the request, which frequently is under-estimated from the beginning because of lack of adequate statistics. The accounting system is often inherited from another ministry or body and not tailored to the needs of the managers at different levels.

*Operation and maintenance resources.* Of importance to the effectiveness of the scheme are also the procedures for procurement and supply of spare parts and materials, the procedures for recruitment, selection, training and up-grading of personnel, etc.

Special attention should also be paid to the procedures for cooperation with external agencies, donors and others. Although most donors nowadays seem to give aid against the background of the overall development situation in the recipient country, there is a risk that projects are guided by the donor's willingness to assist.

The human resources, finally, is the crucial variable when discussing the concept of productivity, efficiency and effectiveness of a water or sanitation scheme, or any activity involving human performance. The knowledge, skills and attitudes demonstrated by the individuals concerned at different levels and at different situations will govern the success or failure of the scheme.

For every position in the organizational hierarchy, and on the operational level, there are specific qualification requirements, in terms of practical and theoretical experience or insight. These requirements have to be met by an adequate personnel policy and realistic programmes for recruitment, training, up-grading, etc. Specific problems might be experienced in this connection, as the availability of skilled manpower often is affected by other openings to the labour force. The career and salary structure and the training programmes have to be balanced with due account taken to the promotion requirements.

A special problem in this connection is the information and education of users of water schemes, taking into account people's reluctance to accept changes in living habits and the attitude towards, for example, sanitation matters. Special programmes and means, and special trainers and 'promoters' might be required. To be considered is also the selection of persons to be in charge of the operation and maintenance of rural water schemes, as persons from other regions might experience difficulties to adjust to the living conditions in the particular rural area. The specific rural conditions should be known, more or less, at all levels and by all officials having influence on the planning and operation and maintenance of the rural water supply and sanitation scheme.

*Each country to find its own solutions.* Evidently, each country has to find its own solutions to its institutional problems and human resources requirements. It should be unwise, however, to pursue such a policy if every country is found to be making the same mistakes. Organized cooperation is required to gain from the experience of others, and to minimize total costs

for research, training and dissemination of knowledge and experience. Such a cooperation is relevant to and between developing countries as well as to international and bilateral agencies.

*Seminar conclusions on planning rural water supply schemes.* The Seminar chose *bottlenecks in planning* as one of the topics to be discussed in the workshop on Planning and Implementation. The Seminar concluded that, at present, such planning of rural water supply schemes is often hampered by a variety of bottlenecks, such as the lack of reliable information on potential water resources and their availability in space and time, water needs in the communities to be served, types and level of external assistance to be sought, and national resources available for proper execution such as finance, logistics, manpower at all levels of remuneration, international support, and more generally by uncertainties as regards the water policy of the government and lack of guidelines in this field.

The Seminar arrived at the following general *recommendations* regarding conditions to be met in planning exercises involving rural water supply schemes:

- each government agency or organization should engage in the planning of the water sector, and all the exercises should be harmonized and coordinated
- planning should be carried out in close cooperation with local authorities
- planning should be undertaken by specialists using appropriate tools.

## **Role of Monitoring and Evaluation**

*Seminar discussions.* The *role of monitoring and evaluation* was chosen as the main topic for the Seminar workshop on Execution and Evaluation of Rural Water Supply Projects. The importance of monitoring and evaluation which has been stressed earlier in the text, is particularly large in the least developed countries, which have scarce resources, so that any mistake made in development projects may have serious consequences. The Seminar concluded that:

- funds should be set aside by project planners for monitoring and evaluation and donor organizations should see to it that such provision has been made within the framework of follow-up activities
- a specialized unit should be established to carry out the checks; it should be responsible to the highest level of management
- monitoring and evaluation should be carried out as a continuing exercise, much like maintenance. There should be no acceptable reason or excuse for not doing it.

The Seminar, however, noted that at present such conditions are far from being met. Monitoring and evaluation are omitted in many rural water supply projects for a variety of reasons. One is that unsatisfactory performance is the direct result of improper operation and maintenance practices. This makes it extremely difficult to identify errors in planning and execution.

*Seminar conclusions on monitoring.* The Seminar concluded that monitoring should be undertaken in an organized manner. Data on project results should be collected so as to facilitate a continuous check on the following aspects: project efficiency, suitability of planning and design, level of implementation, operation and maintenance, adaptability to load conditions, results achieved in training and up-grading of manpower capabilities.

In addition, the Seminar found that specific studies are necessary to assess the *positive* effects of the projects on:

- social welfare and human dignity (for example the improvement of living conditions for women)
- type and level of water use per capita (increase in water consumption)
- health conditions (elimination of water-borne diseases).

The Seminar also found monitoring of health conditions to be extremely difficult. There is of course an overall feeling that the use of tubewells and pumps has a positive effect on health, and that, as a result, life expectancy, especially that of young children, is increased. However, there is thus far no evidence which makes it possible to establish this beyond doubt.

The Seminar, furthermore, found that specific studies are also needed to assess the *negative* effect of rural water supply and sanitation projects, if any, and to define corrective measures.

*Seminar conclusions on evaluation.* The Seminar concluded that evaluation exercises should be carried out by *third parties* as implementing organizations may be biased if involved in this process, and by means of an *integrated approach*, encompassing technical, economic, social and other aspects. The purpose of undertaking an evaluation of a rural water supply and sanitation project are in particular:

- to assess whether the project is working, for instance, if water is produced in the case of water supply at the levels of quantity and quality which were expected and whether it is available to consumers who use it effectively. In other words, that the objectives of the project have been reached and that they were not lost or altered over time
- to assess the economic, social and other benefits of the project—whether expected or not. For example, to determine to what extent the project may

have, directly or indirectly, contributed to improved health conditions and to decreases in mortality; and what beneficial effect there has been on the overall behaviour of the population

- to identify the changes which should be introduced in the project and to improve the efficiency in terms of socio-economic benefits
- to avoid future mistakes in planning, design, execution, operation and maintenance.

## 6. The Three Party Dialogue

Projects are often undertaken without any reference to what the community feels it needs.

Letitia Obeng, UNEP

### **Relation Between Producer and Donor**

*Introduction.* The views and roles of the three parties involved, the consumers, the producers and the donors were discussed already in chapter 1. During the Workshop on Planning and Implementation, the Seminar discussed these views and roles when applied to the real situations in many developing countries and arrived at a number of conclusions regarding the relationships between these different parties. It was found natural to discuss the relations between donors and producers on one hand, and the relations between producers and consumers on the other.

*Seminar conclusions.* The Seminar identified *problems and difficulties* in the relationships between producers and donors as follows.

In some countries assistance in water development is provided by a great number of donor organizations which makes planning coordination extremely difficult. While this assistance is multiple, it is generally largely insufficient. It is often provided with strings attached, with the obligation to use certain contractors, equipment and supplies, which are not necessarily the most adequate or economical or both. As a result, the effectiveness of the projects may be reduced.

It is undoubtable that it would be too much to request from developing countries, and especially the least developed, to reach the objectives of the Decade. It is also quite clear that the goals of the Decade cannot be met unless the industrialized countries and OPEC increase their contributions and share of responsibility significantly.



Donor organizations sometimes offer 'turn-key' projects which may create considerable difficulties in their operation and maintenance due to their unnecessary complexity and sophistication, and which therefore deprive local technicians of an opportunity to be involved in the different aspects of project execution.

Taking these experiences into consideration, the Seminar arrived at a number of *principles* which should be followed in the providing of help from donor organizations:

- aid when provided in the form of equipment, should fit into the countries standardization and self-reliance policies. If funds are donated, they should be followed by proper monitoring arrangements;
- aid should be development-oriented;
- aid should be utilized as far as possible to promote local industries for the manufacture of pipes, pumps, and other products used in water supply projects;
- donors should be aware of financial constraints and limitations of developing countries, and should not require unrealistic counterpart contributions.

## **Importance of Community Involvement**

*Some experiences.* According to present experiences that have been gathered globally from failed water supply programmes, early involvement of the public is a decisive factor for the success of a project. The attitudes of rural people to improved water supplies have been shown to be an important part of the problem of failing schemes (C1). In some places, for instance, installed supplies have not been used as intended. There are cases when the supplies were considered unsafe by the general public, others where they were believed to be taken from sacred sites, a fact that was not known to the developing engineers. In effect, as already stressed, it is quite common that rural people do not understand the implications of safe water.

Quite often, too, the failure of water and sanitation projects can be traced to a lack of adequate community involvement (I2). When the central government sends a team into a village for a day or so to sink a bore hole and attach a pump, then leave, the villagers feel very little sense of involvement. When the bore hole becomes silted up, or the pump breaks down they feel it is not their responsibility and wait for the government workers to return to mend it.

The most successful programmes, on the other hand, are those where the community is involved from the beginning, where they have participated in the choosing of the site for the bore hole or well, where they have contributed labour to the project, often over many months, as they do in Malawi's

gravity fed water system, and where there is not only a sense of local involvement and ownership but where individuals in the community have been trained to carry out routine maintenance.

Community involvement is also more likely to result in the use of appropriate or local resource technology that can be more easily repaired or replaced, rather than importing complex, expensive high technology equipment that cannot easily be repaired. The involvement of communities in the development of water and sanitation programmes requires very careful planning and a major investment of time and energy by those responsible for the projects. However, there is no substitute in terms of the long-range effectiveness of such programmes.

In recent years, the importance of community participation has been increasingly stressed in developing countries, and headway has been made by some of them (C1). Well-known cases are Tanzania and Thailand. Tanzania, in its country-wide villagization program, has developed the ujamaa-concept, and Thailand has developed community participation in all steps of the development of schemes, including operation and maintenance. There, as elsewhere, local initiatives are the starting point for water schemes and the beneficiaries are to participate fully on a self-help basis. The new strategy is now expanding and many new countries are joining.

*Seminar conclusions.* The Seminar discussed *public participation* as one of the topics chosen for the workshop on Social and Economic Aspects of Rural Water Supply. The Seminar concluded that the following main elements of input to a project can be expected from participation by the public:

- involvement and sense of ownership in the project; full understanding of the function and usefulness; interest in the continuous protection and operation of the scheme;
- supply of local labour; supply of local materials; assistance to construction crews such as lodging and food; in rare cases also some technical expertise;
- a financial contribution.

In financial terms the participation may not be substantial but in the order of perhaps 10 % of total costs, considering that construction equipment and materials are expensive and in many cases imported from abroad. What is most important is that the population cooperate as much as possible, according to its capabilities and resources and that, as much as possible, operation and maintenance costs be supported by water users at the village level.

Another important conclusion from the Seminar was that new ways and means should be sought in developing countries to improve, diversify and expand public participation at the village level.

The Seminar found experience to show that the level and nature of public participation are related to a number of factors:

- the size of the country seems to influence to a certain extent. In a small country, such as an island, the country's water supply services are centralized and are at the same time relatively close to the users. The latter, therefore, have little say in project conception, execution and operation.
- the level of sophistication of water schemes has clear importance. On the one hand, water gravity schemes can be constructed and maintained, to a large degree by the local population. On the other hand, a drilling rig is a mobile industrial installation, alien to the village. A well-digging operation, or the construction of a small dam, may involve public participation to varying degrees, according to the technology, equipment, and supplies which are used.
- the type of leadership at the village level is also of importance, whether there is a traditional chief, party representatives, a village council—elected or self-appointed, etc., and also its relationship with local authorities at the district or subdistrict level, and the central government.
- the cultural background and the wealth of the population are other factors of relevance for the public participation.

There are however many problems involved. Public participation may sometimes be difficult to organize. It is also important that women be more involved in it than hitherto. The possibility to realize public participation depends mainly on local and national politics and political institutions. It may sometimes be unpopular and resented as an injustice if a financial contribution is required. However, if an emergency situation develops in water supply systems, as in the case of a drought or with the outbreak of typhoid or cholera, the public is highly motivated and participation is broadly available.

One of the most critical of contact points between the public and external participation is that of maintenance and repair of water schemes, and especially hand pumps when spare parts are needed and are not easily available.

