# OPERATION, MAINTENANCE AND USE OF RURAL WATER SUPPLIES

# IN THE

# INDO-DUTCH RURAL WATER SUPPLY AND SANITATION PROGRAMME

## DISCUSSION PAPER

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## *FOREWORD*

Indo-Dutch cooperation in the rural water sector has been going on for 14 years. The Netherlands provided financial support for the first time in 1978, for the construction of rural water supplies in Andhra Pradesh and Uttar Pradesh. Hereafter, financing for some 140 piped schemes and 20,000 handpumps has followed, amounting to a total value of Dfl. 300 million or Rs. 330 crore.

The technical orientation in the Indo-Dutch cooperation in the field of rural water supply has gradually been replaced by a more integrated approach. Community participation in general and women's participation in particular are now an integral part of all aspects in the project cycle and rural water projects are supplemented by programmes for health education and sanitation.

Moreover, as the aim of the projects is not the mere construction of water supply and sanitation facilities, but also their sustained functioning and use, increasing attention is being paid to enhance the capacities of target group communities and implementing agencies for sustainable programme development and implementation.

It is against this background, that a discussion paper on operation, maintenance and use in the Indo-Dutch rural water supply programme has been prepared. The paper gives an overview of the status of the Indo-Dutch rural water supply projects. Information on the operation, maintenance and use of already completed schemes is included. The paper furthermore aims at indicating what future action may be required to improve operation, maintenance and financing systems to keep the water supply systems functioning adequately and sustain their use.

The paper has been prepared by IRC International Water and Sanitation Centre at the request of DGIS and is the third discussion paper on longer-term Indo-Dutch cooperation in the field of rural water supply and sanitation. Having been discussed in The Netherlands, the paper will serve as the basis for further discussion with Indian implementing agencies and authorities at Central and State level. Focus of the discussions will be on how the Indo-Dutch programme can contribute not only to the implementation of new rural water supply projects, but also to the strengthening of capacities to operate and maintain completed water systems and finance their recurrent costs.

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*SUMMARY AND CONCLUSIONS*

The present paper has been written as a discussion paper on O&M and O&M financing of rural water supplies constructed using Dutch assistance. The present number of Indo-Dutch schemes (piped or handpump) completed or in progress totals 143. Together, they serve over 4000 villages with a design population of over 9 million people. The financial contribution to the construction of the water systems is Dfl. 300 million.

The paper is based on a review of Mission and evaluation reports and interviews with the members of the Review and Support Missions. It contains an overview of current conditions, problems and problem-solving activities in O&M of the partly and fully completed water supplies. Based on this overview, a number of suggestions for further development of O&M is posited for discussion by all parties concerned.

The paper concludes that at present, O&M is not optimal and that system performance of the completed schemes is substandard, both in service and population coverage. Real maintenance costs are not known and financial allocations of the government are insufficient to cover full maintenance requirements. Present estimated annual shortages for state-level O&M are Rs. 100 million and more.

Furthermore, no provisions are being made for depreciation and expansion of village handpumps and distribution nets to keep up with population growth in villages already served. While private connections are increasing (on average 11% in UP and 40-60% in Kerala) and are also to be introduced in AP and Gujarat, revenues from these connections cover only 6% of the direct O&M costs in UP and 20% in Kerala.

Problems with O&M and O&M financing are likely to increase in future, when more and more water supplies are completed. Longer-term reliability of a number of schemes is further threatened by a declining water table, due to insufficient water resources management and control.

The Dutch and the Indian Governments need therefore to enhance the operationalization of their policies on O&M and strengthen O&M capacity building. This should not be limited to new projects, but be undertaken especially in the form of so-called in-service projects and by using more funds for institutional development and training.

Main areas for development are organizational adaptations for O&M, improvement of scheme operation and a greater role for communities in local O&M and financing, including the evaluation of the cost-effectiveness of the various forms of community participation for maintenance and use of completed water supply schemes.

## 1. *INTRODUCTION*

This discussion paper has been written to give an overview of operation, maintenance and use of completed Indo-Dutch rural water supply projects and enhance discussions on how these aspects could be improved in relation to the overall sector policies of the two countries. The paper is based on conditions, issues and actions reported in the progress reports for Indo-Dutch projects in Andhra Pradesh, Gujarat, Kerala and Uttar Pradesh. Karnataka is not included, as the first project has yet to commence. Other sources of information were the evaluation reports of the first generation projects, discussions with the Review and Support Missions and discussions with project staff in Andhra Pradesh, Gujarat, Kerala and Uttar Pradesh.

The report is built up as follows. In the first section (Ch. 2-6) a description is given of the various aspects of operation and maintenance: policy, costs, financing, organizational aspects, community participation and involvement of women. Chapters 7 and 8 contain a summary of the first results: performance and utilization of Netherlands-assisted water supplies of the first generation of projects and the improvements undertaken as a result. The paper is concluded with a chapter on possible options to further enhance operation, maintenance and use of rural water supply projects under the Indo-Dutch programme.