## **Producer—Consumer Relationships**

*Latin American experience.* Over many years, in Latin America, a methodology has developed and is being followed in many countries (L11). The first step is to discuss with the village and their leaders the proposed improvement and reach a decision on their part to participate in the project. Participation means the organization of a village committee, cooperative, or whatever is the traditional body for community organization. The village is

expected to contribute to the capital cost of the system in labour, materials, cash or land for the well site and so forth, and the village committee undertakes this responsibility. The villagers should also pay the local costs of operation and maintenance.

If agreement is reached on these points, a written contract between the village and the Ministry is signed and the water supply system is built. The individual householders are sold the privy slabs and risers at cost and are shown how to build their privies properly.

Throughout the process, the sanitary inspectors of the Ministry of Health, overseen by their regional supervisors and these in turn by the district sanitary engineers, continue to provide advice and guidance to the villagers. These workers are assisted in their work by the health educators who visit the villagers and who also instruct the mothers when they visit the health centres and health posts.

*Seminar conclusions.* The Seminar discussed the *relationships between producers and consumers* during the workshop on Planning and Implementation. The Seminar concluded that, among the *problems* involved, the one concerning water payments appeared to be the most delicate. It is evident that water charge systems should be flexible and diversified according to the various types of service provided and of consumers served. The producer should be at the service of the consumer. The government should provide subsidies to cover the costs of the water given to the rural poor. It is necessary that engineers receive some training in administration practices. They should also have good contacts with local water committees. The organization of a public relations office, as is the case in several countries, may be of great help in assisting the establishment of village water committees with the objective of: selling a national water policy, appointing or dismissing pump attendants, assessing water tariffs, collecting revenues, and obtaining contributions in cash for operation and maintenance. The producer should also guarantee a continuous commitment to water supply projects.

The Seminar found it desirable that the *dialogue* between producer and consumer should be continuing and open from the earliest stages of project planning, through the construction phases up to maintenance and operation activities. In particular, consumers should be consulted on problems which affect them. Wherever they are ready to participate in operation and maintenance costs, producers should encourage the design and implementation of development projects.

If the matter of identification of priorities arises, it may be useful to bring donors into the consumer-producer dialogue. The producers have special

difficulties in reconciling the offer made by the donor with the needs and requests of the consumers, taking into account its own resources and capabilities.

## 7. Water Resources Assessment

In most cases (systematic and reliable) data are not available. This results in designing projects ... through guesswork.

N.K. Msimbira, Tanzania

### Introduction

*Part of the planning process.* An adequate water source being a necessary prerequisite for organized water supply turns water resources assessment into a crucial part of the planning process. Its importance varies according to water availability in general (L8). In countries with water surplus, ample amounts of water are available, and water development may be possible in a piecemeal manner without regular planning. Under water scarcity conditions prevalent in many developing countries, multipurpose projects are embarked upon already at an early stage of socio-economic development.

Under surplus conditions, planning for water supply has been merely a question of deciding what source of water to use, where to take the water, and by what means that water could be made available to the intended users. Under water scarcity conditions on the other hand, the first question might be how much water is at all hydrologically available in the region, and how the best use could be made of that water, taking into account its role as general basis both for the ecosystems and for human development in various fields of economic development.

*Highly different hydrological conditions.* The countries represented at the Seminar have quite different hydrological conditions, both as regards general water availability, and in particular, ease of access to groundwater (C1). The water availability for withdrawal, when calculated on a per capita basis, ranges from 100000 m<sup>3</sup>/year or even more in a West African country like Liberia, to much less than 1000 m<sup>3</sup>/year on the Arabian peninsula.

Fig. 7.1 demonstrates that very large differences exist between different regions of the world, especially when extrapolating to the forecasted populations of year 2000.

As regards ease of access to groundwater, Bangladesh represents quite favourable conditions with 90 % of the population living in areas with the

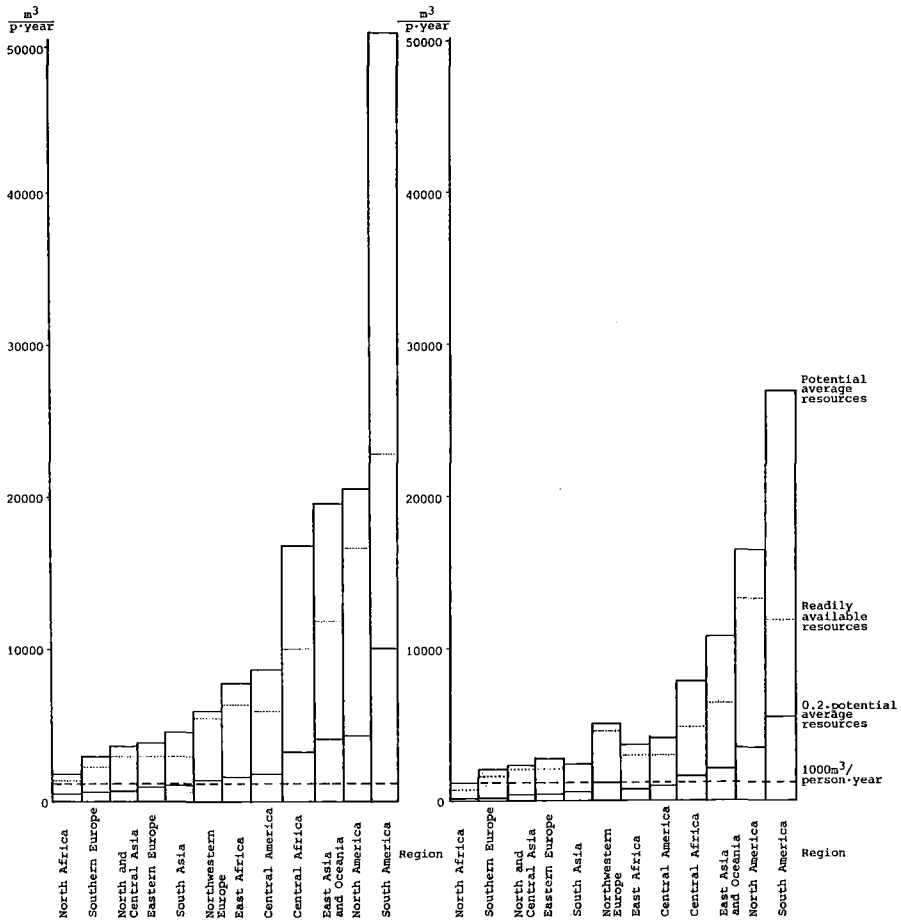


Fig. 7.1. Average water resources available on a per capita basis in different world regions by year 1973 (left) and 2000 (right).

The full columns indicate potentially available resources. Dotted line indicates resources available towards late levels of river basin development. Full line indicates actual availability (assuming dependable flow to be 20 % of mean flow). For comparison, the ultimate water demand during late stages of socio-economic development is indicated by the reference level  $1000 \text{ m}^3/\text{person}\cdot\text{year}$ , based on different estimates in the literature. From Falkenmark (L8).

groundwater table just a few metres below the ground surface. By contrast, in a country like Somalia the water table is more than 250 metres below the surface in some areas. Such different conditions seem to affect concepts such as what depth intervals are covered by shallow wells as opposed to deep wells.

A country like China has to rely upon hardrock groundwater for huge

populations in many mountainous areas with conditions where sophisticated technology is necessary for groundwater development. Cuba, like SW China, depends on karstic groundwater but with the extra difficulty of direct connection with the sea, which creates problems of saline intrusion. These different conditions place water availability and access to water in its hydrological perspective.

*Need to consider ecological balance.* In planning for rural land use development, an *ecological balance* has to be strived at. This holds especially for conditions of water scarcity when water availability might pose a general constraint on the bearing capacity in terms of cattle and agricultural production in an area. In such ecological balance, account has to be taken of the interaction between land use and water quantity and quality in groundwater aquifers and rivers.

Applying the general idea of ecological balance, a rural area might be defined as an area in which human beings live on the biological production yielded by the area (L12). The number of people resident in the area must therefore not exceed the number for which the area can provide a livelihood. In such a case we may perhaps say that a kind of ecological balance exists.

*The hydrological cycle as the starting point.* In our planning we have to adapt to the basic reality that natural water is circulated in the hydrological cycle between sea, atmosphere and land (L8). In the terrestrial part of this cycle, precipitation to a land area is transformed first into infiltration into the soil and/or rapid surface runoff. The infiltrated water partitions into water taken up by the roots and vegetation, and the surplus being percolated down to the groundwater. The river runoff is composed of rapid surface runoff and slower groundwater runoff.

Thus, the soil cover and vegetation heavily influences this partitioning of the water input to land. This means that land activities influence water supply conditions in regard to both groundwater formation, and annual water yield in the rivers including its seasonality and quality. We will discuss this further later.

The water circulated in the hydrological cycle constitutes a complex resource to be allocated between all different kinds of uses: water for plant production, for cattle watering, supply of water to habitats and industries, and extra irrigation of agricultural fields, etc. While passing in the river, water may be used for navigation, fishing, recreation and hydropower production. Fig. 7.2.

*Internal and external water requirements.* In planning the water supply for a rural area, water requirements have to be compared with existing water resources. Assume, at the start, that the requirements of an area must be

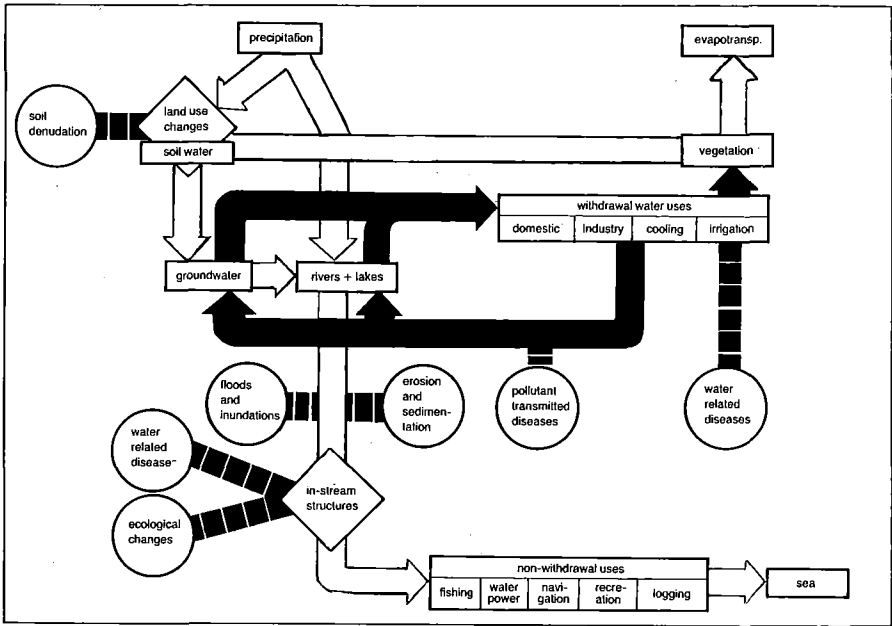


Fig. 7.2. Schematic conceptual framework illustrating how man intervenes in various ways with the natural water cycle.

Natural water flows are white, anthropogenous flows black. Man also intervenes in other ways (diamonds): in the partitioning of water inflow to the soil (land use changes), and in the river flow (instream structures). Circles denote resulting disturbances. From Falkenmark (L8).

met exclusively by local net precipitation, our basis being an areal unit of 1 hectare (L12). We assume that the soil is fertile and the climate good, so that it is possible for plant production to amount to 7200 kg dry matter per year, which would suffice for the needs of four human beings and two large domestic animals (e.g., cows). (By way of comparison, the population density in regions like Bangladesh or West Bengal State in India is somewhat less, i.e., 3 people per hectare as a country average).

In the first place, the plants need water. An *internal* water transport forms part of the hydrological cycle, going through the plant tissues from the soil and roots up to the leaves and out through the stomata. The transport varies with the condition but, on the average, it may amount to 500 litres per kg formed plant mass calculated as dry matter. This gives us a water requirement of about 10000 litres per day, or when converted into annual net precipitation, 360 mm.

Like vegetation, both animals and humans require water for an internal flow of water necessary for physiological functions. For human beings the internal flow for four people is estimated at 16 litres/day, and for the two



animals to 100 litres/day, or when converted into annual net precipitation, 0.6 and 4 mm/year respectively.

In addition to the internal flow of water, vegetation, animals and humans all require an *external* flow of water. In the case of the plants, there must be an external flow round their roots to wash away salts and poisons from the soil, usually estimated at 20 % of the internal flow. What is required for the assumed conditions is then an average of 2000 litres/day, or an annual net precipitation of 72 mm/year. For animals the requirement may be estimated at about 50 litres/day and animal, or an annual net precipitation of 4 mm.

As far as humans are concerned, the external water is needed for cooking, hygiene, laundry, bathing, minor industries, etc. The need varies in relation to standards of hygiene. 10 litres/p·day will suffice if the standards are very low, whereas WHO has defined 100 litres/p·day as a desirable standard. In highly industrialized countries the need may amount to 500 l/p·day. The corresponding figures would be 0.4, 4 and 20 mm/year.

Summing up the water flows for external and internal water, we arrive for the assumed conditions at an *ecologically based water requirement of about 460 mm/year*, of which the plants require 430, animals 8 and humans with modern standard 21 mm. Thus, we note that the completely dominant amount of water is absorbed by vegetation. Even at the highest standard of living, human requirements amount to less than 5 % of that needed by the plants necessary to feed the humans.

*Prevention of interruptions in water supply.* When the basic assumptions are changed the estimate would evidently arrive at other amounts of water needed. Even so the basic argument would however hold that, when working on water questions for rural development, the *part played by water in the entire biological system must be taken into account* (L12).

Until now we have assumed that the cycles possess continuous access to water as a result of precipitation. Unfortunately this is rarely the case. Instead, wet and dry seasons alternate, regularly (in monsoon climates) or irregularly. The irregular alternations are, unfortunately, greatest in the arid and semi-arid regions of the world.

The tolerance levels for interruptions in the water cycles vary considerably. The internal cycles for humans and animals can dispense with water supply for a few days only. Some plants have greater tolerances, and plants found in steppes and deserts can even reduce their water requirements to nearly zero for periods of up to six months or even longer. The maximum tolerance to interruptions is to be found in the external cycles with considerable elasticity, so that consumption may be adapted to existing resources.

In order to prevent harmful interruptions in the water supply, use must be made of stores of water. In this respect plants enjoy a privileged status thanks to their ability to absorb *water at underpressure* from the soil. The magnitude of the water store depends on the type of soil, and is large in clays and small in sandy soils. People and animals cannot make use of the water bound to the soil but must turn to local storages of *free water*, either groundwater or surface water. Groundwater has many advantages over surface water as a local resource for water supply. This state of affairs has become increasingly evident with time, and the use of groundwater for rural water supply has come more to the fore in most countries. The development of techniques for the prospecting and extraction of groundwater has been of great importance. One example is the current extraction of groundwater from crystalline bedrock in the great primary rock formations.

### **How Much Water is There?**

*Water availability to satisfy requirements.* In light of what has just been said, we have to distinguish water availability for plant production from water availability for satisfying human supply needs (including cattle feeding) (L8). Water availability for *plant production* is characterized by the amount of water present in the root zone that can be taken up by the plants. The water is recharged by the amount of water infiltrated into the soil, which means that the infiltration could be taken as an index of this water availability.

*Water for withdrawal* can be taken either from groundwater aquifers, or from surface water bodies, and the water availability is represented by the water flow through these environments: in the aquifer by the annual—or rather the long-term—recharge; in the rivers by the dependable flow, i.e., the time-stable base flow available in the river also during the dry season.

Hitherto we have only spoken about *local* water resources, i.e., resources to be found within the consumption area. Supply based solely on these resources is, however, by no means always possible because sometimes the precipitation is insufficient or is unfavourably distributed at the same time as the possibility of water storage is limited. Surplus water from other places may exist or may be made available. Here, if we wish, we can speak about *transversal* water resources, transferred from upstream regions of the river basin (L12).

### **Impact of Land Use on Water Resources**

*Land use affects rainwater partitioning.* In terrestrial hydrology, as earlier

stressed, the soil and plant cover are crucial for local water availability conditions. They strongly influence the partitioning of the rainfall between rapid surface runoff, water uptake by plants, and recharge of the groundwater that later forms dependable base flow in the rivers. In other words, soil and plants represent a kind of intermediary between climate and hydrology.

Even in temperate climates, vegetation, soil and topography strongly affect the runoff conditions, which are thus modified by land use changes (L8). This dependence on vegetational cover and soil is however very much larger in the tropics, which leads to the conclusion that hydrological conditions in the tropics are quite susceptible to man-made changes within agriculture and forestry.

To this influence of hydrological conditions on soil and plant cover should be added the complementary aspect that water conditions are crucial to the soil. In this respect water plays two opposite roles from the point of view of the landscape. Moist soil as well as a protecting plant cover are important in protecting the soil from erosion during the intense rains typical of tropical conditions. At the same time, water is the main agent in causing erosion of unprotected soil surfaces. Under conditions of expanding desertification, the risk of water carrying away productive soils constitutes a major hazard to food production in over-populated tropical lands.

*Link to be established also in planning.* The close interplay between land-use and water availability on one hand, and between water and soil productivity on the other, necessitates a *much closer link between land-use planning and the planning of water projects than practised today* (L8). Degradation of the vegetational cover leads to increased and more rapid flood flows. Soil conservation, afforestation and other measures apt to increase infiltration are therefore important in increasing water availability by reducing losses of great amounts of water in rapid flood flows. In other words, the interaction between land use and water availability and between different water uses in the same river basin, invites an integrated overall view on water. For the same reason, land-use planning should also be integrated with water planning.

## **Water Resources Assessment**

*The concept.* As earlier indicated, *water resources assessment* becomes increasingly important as water conditions become increasingly pressed (L8). The whole concept of water resources assessment is presently being developed within an international Unesco/WMO project as a follow-up to

the recommendations of the UN Water Conference, which concluded that such assessment is very poorly developed in large parts of the world, especially in developing countries. The latest definition of the concept is as follows:

'Water resources assessment is the determination of the sources, extent, dependability and quality characteristics of water resources, on which is based an evaluation of the possibilities for their utilization and control (WMO 1980).'

*Monitoring availability of free water in hydrological networks.* In order to decide on water availability and possible access to water, hydrological and hydrogeological conditions have to be surveyed. The basis for hydrological studies is data collection networks planned to produce the data needed for general assessments of the water resources available. *Without such data, project planning remains guesswork.*

The available amount of free water may be roughly estimated from water balance calculations (L8). In this regard, one has to distinguish between the total amount of water circulated in the hydrological cycle, and *potentially* available for all uses, and the part of this water that is *actually* available all the year round, i.e., dependable availability. The resources can be increased by technological means: groundwater availability by augmenting recharge, low flow in streams by storing flood water in surface or subsurface reservoirs, or sometimes by importing water from an adjacent river. However, physiographic and socio-economic conditions impose constraints on the possibility to increase availability. The socio-economic constraints normally decrease as development proceeds. In modern societies, the ulterior constraint is imposed by physiography, and defines what can be called *ultimately* available resources.

*Interzonal transfer of knowledge.* Water resources assessment is to a large degree not only a question of data but also of manpower, trained in hydrology. If the formidable goals of the Water Decade are to be met, and if manpower needed to reach these goals is compared with the present education in many developing countries, it seems that these countries will have to benefit to a large degree on experiences and know-how in industrialized countries. Such large-scale transfer of knowledge achieved in high-latitude countries with water surplus conditions to low latitude countries with water deficiency has to avoid any climatic bias in the transfer (L8).

In the large-scale transfer of knowledge to be foreseen during the Decade, it seems essential to focus also on relevant similarities and dissimilarities in hydrological conditions. The International Hydrological Programme under the aegis of Unesco will, in its activities during the 80's, give special stress

to low-latitude hydrology, and to adaptation of 'imported' knowledge to local conditions.

The hydrological conditions are governed by precipitation patterns in time and space, and by the interactions between water, air, soil and vegetation in the ground. Even if the basic processes are similar in all physical environments, the size and relative importance of different water balance elements vary considerably between zones (fig. 7.3). Such large differences should be taken as a warning, remembering that the existing know-how, as expressed in textbooks, graphs and equations, is often based on temperate conditions and cannot automatically be transferred between zones. Thumb rules, graphs and diagrams have therefore to be checked by basic studies on the local hydrology and by operation of hydrological observations networks.

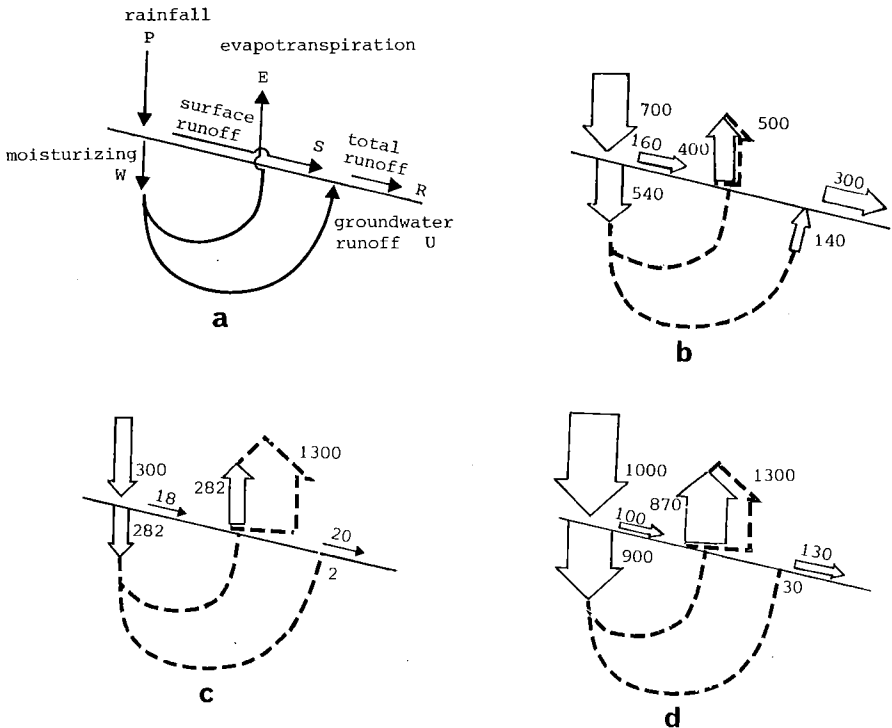


Fig. 7.3. Hypothetical difference between hydrological conditions in a high-latitude donor country and in a low-latitude developing country.

The figure visualizes the relative size of main water balance elements, when taking an aggregated view on the river basin as indicated in (a).

(b) indicates taiga zone (c) desert savanna and (d) dry savanna. Dashed arrow denotes potential evapotranspiration.

Data source: Lvovich 1974.

From Falkenmark (L8).

## 8. Technology and Maintenance

... often pumps and wells lie unused because no one in the community has even the basic knowledge to maintain them in operating order.

P.G. Bourne, UNDP

### **Inappropriate Technology and Scheme Failure**

As already stressed, in the past water supply technology has often been transferred without any serious consideration of its appropriateness. Projects have often been undertaken without any reference to what the community feels that it needs. Little community participation has also been attempted, either in execution or maintenance. A report from a typical small village in northeast Thailand illustrates some of the problems involved (L22).

*Some cases.* A unique water filtration system was installed which was 'a gem of appropriate technology' according to a water engineer (L22). The system was constructed almost entirely from locally available materials. The filters were simple enough for the villagers to maintain without skilled supervision. They were inexpensive and could be easily copied by neighbouring villages. There were two filtering stages. The first used chopped coconut husks, to remove mud and other solids. The second was burnt rice husks, to remove colour, taste and odour, and leave the filtered water clear and sparkling. The coconut fibres and rice husks had to be changed every two to four months. Even if the filter did not reach the standards set by WHO, it was a great improvement on no treatment at all, and offered one way of helping to reduce water-related diseases. The filter system was introduced in 1973, and accepted with enthusiasm. Three years later it had been abandoned, as had a similar project in a neighbouring village. Because of lack of effective organization at the local level for maintenance, the project became a failure.