The paper covers a wide range of systems, from handpump wells and piped water supplies for single villages to large comprehensive piped schemes serving 100 villages and more. Some sections therefore refer particularly to one type of system, while others are more general. To avoid repetition, this distinction is not referred to when it is clear from the context that the section concerns only handpumps, single village piped schemes or comprehensive piped schemes.

## 2. *O&M POLICY*

### 2.1 National guidelines

Both the Indian and Dutch Governments emphasize the importance of O&M in their sector policy. The Department of Rural Development states that maintenance is essential. It recommends that states develop O&M norms for different water supply systems, allocate O&M funds based on these norms and review and streamline maintenance arrangements. In technology choice, the cost-effectiveness of different alternatives should be analyzed, taking into account related factors like O&M. Panchayats are to be involved in O&M as much as possible and more women ought to be trained for tasks such as handpump maintenance, chlorination, water sample testing, etc. Mobilization of local resources can be a part of community participation activities (GOI, 1986, sections 14.6, 21.1-3, 21.5, 25).

The VIIIth Five Year Plan stresses coverage of the remaining 11% of the rural population without adequate water supply, including the 35% belonging to scheduled castes and 25% belonging to scheduled tribes. The outlay for O&M will be increased, but will nevertheless fall short. Efforts to mobilize funds from other sources, including communities and beneficiaries will therefore be stepped up (VIII FYP, 1992).
The Dutch policy paper for the water sector mentions neglect of institutional development for O&M as an important constraint and stresses choice of affordable technology, maximum decentralization and devolution of O&M and coverage of at least the direct O&M cost (GON, 1988, p. 9 and 4-7).

## 2.2 Application in NA-projects

Operationalization of these policy guidelines at state level is still limited. The norms which the states have set for O&M are usually financial, e.g. in Gujarat (5% of the capital cost of the scheme, Wijdemans, pers. com.) and UP (UP-28, p.15). Because norms for the functioning of the schemes are not yet set, allocations for O&M are based on financial criteria and not on what the schemes require to maintain a certain level of operation and performance.

When choosing the technology, either a new proposal may be prepared or a solution already identified earlier may be proposed, with updated population figures and costs. A comparison between different technology options may have taken place, which includes the O&M implications and is based on field studies, but if so, this is not summarized in the ultimate project document. This may partly reflect another national policy guideline, which asks State Governments to have "a shelf of schemes for works to be taken up under the ARWS Programme conforming to the prescribed norms and design criteria" (GOI, 1986, p. 12).

In Uttar Pradesh, priority is given to the installation of handpumps, wherever this is feasible. Main reasons are that handpumps are cheaper to install and maintain and are not dependent for operation on an often erratic energy supply.
The type of handpump installed is the India Mark II. In some cases, this pump is already maintained by local, agency-paid mechanics. These may be either men or women. The cost of this village maintenance is said to be equal to, or lower than the usual mobile maintenance team, while effectiveness of maintenance is better (more preventive maintenance, shorter breakdowns). These are important findings, both nationally and internationally, which deserve to be quantified and published.

Meanwhile, India has developed a new type of pump, India-Mark III. This pump has an open top, which makes it easier for the village mechanics to remove the underground parts and may therefore be more suitable for village-managed and financed maintenance and repairs. Capital costs are however higher, so it will be important to determine whether these are set off by lower maintenance and repair costs and quicker village repairs. Data on these aspects have been collected for some years, but have not yet been brought out. Should village maintenance of the Mark III indeed prove to be easier, it might be worthwhile for the Dutch Government to finance the cost of replacement, if this results in better and lower-cost maintenance.

The option of improving traditional water sources is only so far being tried in Kerala. A local NGO, PASSS, involves local men and women in protecting small springs and wells and maintaining the systems. PASSS works in areas which are too far away and which have too a scattered population to be served by the Kerala Water Authority (PASS, 1991, 1992).

Improvement of traditional water sources as part of overall village water source development and management plans (which thus combine the introduction of new water systems with the protection of selected traditional sources) is still in the planning and policy development stage. This component is likely to be developed further in the future (experiment with chlorination of traditional wells by women's groups in Kerala; possible incorporation of upgrading selected traditional water sources in AP-III).

Involvement of Panchayats in O&M exists in Andhra Pradesh (PWS and MPWS systems). Involvement of water committees and women in O&M has started in Uttar Pradesh (handpump maintenance pilot project, upkeep public taps), Gujarat (upkeep public taps) and Kerala (upkeep public taps and monitoring and reporting tap performance). More details are given in Chapter 6, Community Participation.

For the mobilization of local resources for O&M, two mechanisms are used in the Indo-Dutch piped systems: installation of private connections for which a tariff can be charged and charging Panchayats for O&M of public taps. The Panchayats may pay these charges from their general income from taxes, etc. or charge all households a special water tax. However, Panchayat contributions are not asked in all states and for each type of public waterpoint (handpump, standpost). Both types of resource mobilization are discussed further in Chapter 4, Financing.