For further illustration, in 1969 a WHO/UNICEF team reported that British pumps in India were regularly breaking down after only one week's use. The team recorded that a WHO consultant had made a similar criticism of the same pumps in 1968—but that UNICEF was still using them. The pumps were of relatively light construction and were never intended for the heavy duty to which they had been subjected at a public well in Rajasthan. Tougher pumps would be needed. Thus, the pumps were provided with good intention—only they were inappropriate for local use.

There are also in the country reports to the Seminar numerous examples from the past of water schemes failures (C1). In Bangladesh, for instance

10 % of the wells became choked off annually, partly from corrosion of the tube material. Tanzania has reported that 50 % of existing schemes did not operate while in Liberia 30 % of the wells were reported out of order. Similar conditions have been reported also by other countries. In many areas, the great frequency of failure is due to difficulties with the operation and maintenance of the schemes. This turns out to be the combined effect of a number of constraints, including lack of trained manpower, lack of operation and maintenance funds, lack of logistic support including spare-part fabrication and delivery, and lack of interest from the local beneficiaries. This is due to the absence of a sense of ownership which would prepare beneficiaries to take on the burden of caring for the installations. Today, certain countries in their planning have given priority to operation and maintenance. This includes Botswana, where routines used in operation and maintenance have been described. Other countries find it necessary to accept failures during a certain phase of development, until the constraints have been eliminated.

In many water schemes, there are problems with the water quality. For example, in Sri Lanka, only 25 % of the wells tested in 20 UNICEF schemes were bacteriologically safe. Facilities for treating the raw water are not easy to operate, and depend, among other things, on a regular delivery of chlorine which is difficult to secure, especially in cases of lack of transport facilities and equipment.

Nowadays, the use of low-cost technology is widely accepted as a new strategy to cover the basic needs of the whole rural population in order to reach the targets of the Decade. It has been pointed out that appropriate technology and community participation should be seen as inseparable. Low-cost technology may be seen as a first step, later to be upgraded to match the progress of socio-economic development in general. The best *technological mix* is to be designed according to natural conditions in different regions of a country.

## **Choice of Water Supply Technology**

*Rural well deterioration.* For a population of 1000 million in rural areas to be supplied with adequate drinking water supply before 1990 the drilling or digging of some 2 million wells would be required. The operation and maintenance of millions of such installations, including those which already exist, scattered in vast, poor, sometimes hardly accessible areas, will not be without problems. It is a proven fact that it is easier to carry out large-scale well construction programmes than to keep the wells themselves in operation (L6).

In principle, such simple installations as dug or drilled rural wells equipped with handpumps should not be difficult to keep operational. However, the results of surveys carried out in several countries proved to be somewhat deceptive. For example, in a West African country, only two hand pumps out of a total of 50 were still operating after 5 years. In another country, 80 % of the installations were out of order. It is therefore worth examining the various processes of deterioration which may affect the installations and determine how to prevent and cure such defects.

*Open wells:* Theoretically, open wells do not require maintenance, especially when they are lined with concrete. However, the lining may deteriorate, and cave-ins may occur at the level of the water table. It may also happen that in the course of a prolonged drought period water levels go down and wells run dry. More frequently, sediment will accumulate in the bottom of the well, possibly up to the water table. This happens mainly in sandy areas. Sand may be blown into wells by wind, or may be brought slowly but steadily by the humid extraction ropes which may collect it on the ground. An open well is a receptacle for a number of foreign bodies: dead animals, refuse, wooden branches and bushes, rocks, etc., which may cause pollution. Open wells are sometimes equipped with extraction devices which may deteriorate rapidly with time—especially wooden parts. Stones bordering the well on the ground may be deeply incised by the ropes after some time.

Personnel needed to keep open wells operational include primarily masons, public works technicians and labourers. Cleaning a well requires winch-and-bucket light cranes. The deepening of wells is a more complicated, construction-type operation which most often involves the use of prefabricated concrete rings, motorized cranes, compressors and sump pumps. It can be slow and difficult work.

*Tubewells:* Tubewell deterioration is mainly caused by casing-screen corrosion or deformation. Sand intrusion in the well, a drop in the water table and contamination of water by harmful constituents may also be mentioned.

Little can be done to rehabilitate an out-of-service tubewell. In most cases corroded or squeezed casings cannot be pulled out even if powerful machinery is available. Drilling into an existing borehole to deepen it is generally uneconomical—even if technically feasible. On the other hand, sandy deposits and pollution can be eliminated once the pump has been removed, by flushing out the deposits by the use of airlift, using a powerful compressor.

A sustained operation of tubewells over extended periods of time can best be secured if preventive measures are taken, such as selection of mechanically-resistant and corrosion-proof casings and screens; setting properly calibrated gravel packs and selecting adequate screens, so as to prevent



sand intrusion; driving the tubewells at appropriate depths so as to offset—in advance—detrimental effects resulting from a drop in the water table during periods of drought; and providing the well with an adequate antipollution superstructure.

Another preventive measure consists in drilling tubewells in pairs on each side so as to secure the availability of a reserve well if a breakdown occurs. The cost of a twin well is only 25 % higher than that of a single well, which is not a high price to pay to have a supply of water secured on a permanent basis.

*Selection of well types according to maintenance problems.* In selecting rural water supply systems, policy makers have basically to make a choice between open wells (dug by hand or excavated using mechanical means) and tubewells (L6). The main advantage of a tubewell is that it can be completed in a matter of days instead of months, and that it can be easily drilled down to such a depth that a lowering of the water table will have little or no impact on its productivity. On the other hand, it is clear that the maintenance of open wells and their continued operation can be secured without major difficulty.

In areas where the maintenance of pumps is not likely to be provided adequately, it is preferable to dig open wells, although the process may be much slower, expensive and require a large number of vehicles and abundant personnel. Several studies have been made on the subject of the comparative advantages and setbacks of open wells and driven wells and the maintenance aspects appear to be the decisive factor when a choice is to be made.

It is clear, however, that if the objectives of the Decade have to be met to a reasonable extent by 1990, massive well-drilling programmes will have to be implemented and related maintenance and repair organizations will have to be established in the earliest stages of programme implementation to avoid a rapid collapse of the system, as has been the case in a number of areas in recent years.

*Handpumps.* The maintenance and repair of handpumps is one of the major weak points of rural water supply programmes (L6). The ideal handpump, if not beyond reach, still remains to be designed and manufactured so as to meet a number of requirements (sometimes contradictory) such as being very sturdy and wear-resistant with a small number of moving parts; adapted to local climatic and other environmental conditions and to the cultural habits of the population; corrosion resistant; capable of operating at reasonable depths (50 m); able to operate for at least one year without major

maintenance or overhaul; simple enough to be serviced by unskilled personnel; may be pulled out and taken down using simple tools and no motorized equipment; and possible to manufacture in the country of use.

In any case, the maintenance and repair of great numbers of handpumps in rural areas require the backing of central and local workshops, the availability of skilled mechanics, vehicles and hoisting devices. It is a costly and complex operation in which the beneficiaries have to be involved to the largest possible extent.

Handpumps have been available for many years (L2). Indeed, in the Western world, they were common 100 years ago but in modern times the availability of piped water supplies has relegated the handpump to a comparatively unimportant position. There has been increasing interest, however, in the use of handpumps to provide safe drinking water in developing countries, especially during the last 10–15 years.

Where there is a suitable groundwater, the use of a handpump is generally the cheapest means of providing a potable water supply. The use of such pumps in developing countries, however, has produced many problems as well as solving some. Many, perhaps the majority, of these problems have their roots either in the sociological and cultural attitude of the pump users or in the organization (or lack of it) of the handpump installation and maintenance programme. One major problem, however, is the unreliability of the pumps which have been installed and the problems caused to the water supply as a consequence of it.

The unreliability may result from several sources:

- the intensive use of a pump in a village water supply scheme which may require it to be in operation for perhaps 12 hours of the day, when it was designed for only occasional use at a farm
- the use of cheap and unreliable pumps as an effort to provide water to the greatest number of people within the scope of a limited budget
- the choice of a poor pump simply due to the lack of suitable, unbiased and reliable test data on the pumps available
- lack of sufficient knowledge of pumps to foresee those peculiar features which could clash with the cultural behaviour of the pump users, or other environmental conditions.

*Testing of handpumps.* As far as is known there has been no wide scale, fully comparative testing of handpumps under controlled laboratory conditions (L2). In 1977, the British Overseas Development Administration ordered a laboratory specializing in comparative testing of consumer products to test 12 brands of hand or foot-operated deepwell force pumps for use in developing countries. The tests were fairly long-term, each pump

being endurance tested for 4000 hours. The results have been presented at a Conference organized by the International Reference Center for Community Water Supply in Hague, Holland in 1979. The 12 pumps were selected from all over the world as being typical of those used in village schemes and based on a complete world market survey.

As it can be safely predicted that many hundreds of millions of dollars will be invested by governments in handpumps over the course of the Decade, UNDP/World Bank have recently decided to embark on a multi-stage global project that will deal with laboratory and field testing of handpumps. The tests include a further testing of 12 pumps at the same British laboratory, mainly pumps from developing countries selected according to a certain set of criteria. Outputs from the project will be a guide for selection of handpumps best for particular installations, locations, cultures and applications, as well as a manual on handpump installations covering also well design and construction methods. These will not only facilitate maintenance and repair but ensure that pumps are properly protected against undue strains and abuse through improper mounting and poor arrangements.

## **Choice of Excreta Disposal Technology**

In considering the technologies for excreta disposal to be used for rural areas (and fringe urban areas as well), evidently the conventional public water-borne sewage system is not feasible because of the cost of the pipe and the appurtenances, inhouse plumbing, quantities and cost of water required, etc. (L11). Instead, there are a series of facilities at hand including the following:

*household*  
pit latrines  
poor-flush toilets  
composting toilets  
aquaprivies  
septic tanks

*community*  
bucket latrines  
vault toilets with vacuum  
cart collection  
communal facilities

It would be interesting to discuss the various advantages and disadvantages of each type of facility. But the selection will have to take into consideration the habits and customs of the people, the various soil conditions, the availability of materials, and the funds available.

Essential factors to be considered in a sanitation programme are as follows. It should form part of a larger programme such as water supply or an integrated development programme. A responsible entity should be designated and provided with basic staff funds to plan the programme and later to finance it. While one or two wells with handpumps may constitute a village water supply, the same village may have 50 to 100 households, each

requiring some suitable excreta disposal facility. This means that each family must be reached in some way—either by a village worker or sanitarian or health inspector from outside the village. This signifies a great deal of manpower to deal directly with the villagers, and obtain their participation.

The World Bank has carried out a research project to identify and evaluate sanitation technologies that can be afforded and maintained by the people to be reached (World Bank in L11).

## **Operation and Maintenance**

*Organization of maintenance and repair.* If a rural water supply organization is to be created for the maintenance and repair of handpumps a number of conditions have to be met (L6):

- an independent source of financing such as a revolving fund for rural water supply has to be established
- national personnel such as mechanics, masons, drilling technicians, sanitary engineers have to be trained and if necessary taught to read and write
- a monitoring system has to be established at the village level to maintain the pump in good condition and to carry out minor repairs. To this effect, the population has to be made aware of the advantages of the pump system, of its weaknesses and of the ways and means to prevent and offset minor breakdowns
- the problem of storage and timely delivery of spare parts has to be studied and solved
- at the village level one or several potential repairmen have to be identified, entrusted with the responsibility of keeping the pumps in operation, and provided with related basic training.

Ideally, the organization should develop at three levels:

- at the level of central government, central workshops should be established for servicing of public works equipment including major repairs and overhauling. The main vehicles on this level would be trucks, and truck-mounted mobile workshops, pumping-test units or cranes
- at the district level, smaller 'bases' should be established for simple operations including the servicing of pumps after 1 to 2 years of functioning. The basic vehicles and equipment at this level may be the jeep and the hoist
- at the village level the basic vehicle should be the bicycle.

Experience has shown that it is desirable to organize a service entrusted with the maintenance of pumps independently of the services in charge of the construction of wells, as the skills and problems and the involvement of the population in the process are quite different.

In the beginning of the Decade it is quite understandable that emphasis should be placed on preparations for large-scale water-well drilling programmes to meet the objectives assigned for the early 1990's. While a

number of donor agencies and development banks are ready to cooperate on such programmes, less spectacular but essential maintenance programmes receive insufficient attention.

It should therefore be the responsibility of the relevant UN agencies to identify gaps which may develop in this field, to bring them into focus, to propose solutions, especially as regards institution building and training, and to provide assistance. It is, indeed, likely that maintenance and operation problems will largely dominate the second half of the Decade—if not earlier—offsetting to a large extent those related to financing and construction of the systems unless adequate measures are taken on a priority basis.

*Communication as part of the problem—the Kenya case.* For the water supply to be properly managed and repair work done in good time, it is necessary to improve and maintain a highly efficient method of communication (L18). In Kenya, the planners distinguish between three levels of interactions: within the scheme itself, between the schemes and the District and Provincial headquarters, and between the headquarters and the main Nairobi headquarters. Within the scheme, walking and cycling may do except where bulky materials have to be delivered. Where possible, telephone/radio systems are now being installed to create efficient links for easy communication. Road transport is still very much used, although railway communication is also used to a limited extent. But the number of road-worthy vehicles is limited considering the large number of water supply systems distributed all over the country. Tied up with this issue is the subject of workshops, spare-parts, etc.

A crucial problem is the financing of operation and maintenance. Without funds little improvement may be realized in any water supply. Workshop and storage facilities are required. Vehicles, spare-parts, etc., all require money.

*Field experience in India and Thailand.* A few examples might illustrate some approaches that right now are being practiced in an increasing number of cases (L3). Examples from village supply projects in India and Thailand show that the planning for the operation and maintenance as well as other phases of planning and programming for water supply and sanitation can be carried out only on location. Everybody—governments, villagers, international, bilateral and voluntary bodies—had to learn the hard way. The result has been a complete reappraisal of strategies and tactics how to provide water and sanitation along with other basic services and how to make them function. This sector along with other parts of community development has developed from the harsh rules of technocrats to a broader, more compre-

hensive approach, trying to see the problems through the eyes of the villagers.

The problem included the one of huge handpump schemes with tens of thousands of pump sites and villages with ultimately hundreds of millions of human beings involved.

In the *India Village Water Supply Programme*, coordinated by the public health body of the Ministry of Works and Housing and implemented by the state governments, a major all-out effort is being undertaken since 1974 in order to bring the more than 70000 handpumps installed so far, into constant use with a minimum of interruptions. A detailed description is given in UNICEF (1980). Two approaches were simultaneously used:

- improvement of the handpump design, resulting in the India Mark-II handpump
- the 'Three-tier Maintenance System' working both ways from the villages to the state water authorities.

A salient feature is the involvement of the villagers themselves with the help of the Block and District Development Officers (who found themselves in a new and often much closer contact with the villagers). An important element is the inclusion of health and sanitation education in the training of the village handpump caretakers. This is a simple, straight-forward approach adapted to the particular social and administrative structure of the country.

Special mention should be made of the first pilot project several years ago in the South of India, centred on the Tirunelveli area in the state of Tamil Nadu. This was based on the Tamil Nadu Water and Drainage Board, the responsible state organisation for rural water supply, who undertook to pioneer this major effort which is now being spread throughout the other parts of India. One personal effort deserves mention. The coordinator of the pilot scheme, Mr. Francis, had been the Deputy Director for Rural Development of the State of Tamil Nadu. His broad base of knowledge, as well as being a wellknown personality throughout the state, did much to make this a true community-based scheme.

In *Thailand*, similar projects to improve the use, maintenance and operation of handpump schemes could be even further elaborated as parts of ongoing community development schemes with a strong primary health care component (UNICEF 1979). The Rural Water Supply Group of the Ministry of Public Health, consisting of rural water supply engineers, technicians, sanitarians, trainers, public health officials and UNICEF officers, undertook a series of field trips to interview health officials at three levels, as well as handpump caretakers and villagers. The object was to find out the problems of previous handpump efforts and to learn what kinds of training

each person involved in the project should receive. The result was a detailed listing of possible content for meetings and workshops, on which further comments will be given in chapter 10, when discussing educational matters.

In summary, in a complex setting the operation and maintenance of village water supply and sanitation are no isolated activities (L3). There is a need for involvement of the communities and the individuals. Links should be established with community development and primary health care. Links should be established between water supply, environmental sanitation with excreta disposal, and personal hygiene. There is a need for appropriate backstopping on mechanical aspects and social approaches (community activities motivation and education). And not to forget: monitoring and evaluation of these phases have to be carried out along with the rest of the programme.

## **Seminar Conclusions**

The Seminar devoted two of its workshops to the discussion of the topics of this chapter. *Choice of appropriate technology* was chosen as one of the two topics discussed in the first of the two workshops on Social and Economics Aspects on Rural Water Supply. *Operation and maintenance* was the theme under discussion at workshop 4 of the Seminar.

*Appropriateness of technology.* On appropriateness of technology the Seminar arrived at the following conclusions.

The appropriateness is to be considered in reference to both existing natural conditions, existing economic conditions, and the human factor. Under difficult natural conditions, for instance hard rock (igneous or metamorphic rock as contrasted to sedimentary rock), there might be no choice as regards technology to be used to develop groundwater, that is, a need for expensive, imported, sophisticated equipment. The obligations to carry out a large-scale programme within a limited time may also lead to the choice of expensive and sophisticated technology.

Under more favourable conditions, there might be more desirable economic solutions before considering sophisticated technology and imported material. Thus, it may be desirable to consider the following possibilities:

a. improving existing traditional construction methods; for example providing better lifting devices in the digging of open wells, better lining systems, better methods for digging under water;

b. using local material as far as possible: stone, bamboo, trunks of palm trees, etc; or equipment which can be manufactured in the country itself (PVC pipes, hand-pumps such as the India Mark-II);

c. the technology should be adapted to the population: its needs, its resources, its

cultural level and habits. The rural water supply installations are expected to be used to meet real needs, and to operate continuously. In particular, maintenance and operation should be uncomplicated and inexpensive. Many project failures are due to wrong choices being made in selecting the technology to be used.

The present experience furthermore allows the following conclusions to be made:

1. low-cost technologies, especially those which are imported, are not necessarily economical or appropriate to serve the rural poor;
2. a certain level of standardization is required in rural water supply systems if efficient management is to be achieved;
3. research and inventiveness at the local level should be encouraged;
4. local industries for the manufacture of handpumps, pipes, simple excavating devices and other equipment involved in rural water supply should be developed with a view to increasing self-reliance.

*Operation and maintenance.* In the workshop on operation and maintenance, the Seminar concluded that conditions which must be met to achieve a satisfactory level of operation and maintenance for rural water supply installations are the following.

At the *planning stage* any large-scale rural water supply programme should include an item for operation and maintenance of equipment and facilities. The size of the resources which are necessary to secure the continuous functioning of one handpump for a year is about 40 to 50 % of the cost of the pump itself. It has happened too often that governments have embarked on large-scale rural water-supply programmes without being aware of this essential consideration.

These resources should be made available through an independent *fund*. They may originate from

- government subsidies, intended to benefit the rural poor;
- specific benefits arising from the sale of water to industries and rich urban areas;
- modest or symbolic contributions made by the water users in rural areas and which will motivate them to use an installation with proper care. In several cases, however, such contributions are considered unjust, not feasible and unacceptable by the governments and by the rural population;
- possible external assistance in the form of equipment, supplies and spare parts.

The Seminar also concluded that a specialized *organization* for operation and maintenance should be established, aside from those dealing with well drilling construction and pump installation. The organization should not be too centralized (especially if the country is large) with initiative and sufficient means of action at the village and the district level. The organization should be set up before or during the construction phase with



- sufficient instruction at the village (mechanic) and district (workshop) level, including means of communication (motorbike or vehicle);
- adequate procedures provided with the necessary flexibility especially as regards procurement, purchase of spare parts in foreign currencies;
- qualified personnel at the village and district level in sufficient numbers (but not overqualified lest they be lost to better-paying positions elsewhere).

Operation and maintenance will be facilitated if the following conditions are fulfilled:

- simple and sturdy equipment and adequate construction methods have been selected;
- adaptable and simple tools are used;
- equipment is protected against misuse and vandalism;
- the population is motivated to help keep the installation in working order;
- simple operation manuals with clear instructions are provided.
- spare parts and simple tools are readily available.

## 9. Water Pollution and Legislation

... enforcement of the law relating to water pollution ... is hampered by the shortage of skilled manpower.

F. Muslim, Kenya

### Degradation of Water Resources

*Need to protect drinking water sources from pollution.* In many developing countries there is a great need to protect drinking water against pollution, as water is generally distributed to consumers untreated (L13). Furthermore, water treatment itself is in many cases unlikely to eliminate toxic elements originating from industrial waste, and harmful substances such as pesticides and fertilizers used in advanced agricultural practices. Preventive measures are therefore essential.

Important environmental impacts are also arising from the provision of drinking water supply and sanitation since the provision of such facilities may in fact lead to serious health problems due to the improper handling and disposal of household waste water, particularly in areas where there were no such facilities before (L19).

But also the rapid industrialization occurring in many developing countries as part of the economic development carries with it heavy hazards as to water quality. This involves the problem of finding efficient waste water treatment methods to be used in connection with simple industrial

technology adapted for use in settings with low level of public understanding and great manpower deficiencies. The problems emerging in Lake Nakuru in Kenya offer an illustrative example.

*Case of Lake Nakuru, Kenya.* Lake Nakuru lies within the Rift Valley internal drainage system which is one of the densely populated areas in Kenya and occupies a place of pride in the agriculture industry (L21). Right from the colonial period the area was an important component of the settler plantation economy and produced many of the cash crops which were the backbone of the colonial economic structure. Lake Nakuru has great importance as a source of water for human, agricultural and industrial purposes besides being a unique ecosystem whose value goes beyond economic estimation.

The availability of raw materials, a pool of labour and a ready market have all worked to attract industries to the Rift Valley area around Nakuru town, situated close to the lake. Among the *industries* are tanneries, dairy industries, consumer goods industries, etc. The agricultural and industrial activities have a direct impact on the area's water resources. Of more cultural and scientific rather than economic significance is the fact that Lake Nakuru is the home of more than one million flamingoes, this being the largest concentration of flamingoes in the world. The lake as a feeding and wintering haven is essential for their survival.

The degradation of the lake witnessed already can largely be attributed to the expansion of the human activities, including the depository of by-products and wastes. The authorities have not been able to provide an efficient sewage system in most urban centres in the country. In Nakuru, the absence of a viable alternative for a fast-growing population may operate to encourage the use of the lake as the depository of the *town's sewage*. The pollution may become a problem and expensive to control if corrective action is not taken soon. Apart from the degradation of the water quality of the lake, pollution would have the adverse effect of destroying the habitat which the lake provides to flamingoes and other bird life.

The agricultural industry has had wide-ranging repercussions on the lake's water. The industry has had to expand productivity so as to provide for local consumption as well as provide for export which earns the country valuable foreign exchange. Because of the country's limited land resources and because irrigation is not a viable alternative to increase the acreage of land under cultivation, due to the costs involved, increased productivity can only be attained through the use of fertilizers to maintain and improve soil fertility, and the use of pesticides to eradicate pests which otherwise invade and destroy crops under cultivation. *Chemical substances used on the*

*farmlands* are gradually drained into lakes and rivers. The presence of pesticides, including PCB, has been established in nearly all samples analyzed in natural water from the Rift Valley. The problem of chemical pollution facing Lake Nakuru began to receive attention in 1971 when there was a sudden fish die-off in which nearly 75 000 fish died following a sudden heavy rainfall in the town of Nakuru.

The water resources of the region in general, and that of the lake in particular, are facing eventual depletion and possible destruction as a result of *destruction of vegetation in the catchment* due to indiscriminate felling of trees for charcoal burning, the clearing of forests to create room for human settlements, overgrazing, forest fires, etc.

*Kenyan Water Act is not effective in pollution control.* None of the problems facing the lake are on the decline. On the contrary, their gravity is exacerbated day after day in spite of the fact that they regard contexts covered by legislation.

Thus, the Water Resources Authority has the responsibility of investigating the water resources of the country, advising on the improvement, preservation, conservation and utilization and apportionment of such resources (L21). The pollution can be dealt with already when a particular activity is being planned by the provisions in the *Water Act* which requires an applicant of a permit to use water to indicate possible effects on water quality, public health, fish, etc. The applicant is required to state what steps are proposed to render the effluent innocuous or pure before returning it to the stream. Furthermore, the Act expressly prohibits the pollution of water used for human consumption, domestic purposes or for the manufacture of food or drink for human consumption.

However, the Water Act may not be effective in controlling the chemical pollution from activities where no water is extracted. For instance, in rain-fed agriculture, no conditions are imposed for the use of the water. Any pollution control programme to deal with chemical pollution must therefore proceed on the basis of *other legislation*. This includes the Food, Drugs and Chemical Substances Act, according to which water resources used for human consumption are protected against contamination; the Fertilizers and Animal Foodstuffs Act, which is, however, not designed to avert hazards associated with the substances regulated; and the Poisonous Substances Act, which seeks to avert hazards of direct poisoning rather than pollution of water resources by poisonous substances.

*Institutions in conflict.* Each of these acts establishes institutions for its administration and enforcement. However, the enforcement of the law

relating to water pollution is hampered by the shortage of skilled manpower to monitor the quality of water and to keep an eye on those activities which have a potential for causing pollution. To be effective, such monitoring operations need to be regularly maintained, so that a reliable basis for effective action can be established. Nor has the pollution control been assisted by the fact that there is a multitude of institutions exercising various powers in relation to the country's water resources. In the absence of a defined policy for the management of the country's water resources, a situation has emerged whereby each institution pursues its own objectives in complete disregard of what others are doing. This has precipitated a situation of institutional paralysis and at times obvious conflict.

### **Water Protection in Four African Countries**

*Water quality degradation is advancing.* A comparative study has been carried out on water protection in the four African countries Ethiopia, Kenya, Tanzania and Botswana (L13). These countries all have scarce water resources with uneven distribution. The industrialization of the countries concerned, so far comparatively limited, is foreseen to play an important role in their economic development. Water is here a basic element. Rural as well as municipal water supply, cattle watering and last but not least irrigation, will heavily strain the water resources.

Even if vast areas of the four countries concerned are not yet significantly affected by pollution, it is evident that the situation is gradually getting worse and that the affected areas are enlarged. This deterioration makes it more difficult or even impossible to use water for qualified purposes. Pollution can be counteracted through purification of the drinking water—that is true—but only to a certain degree.

*Required water management measures.* The demands of today and in the future evidently require an advanced water management from both a quantitative and a qualitative point of view (L13). The balance between exploiting and protecting forces would need careful control. Most often the exploiting forces are the strongest ones. It is worth noting that, according to Swedish experience, a programme for water protection can be implemented with the industrial competitive force still being maintained, in paying regard to the fact that industrial reuse of water includes recovery of valuable raw material and less pollution of natural waters. It should also be noted that once the water resources have been destroyed the costs to remedy are high.

Sensible use and reuse of water must form an integral part of a management policy. These objectives demand that water protection measures are

planned at an early stage. Good environmental in-plant measures in the industry are essential. Measures that have to be taken fall into three different categories: legislation, administration and manpower.

*Legislation:* It seems that the existing water protection legislations in the four countries do not satisfy the requirements of today to prevent pollution effectively. A general statute in the water act to prevent pollution, giving the pollutor himself the possibility to decide on the actions to be taken is seldom successful enough. A better way would be to have a pre-trial by a permit issuing water board to find out, in each individual case of water use and waste water discharge, what should be done, taking into regard what is technically possible and economically feasible to do to protect the water resources. The condition of the water receiving the waste-water outlet is no doubt an important factor as well as the necessity to have an equal trial of competing industries.

It is desirable that the legislation is flexible and gives the water board the possibility to

- decide upon the siting of new industries and similar polluting activities;
- give the provisions for inspection of industrial processes;
- issue regulations for the protection of water sources and catchment areas;
- take into account other activities that can affect water quality such as soil erosion, disposal of solid waste and toxic material.

*Administration:* Beside the water board there is a need for a policy-making and coordinating unit to

- investigate and follow up the general water situation and report on matters that need consideration and counter-measures by proper authorities;
- work out 'narrative' guidelines and minimum requirements from the water protection point of view for most common industries. This will facilitate and reduce the administrative work and give information to industries at an early stage as to what is expected from them. The Water Resources Dept in Kenya and SIDA have presented such a study for the Kenyan leather industry, which might serve as an example of that kind of work;
- inform on water management. The growing public awareness of pollution is an important factor in a well functioning protection system;
- propose to the water board conditions for water use and waste water discharge in connection with applications for permits;
- inspect industrial processes and facilities for prevention of water pollution;
- propose tariffs for water and waste water, such that they encourage reduction of water consumption and pollution load.

*Manpower:* As important as elaborate water protection legislation are the available manpower resources. Education and experience from the field are key elements. Technical people for industrial waste water problems and municipal water and sewage matters are needed as well as hydrologists and

biologists. Personnel with the traditional academic research-oriented background should get the possibility to go abroad to get experience from other countries with an advanced administrative pollution control system. Matters of education and exchange of knowledge are in fact important enough to call for immediate and high level attention.

## Seminar Conclusions

The Seminar choose *case studies on legislation and regulation* as one of the two topics discussed in the workshop on Institutional Aspects on Rural Water Supply. The Seminar arrived at the following conclusions.

Water legislation, especially as regards protective measures against pollution, is in many countries lacking or inadequate. The implementation of laws and regulations is difficult. One of the reasons for this is that a controlling and monitoring function is required which may not be available owing to the lack of manpower and financial resources, but also to technical difficulties.

It has to be realized, also, that pollution cannot be entirely avoided or eliminated and that the fundamental objective of legislation is to keep pollution within 'acceptable' limits. A periodic revision of laws and regulations is needed to deal with rapidly changing conditions. Authoritative enforcement is not the most effective way to implement laws and regulations. The education of both political leaders and the general public, and the creation of public awareness are more conducive to successful implementation.

Legislation should be harmonized on a regional basis—especially as regards acceptable standards for industrial effluents and water quality. It is well known that investors are attracted by lenient legislation. Conditions for unfair competition and for the development of hazardous situations may be created if the countries of a region or subregion are not equally protected by water laws and regulations. Such cooperation is even more necessary for countries sharing water resources from international lakes, river basins and aquifers.

So far the Seminar conclusions. It ought to be added (L21) that, whereas short-term measures are related to the strengthening of water acts and water institutions and to the assessing of environmental impact of various economic and other human activities, a long-term solution should aim at regulating the use of a country's environment on a holistic basis.

## 10. Manpower and Education

If modest programmes are to be carried out in most countries, as many as 4,000 professionals and well over 2 million subprofessionals have to be trained.

B.H. Dieterich, WHO

### Manpower and Training Needs

*Lack of trained manpower a major constraint to the Decade.* It is now well documented that water programmes are adversely affected by shortages of managerial, supervisory and technical skills, which can be met through training (L27). The World Bank, WHO and ILO all have confirmed that the lack of trained manpower is one of the major constraints to the effective and efficient development of the water sector in developing countries. From a programmatic standpoint, the single most important element in ensuring the Decade's success will therefore be the training of adequate manpower (I2).

A few facts must suffice to demonstrate the magnitude of what lies ahead (L16). According to McDonald (in L16) 'if one wants to gradually upgrade water quality and install new systems, then trained manpower is at the heart of the requirement. Five years ago Brazil set the training of 60,000 people in six years as a national priority in order to bring water supply service to 80 % of its urban population'. Ishamabad reports that 'experience in Pakistan has shown that 1 technician would be required for 1000 persons for operation and maintenance of a basically adequate system'.

The worldwide need for skilled and competent people in this field probably exceeds a half million (I2). This includes village level technicians to repair and maintain pumps, government administrators and planners, and Ph D hydrological experts. In many countries there is an almost total absence of trained personnel, and often pumps and wells lie unused because no one in the community has even the basic knowledge to keep them in operating order. Creating cadres of trained personnel especially at the lower levels must be the highest priority. Even if the goals of the Decade are not met in a specific country within the next ten years, if adequate people are trained during this period of time it should ensure that, ultimately, that country will move towards clean drinking water and sanitation for all.

*Seminar conclusions on problems of human resources.* The Seminar discussed the problems of human resources as one of the two topics chosen for the workshop on institutional aspects of rural water supply. The Seminar concluded that: Unfortunately, in many areas of the world skilled manpower is in short supply while many specialists are engaged in routine activities. Recru-

itment of staff at the operational level should not be confined to university graduates. It would be better to draw from a specialized technical school organized by the water ministry which has a clear knowledge of the personnel and skills required. The training of executive personnel should not be limited to technical matters: it should also include management and financial issues, sociology and public relations. Training of operating personnel should be organized preferably within the region. As far as possible it should be 'self-sustaining' (training of trainers has been organized successfully in the Caribbean area, cf. below). Special attention should be given to instruction manuals and job aids appropriate to the level of the trainers. One aspect not to be neglected is the need to understand the motivations that move people into certain activities in preference to others, e.g., to car repair rather than waterworks maintenance.

## Some Educational Problems

*Training levels.* Typically, training can be approached by identifying three levels: training of engineers, craftsmen, and operators, with training coming preferably from the direct managers at each level considered.

The skills requirements for rural water programmes vary from simple skills (repair of village handpumps) to more complex ones (complete overhaul of drilling rigs) (L27). Countries must also have viable plans for training technicians, engineers and managers who should be responsible for the planning, organization, administration and supervision of the national water systems. Training should have a dynamic flexibility to cope with equal relevance and effectiveness, with the skills requirements throughout this range. It can be argued however, and perhaps rightly so, that priority should be given to training of:

- workshop personnel who should carry out specialized repair, overhaul of and test pumps, engines and ancillary equipment;
- itinerant maintenance and repair mechanics who should carry out periodic maintenance, over-all inspection of installation and supervision of records;
- village craftsmen or at least two villagers who will be responsible for the care, operation, maintenance and simple repair of equipment.

Provision of training programmes would require a degree of coordination with existing national training and educational institutions. Establishment of new specialized institutions for training of rural water personnel is not advocated. It can only be justified if no institutions already exist, which can be adequately equipped to meet the training requirements. Assessment of rural training centres, agricultural schools, etc., should be made to determine the possibility of using them for training of rural water personnel.



*Where to teach, who is to teach?* An essential problem is where to teach and by whom, at what level, at whose expense, and with what consequences (L16). Complex works raise the training requirements and may lead to a gain in quality (in theory) which is counterbalanced by interruptions in quantity as reliable operations falter. For example, chlorination and water metering can raise the training requirement significantly. Should their automatic introduction be resisted?

Centres of excellence need to be made known. To them may go those at senior level for improved experience but, still more important, from them could go out trainers with an itinerant task.

Training materials, based on simple core vocabulary that is easy to translate, will be in demand as hand-outs and correspondence courses. Use of radio, cassette tapes and even video cassettes should not be overlooked although replacement of 'on-the-job' demonstrations is unlikely.

There will need to be a recognition of the role played and to be developed by other staff at agencies with a rural presence, e.g., schools, hospitals/aid posts, agricultural and estate centres, police stations, etc. This may involve a retention of (or return to) the multi-role worker who knows when to refer to the appropriate professional superior at a distance when a problem arises.

Training institutions may need to look to the examples set by health campaigns (e.g., sanitarian training in Indonesia) or agricultural development (e.g., in major rice producing nations). This will be away from college type courses towards field demonstrations or 'hearts and minds' work. Consequently, identifying future financial requirements cannot be easy although it is considered that in the previous development of regional centres of WHO, there is already a framework for identifying priorities and instigating action. Nevertheless, the real work will be done in those countries that whole-heartedly accept the challenge that the Decade poses.

*Training methodology.* As to training methodology, a modular approach is usually more systematic and efficient (L27). Training programmes designed on the basis of this approach have the following characteristics:

- the basis of training is the identification and analysis of training needs and necessary skills levels;
- training objectives are precisely formulated to ensure that knowledge, skills and attitudes acquired meet the specific requirements of the work to be performed;
- training content is explicitly related to the working requirements and communicated in a language and at a level which is conducive to a full understanding on the part of the trainees;
- instructional tools and equipment are selected to conform to the requirements of the work to be carried out;
- training courses operate on the 'fixed achievement variable time' model, where the achievement level is fixed and matched to the job requirements.

The modular training approach can be grouped into four stages:

1. identification of the training activity(-ies), so as to determine precisely what should form the content of the training programme;
2. preparation of a delivery system, including establishment of supporting infrastructure, preparation of learning materials and instructional staff. The modular preparation of learning material is advocated because of the high degree of flexibility which can be brought into the training programme;
3. implementation related to the delivery system at the learning level. As much as possible, training should be carried out where the activity(-ies) are normally performed;
4. evaluation relates to performance during training and post-training performance. A follow-up system must be an integral part of evaluation.

*Training of trainers.* The crux of any training programme lies with the instructor of trainers (L27). With poor trainers, even the finest training system design will be worthless. Trainers may be drawn from government projects, teacher training colleges and technical training and educational institutions, the private sector, equipment supply companies and foreign sources. Some form of pedagogical training will be needed to prepare trainers to give instructions in a setting similar to that in which the actual work has to be performed. Trainers should also have an orientation conducted by people who are familiar with the content of training materials in the course of training in water development, prior to the assignment of trainers.

An interesting case of regional training of trainers is given by the East Caribbean countries, where a regional training delivery system has been started as a demonstration project with the participating countries in the region. The project is supported by international agencies, and embodies a joint education programme for waterworks personnel (Yearwood, C3). An assessment in 1977 of the water-utility training in the region revealed a gross imbalance between the training of different categories, most resources being laid on engineers and technicians, whereas semi-skilled and unskilled employees constitute over 80 % of the total work force. The existing nucleus of technically trained people could be used as a basis on which to build a self-sustaining training capability in the region. A Training Delivery System (TDS) was introduced in the region and supported by ten countries.

The idea is to train trainers who can then go home and train on a national basis. Barbados was chosen as the most suitable location for the office of training coordination, taking into account the possibility of relying on the Waterworks Department with its staff of 1000 persons and on existing training institutions. All participating countries appointed a training coordinator to form the link between the central office of the system and the respective national bodies. The training aims at communicating skills and instruction techniques, and is realized through a series of one-week work-

shops at four-week intervals. Out of 142 participants from the ten East Caribbean countries participating, 72 % certified according to performance-oriented tests.

A number of manuals and job aids were developed within the TDS by participants selected from the trainees and following a standard format. The work was organized as an introductory one-week workshop, followed by a seven-week period for interviewing and writing and a final one-week workshop for wrapping-up. Six manuals and four job aids had been completed by October 1980. It seems that TDS as outlined offers a good chance for the area to become self-reliant in waterworks training.

*Community-based training.* Experience in vocational training in rural areas is still insufficient and the need for developing innovative techniques in reaching the people lacking skills is great (L27). At the same time, rural training suffers from the low status attached to its participants. One does not need to make a thorough search to discover that in many developing countries, educational and training activities are concentrated on selected technical and engineering skills for the professional and sub-professional groups of urban employment. The tendency to locate training facilities in urban areas has often resulted in giving emphasis to alien modes of training and ideas.

Training needs of rural people are different, because few of them have grown up in a mechanized environment. The replacement of a simple rubber washer becomes a major task to the uninitiated. When machines—simple as they may be—are introduced, many new skill requirements become apparent. People will need training in skills which will help them properly use, manage, maintain, repair, and safely operate the new machines.

There are many factors determining the training needs, the identification and analysis of which should be 'village specific' in the sense that the identification is made of those areas of activity that the villagers themselves feel are in need of attention. Few will dispute that there are many statistics and figures at the macro-level, but these could hardly be used for village-level planning. By means of a community survey, the study should produce something like a 'village profile' covering presence (or absence) of water facilities, population, training opportunities, absence or presence of capability of existing craftsmen to install, operate, maintain and repair equipment. Arising from this survey, a number of technical learning needs can be identified which then become the basis of planning and organizing skillstraining programmes.

*A communication strategy in Thailand.* If the benefits of safe water are not understood by the rural population concerned, and their full participation is

not promoted, the success of the programme will be limited. In Thailand, a communications strategy has, as earlier mentioned, been developed which will help field staff in their efforts to mobilize the kind of community support and participation in the development of village water supply that is so essential (UNICEF 1979). The governing strategy of the water project in question is that all levels of people involved be provided with an opportunity to participate in its planning and implementation. As indicated in chapter 8, the basis of the training programme was laid by a series of field trips to get an idea of what kinds of training each person involved in the project should receive, the results of which was embodied in a detailed listing of content for meetings and workshops. A decision was made to structure the workshops so that participants could comment on individual segments of the rural water supply project's operation. The idea was to create an atmosphere and reality of ownership: participants would be able to see that the project belonged to them, and, therefore, would be more committed to helping it achieve its objectives. Working in small groups of six to seven people, it was felt that participants would find the atmosphere non-threatening, non 'classroom-like', and creativity would flourish.

A core of exercises was worked out with the following general objectives:

- for participants to learn the proposed procedures and operation of the rural water supply project;
- to elicit opinions and suggestions from participants;
- to provide participants with an opportunity to discuss concrete ways to contribute to the rural water supply project as a whole and in local communities;
- to analyze and discuss community participation through a structured exposure to other experiences;
- to plan motivation activities in their communities;
- to build support for the rural water supply project.

Since the workshop was composed of both senior and junior officials as well as people of all ages, one procedural problem was how to arrange people into groups so that no one dominated by virtue of rank or age. It was decided to form groups according to position: that is tambol officers comprised one group, amphur officials another, government midwives another, etc. This seems to have been a successful way of proceeding, since there was no reluctance to offer opinions within the small groups. Nor was there reluctance when the groups reported their opinions. The opinions from the groups of junior officials were given as much weight as opinions from senior officials.

After completion of the workshop, another field visit was made to interview participants on the job with the objective to evaluate the training offered.

## Health Education

*Awareness to be created on hygienic matters.* We have in earlier chapters noted that improved health does not normally follow solely from access to safe water. A lesson in this regard is that sanitation, hygiene and hygienic behaviour are as important for health as clean water (L26) and that the achievements of health benefits certainly do not come automatically with the provision of safe water.

Clean water alone will not significantly alter health status if it is not accompanied by an intensive educational programme. In many villages in Thailand, for instance, after bore holes were drilled providing copious clean water, people continued to get their drinking water from the village ponds where the water buffalo lived. They complained that the water from the bore holes had no taste, and only an extensive education programme convinced them that deaths of their children and their recurrent diarrhea was the result of contamination of their traditional water source.

Intensive health education programmes must therefore be an integral part of the Decade's strategy. In those countries where there is already an initiative to develop primary health care programmes, the health education can be made an integral part of that effort. Where there is not, then it will be necessary to rely on whatever strategies or organizations exist in the society to reach people at the community level and teach them about the importance of clean water and hygienic practices.

Also sanitation programmes have an important content of hygiene, implying again that the importance of health education cannot be overstressed (L11). It is required to secure the understanding, support and participation of the rural population. Adequate funding, materials and staff for this is a relatively small investment in the overall programme. Utilization should be made of the available local, provincial and national personnel with skills and experience in family and group education methods, of village committees, village leaders, and simple teaching aids and visual materials.

As already indicated in chapter 2, sanitation programmes are perhaps more difficult than water supply projects. First, because of the greater number of families that must be dealt with on an individual basis; second, because of the task of explaining the need for such facilities to break the disease transmission chain and motivating the people to improve their hygiene habits; and third, the organization and logistics involved on the part of the existing agency to carry out the programme.

At a local or district level there should be well-trained sanitary (public health) inspectors directly in charge of carrying out the programme. These inspectors are assisted by health assistants or technicians posted to the rural

towns and villages. If possible, village level-workers or community groups should be organized in each village to provide self-help. All these people should be carefully trained, from the supervisors to the village workers. The health assistants or technicians are especially important since they are in close daily contact with the population. The training should be done locally and include more than just the construction of the facilities. Depending on the level of education, they should be trained in basic sanitation, basic construction practices, and stimulating self-help.

*Crucial role of women.* We have in this report already drawn attention to the crucial role of women in health care. Apart from the health implications of nutrition, rural women need basic knowledge about the maintenance of health and the causes of illness. In poor families, women provide first-line and often the only health care (L14). Much depends on their ability to recognize and deal with health problems before they become acute. Women have to be willing to use the health services that may be available, and be able to afford the time and transportation costs of doing so. Women are also responsible for inculcating good habits of hygiene and sanitation, which may be as important for health as good food and good eating habits. Some sanitation problems and sources of contamination are partially beyond their control, but women can be assisted and educated to minimize their adverse effects. The control of diseases bred by these conditions requires efforts of whole communities rather than of individual women.

*Integrate with traditional beliefs and attitudes.* Health education programmes should also take into account traditional social beliefs and attitudes (L15). Most, if not all societies—tribal, peasant, rural or urban—have their own beliefs and practices concerning health and curing of diseases. To a greater or lesser extent these may reflect what is considered to constitute the 'scientific knowledge' in this area. It has sometimes been pointed out that traditional medicine has certain advantages over imported systems of medicine because,

'... as an integral part of the people's culture, it is particularly effective in solving certain cultural health problems.

Moreover, traditional medicine has often a holistic approach—i.e., that of viewing man in his totality within a wide ecological spectrum, and of emphasizing the viewpoint that illhealth and disease is brought about by an imbalance, or disequilibrium, of man in his total ecological system and not only by the causative agent and pathogenic evolution' (WHO in L15).

The implication of such concepts for rural drinking water supply is that the local people might find it difficult, even impossible, to see any need for a water project and to agree to its underlying hypotheses. The link between

water and health will not be obvious for the villagers if, in accordance with their traditional health beliefs, they are convinced that certain water-related diseases are caused by physical exertion, hot or cold temperatures, God or Fate, or even the working of an evil eye (Lewis in L15). The problem to be resolved by drinking water projects is, in such a case, how to bring the positive element of the two medical systems together. Health education programmes will be of great importance in this respect and should form an integral part of the rural water supply projects.

## 11. Research Needs

Nevertheless the real work will be done only in those countries that whole-heartedly accept the challenge that the Decade poses.

Frank Law, Unesco

There are still wide areas of ignorance about water supplies, sanitation and health. The investments in the Decade will be massive; of the order of hundreds of billions of dollars. It is necessary that a small proportion of this investment (say 0.01 %) be allocated to applied research which will assist us to design each investment in water supplies and sanitation in a way that achieves the maximum possible improvement in the health of the community (L10).

### Research on Strategy Options

*Fundamental issues.* Over the past few years it has become clear that there is more to water supply and sanitation than the construction alone. As shown in earlier chapters, several fundamental issues require urgent action to create self-reliant conditions which guarantee long-term construction programmes, adequate operation and maintenance to ensure long term usefulness and cost-effectiveness, and an understanding of the benefits of the services and their proper use by the population.

However strong the convictions of the need for such action may be, strategies which integrate past experiences and new thinking are not readily available (L5). These should translate items for action, adapted to different country situations, and which involve all existing national and international options for cooperation. Research is needed to develop options for national strategies for manpower development; community education, involvement and participation; institutional and legislative development; and alternatives for financial management.

The lack of options hamper development in many countries. They have received, relative to engineering issues, insufficient attention. In the context of the Decade, these issues should receive due attention. Thus, Decade goals become not only an end in themselves, but also a vehicle in the process of self-reliance.

*Research to be translated into action.* It needs to be investigated with urgency by whom and where the various research activities should be carried out (L5). The UN Steering Committee for the Decade may be the appropriate mechanism to trigger further consultations. It should also be considered how such research items, such as combined research, development and demonstration activities, can be integrated to provide an enriching cross-current of knowledge and experience for developing world workers.

It should be emphasized, however, that research and development alone is of limited use. The glaring lack in many cases is the communication and application of the results of research and development. Knowledge and experience may often be available but not accessible to others.

Finally, cooperation is an essential element, to ensure that the limited research capacities are utilized to their optimum and that results are made known widely. It may well be that successful research cooperation for the Decade could prove to be the most cost-effective issue of all.

## **Appropriate Technology**

*Some suggested priorities.* Although a wide range of research work and development work has been devoted to appropriate technologies, certain issues require further work (L5). Extensive information has been accumulated on these needed developments, which deserve close attention. A document which presents suggested priorities for research in South East Asia is worth quoting on this issue because it can be regarded as having a wider importance (WHO/Regional Office for South East Asia, ref. in L5).

1. studies to develop, adapt or adopt appropriate technologies in environmental health at the village level, specifically on
  - hand pumps including maintenance systems
  - rain water collection
  - excreta disposal systems
  - waste-water disposal system
  - integrated systems including water supply, excreta disposal biogas units and composting-aquaculture-gardening systems;
  
2. studies to develop strategies and approaches for the wider application of potentially appropriate technologies together with assessment of their applicability in the rural village:



- excreta disposal systems such as pit privies, water-seal latrines and compost latrines
- composting
- biogas
- hydraulic rams
- chlorination of drinking water
- iron removal in drinking water
- filters for pond/tanks used as drinking water sources.

It might be added that World Bank research on sanitation issues in recent years has led to notable results.

*Integrated approach.* Of utmost importance is the approach taken on such studies. Experience in integrated approach has been gained in a project on slow sand filtration coordinated by the International Reference Centre in Hague (L5). This project is characterized by an integrated approach towards the implementation of a village water supply. A health education programme is used to inform the population about the health aspects of the water supply, and thus motivate them to participate actively in the various stages of implementation planning, design, construction, operation, maintenance and management of the system.

During a recent meeting of representatives of countries participating in this project, it was again stressed that this participatory approach together with project support through a health education programme, proved a proper method to incorporate an environmental health-related technology into a rural community. This ensures a continued functioning of the newly installed commodity and increases the self-reliance and self-sufficiency of the rural population.

Over the last few years the application of solar energy has become increasingly important, particularly for pumping. Outstanding advantages of solar energy are durability, simplicity of maintenance, low cost of operation and possibility of application in remote areas. Its disadvantage is the present high cost of the equipment. Further research according to the above approach should be able to make this system ready for wide-scale application. Application of wind energy, although perhaps of less potential, should also receive more attention.

## **Water Use and Sanitation**

*Water use parameters.* Thus, there is undoubtedly room for action-oriented research in many areas. A general area where we still know little is what one might call water use parameters (L26). Some such work has been done in

connection with schistosomiasis research by the Tropical Disease and Training Programme of the WHO. Yet, we know very little about traditional systems of water use and how people in different cultural settings interact with water, how it is stored, how it is used, and how it is contaminated. It is quite evident that such contamination of water takes place between the collection and the consumption at home. Much diarrhoeal disease may have its origin in the unhygienic handling or storage of water. Our knowledge of the handling of water 'from the tap and beyond' is most insufficient and there is a need for a combined engineering and behavioural study of the peripheral end of the water system. This would include the location of taps, home storage vessels and their microbiology, facilities such as laundry-shower units and their effect upon water use, etc.

The multiple use of untreated water sources will probably increase as a consequence of the Decade. The bacteriological surveillance of such sources has been neglected in the past, but there will probably be a need for such surveillance. We need new knowledge on how to operate and sustain different types of organizations for surveillance at low cost, and answers to questions like how frequently samples should be taken, on action levels of bacteria, and on problems of indicators' measuring, sampling and analysis under tropical conditions.

*Social and cultural factors.* The social and cultural aspects of sanitation is another area where knowledge is very limited. A better choice of disease control measures and sanitation arrangements would be possible if there was a greater familiarity with social and cultural determinants (L26). It is typical that we know so much more about the technical aspect of sanitation than of the social. The IDRC bibliography has 532 entries, seven of which deal with 'social aspects' and a further 17 with 'public opinion'. It is evidently easier to discuss the technicalities of biogas chambers and 'appropriate technology' than cultural aspects of anal cleansing, defecation behaviour and habits of human waste disposal.

Another area of interest is related to which existing cultural and social structures could be used especially in diarrhoeal prevention programmes. This was discussed already in chapter 2 when treating the question how to break the chains of disease transmission.

*Methodology.* Finally there is a general need for developing methods. Investigations into the benefits of water on health can be very cumbersome, longterm and expensive. There is a need to work towards an optimal ignorance, i.e., not collect more data than necessary for the solution of a certain problem. Minimum Package Solutions are also greatly in demand.

However, it is not enough to come from understanding to prescription. There must also be ways of coming from prescription to action.

## **Final Comments**

In conclusion, for the Decade to reach its objectives, operational research is urgently needed and should entail cooperation between the countries, and dissemination of needed forthcoming information. Among the aspects which hinder the now stepped-up planning and implementation of water supply and sanitation works in many developing countries are (L5, L26):

- the relatively low attention paid to convincing policy-makers and potential users of the benefits of water and sanitation facilities;
- the lack of integration of different sectorial developments in rural areas;
- the still prevailing lack of appreciation of the need to act on such issues as manpower training and community participation;
- the limited availability of application strategies for appropriate technologies;
- insufficient understanding of local attitudes towards water and excreta;
- various aspects of incentives, timing and information in changing hygienic behaviour.

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- L16. Law, Frank: Prospects for advances in rural water supply at the technical and operational level and the implications for training policy.  
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- L17. Lee, T.R.: The provision of drinking water and sanitation to the rural population in Latin America.  
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- L20. Mascarenhas, Adolfo C.: Determinants of the execution and administration of water projects in Tanzania.  
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- L21. Muslim, F.: Environment impact assessment legislation and water resources management in Kenya: A case study of Lake Nakuru.  
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2.	<i>Country reports</i>	<i>Author</i>	<i>Title</i>
C1.	(rapporteur— report)	Falkenmark, M.	Country and thematic papers: conclusions and summaries
C2.	Bangladesh	Kahn, M.H.	Rural water supply in Bangladesh
C3.	Barbados	Yearwood, D.K.	Towards the evolution of a training delivery system for the Eastern Caribbean (Barbados)
C4.	Bolivia	Lizarazu, J.	Bolivian high plain basin
C5.	Botswana	Gopolang, M.J.	Construction, operation and main- tenance of rural water supply schemes in Botswana
C6.	China	Jin, Fei	Experiences of ground-water searching in some deficient areas of China
C7.	Cuba	Andraco, L. Sotto	Experiences in water supply in rural areas in Cuba
C8.	Ethiopia	Gebeto, P.	Thematic paper
C9.	Haiti	Felix, C.J.	Design, construction and rural project management at local, regional and national level (Haiti)
C10.	Indonesia	Widodo, W.	Rural water supply in Indonesia
C11.	Kenya	Kago, J.	Evaluation of rural water supply programmes I, II and III (in Kenya)
C12.	Liberia	Yarsiah, J.	Rural water systems development in Liberia: An integrated rural development strategy
C13.	Malawi	Marcello, P.J.	Ground-water resources develop- ment in Malawi
C14.	Nepal	Sharma, S.N.	Execution and administration of projects at local, regional and national level (in Nepal)

C15.	Nigeria	Okeke, E.O.	Water—A rare commodity! Rural water supply in Nigeria
C16.	New Guinea	Oti, U.	Water and living conditions in Papua New Guinea
C17.	New Guinea	Matango, M.P.	Rural water supplies in Papua New Guinea
C18.	Somalia	Yusuf, M.E.	Future plans for water resources development in the rural areas of Somalia
C19	Tanzania	Msimbira, N.K.	Rural water supply in the United Republic of Tanzania
C20.	Tanzania	Bali, B.K.C.	Examination of issues related to the organization, investment, planning and implementation of rural water supply programmes in Tanzania
C21.	Thailand	Kruerklai, D.	Preparatory and planning phase of safe drinking water supply in rural areas (Thailand)
C22.	Thailand	Pissathanporn, S.	Rural water supply in Thailand
C23.	Yemen	Ba-Abbad, S. A-R.	Rural water supply scheme in the Peoples Democratic Republic of Yemen
C24.	Zambia	Zulu, P.A.	Water and living conditions. Health aspects of water develop- ment (in Zambia)

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# United Nations Interregional Seminar on Rural Water Supply

## AGENDA

### Monday, 6 October 1980

#### *Introductory session*

- 'Community Water Supply as a Facet of Economic and Water Resources Planning', *E. Fano*.
- 'The International Drinking Water Supply and Sanitation Decade', *D.V. Subrahmanyam*.
- 'Water Demand and Water Supply', *Y. Gustafsson*.
- 'Water Resources and Water Assessment', *M. Falkenmark*.
- 'Integrated Rural Water Supply—Environmental, Social and Economic Aspects', *L. Obeng*.
- 'Water, Sanitation and Health', *C.G. Widstrand*.

### Tuesday, 7 October 1980

#### *Session 1. Social and economic aspects*

- 'Report on the African Regional Meeting on Community Water Supply—August 1970', *Y.W. Emmanuel, ECA*.
- 'Water Supply and Excreta Disposal—Health Issues', *R. Feachem*.
- 'Rural Water Supply and Sanitation: Organization and Administration', *J. Freedman*.

#### *Workshop 1. Social and economic aspects*

Topics: 1. Public participation. 2. Choice of appropriate technology.

### Wednesday, 8 October 1980

#### *Session 2. Social and economic aspects*

- 'Drinking Water Projects and Women in Rural Areas in Africa', *K. Jørgensen*.
- 'Patterns of Water Contact—Attitudes and Behaviour', *C.G. Widstrand*.
- 'Social Impact of Rural Water Supply', *I. Kaul*.

#### *Workshop 2. Social and economic aspects*

Topic: Social Impact Assessment of Rural Water Supply.

### Thursday, 9 October 1980

#### *Session 3. Planning and implementation*

- 'Perspective and Role of ESCAP in the International Drinking Water Supply and Sanitation Decade', *A.S. Manalac*.
- 'Strategies for the Decade at the National Level', *I. Ahman*.
- 'Implementation and Administration of Projects at Local, Regional and National Level', *A. Mascarenhas*.

#### *Workshop 3. Planning and implementation*

Topics: 1. Consumer-producer-donor relationships. 2. Bottlenecks in planning.

**Friday, 10 October 1980**

*Session 4. Operation and maintenance*

- 'Planning for Rural Water Supply Programmes—Rehabilitation and Extension', *S. Makondiege*.
- 'Operation and Maintenance of Water Supply Systems', *R. Dijon*.
- 'Operation and Maintenance of Water Supply Systems—Some Field Experiences', *M. Beyer*.

*Workshop 4. Operation and maintenance*

Topic: Operation and maintenance of water-supply systems.

**Monday, 13 October 1980**

*Session 5. Institutional aspects*

- 'Institutional and Human Resources Aspects of Water Planning', *G. Steneroth*.
- 'Water Protection and Legislation in Some African Countries', *B. Hawerman*.
- 'Environment Impact Assessment Legislation and Water Resources Management in Kenya—A Case Study of Lake Nakuru', *F. Muslim*.
- 'Activities in the Latin American Region related to the Water Supply Decade', *T.R. Lee*.

*Workshop 5. Institutional aspects*

Topics: 1. Problems of human resources. 2. Case studies on legislation and regulation.

**Tuesday, 14 October 1980**

*Session 6. Project Execution and evaluation*

- 'Selection of Low-cost Technologies', *M. Beyer*.
- 'Manual Pumping Devices for Rural Water Supply—Joint Global Project', *S. Arlosoroff*.
- 'Small-scale Technology in Rural Water Supply', *P.F. Tröften*.

*Workshop 6. Execution and evaluation*

Topic: Role of monitoring and evaluation

**Wednesday, 15 October 1980**

*Session 7. Education, training and research*

- 'Education and Training Needs', *J. Zarraga*.
- 'Research Strategies for Development', *J.M.G. van Damme*.
- 'Prospects for Advances in Rural Water Supply at the Technical and Operational Level and the Implications for Training Policy', *F. Law*.

**Thursday, 16 October 1980**

*Concluding session*, Chairman: A. Sundborg

Review and approval of final report. *E. Fano*.