The intention to give more structural support to improvement of O&M is laid down in the Frameworks of Collaboration, which have been or are being agreed on between the government of the Netherlands and the respective Indian state governments. Support will be given both as part of new construction projects, in which planning for O&M will be an important element; in so-called in-service projects, which can be developed to improve the performance of already completed schemes, and in institutional development projects, which can include training for O&M at all levels.

An initial training project, for 6500 village handpump caretakers, has now started in Uttar Pradesh. It will be followed by a training project for village mechanics and probably also by a project to train Panchayats and village water committees in the management of such local maintenance.

## *3. O&M COSTS*

### 3.1 Estimated costs of completed systems

Under the Indo-Dutch programme, improved water supplies are being established for nearly 4500 villages and 16 rural towns with a total design population of almost 10 million people (Table 1).

The first generation projects, covering a design population of some 2.5 million people, have recently been completed. The growing number of completed schemes and the low user contributions to O&M means that recurrent costs of these systems are an increasing burden on state budgets. Table 2 gives an overview of the estimated O&M costs of the Netherlands' assisted water systems. The table is incomplete, because data were not available for all schemes.

TABLE 1: TYPE, SIZE AND STATUS OF RURAL WATER PROJECTS FINANCED UNDER INDO-DUTCH RWSS PROGRAMME

| *Project* | *No. piped schemes* | *No. hand-pumps* | *Design pop.* | *No. of villages* | *Status* |
|---|---|---|---|---|---|
| AP-I | 54 | - | 718,000<br>+44,000 | 171<br>30 | completed |
| AP-II | 45 | - | 730,000 | 288 | in progress |
| AP-III (Phase I) | *) | *) | 408,000 | 82 | being planned |
| GU-I | 1 | - | 121,000<br>+117,000 | 72<br>48 | completed |
| GU-II | 2 | - | 452,000 | 147 | in progress |
| GU-III | 5 | - | 1,003,000 | 312<br>+3 towns | proposed |
| KE-I | 2 | - | 595,000 | 16**) | completed (?) |
| KE-II | 5 | - | 512,000 | 15<br>+5 wards | almost completed |
| KE-III | 1 | - | 868,000 | 18+3<br>+3 towns | in progress |
| UP-I | 22 | - | 912,100 | 724 | completed |
| UP-II | not taken up | | | | |
| UP-III | - | 5,830 | 669,000 | 603 | almost completed |
| UP-IV | 11 | - | 384,000 | 199 | almost completed |
| UP-V | sanitation project | | | | |
| UP-VI | - | 13,599 | 1,810,000 | 1410 | 70% completed (May '91) |
| UP-VII | 10 | - | 455,800 | 156<br>+10 towns | proposed |
| UP-VIII | - | 18,767 | 178,447 | 185 | proposed |
| TOTAL | 158 | 38,196 | 9,977,347 | 4479 | |

*) Details not yet known **) In Kerala, av. pop. 25,000/vill.

Source: RSMs'& TLO's progress reports; DAL/ZZ 6th joint meeting; Kurup (1991); Indo/Dutch/Danish Mission, Kerala, 1989.

TABLE 2 ESTIMATED SHORT-TERM O&M COSTS OF NETHERLANDS' ASSISTED RURAL WATER SYSTEMS

| *Project* | *Number of schemes* | *Year of costs* | *Est. O&M cost per $m^3$ mill. Rs.* | *Est.production* |
|---|---|---|---|---|
| AP-I | 54 | 90/91 | 6,6 (revised to 9,1) | - |
| AP-II | 45 | 90/91 | 25,1 | 1,89 |
| AP-III (proposed) | | 90/91 | 28,0 | 1,60 |
| GU-I | 1 | 88/89 | 2,3 | 0,85 |
| KE-I | 2*) | 88/89 | 4,5 | 0,93<br>1,86 |
| KE-II | 4**) | 88/89 | 3,2 | 0,7-2,03<br>av. 1,16 |
| UP I&IV | 33 | 91/92 | - | av. 1.19 |

*) For Vakkom Anjengo, only est. O&M cost per M3 is given: 1,86
**) No information on Kundura scheme

Source: NAP AP-III,p.105;AP-24,p.26;Shirahatti,1990,p.31; Indo/Danish/ Dutch Mission Kerala, p.23; Evaluation Mission UP, p.24.

In Uttar Pradesh, NA-handpump projects have also been completed. For maintenance, the government of UP uses an estimated costs of Rs.400/pump/year, Rs. 407 where groundwater is corrosive and Rs. 437 for very deep wells. Allowed O&M allocation under the Unicef-recommended maintenance system (more frequent servicing) is Rs. 585/pump/year. In Andhra Pradesh, where handpump projects are at present not part of NA-projects, the PRED uses an estimated O&M cost of Rs. 360/handpump/year.

As a general yardstick, the evaluation mission in UP has recommended to use Rs. 500/pump/year (1992 prices) for O&M costs of handpumps. This is Rs. 3,3 per capita, when each pump has 150 users.

### 3.2 Aspects not covered by present estimates

For a number of reasons, real costs are likely to be higher than the estimated costs reported above. Important points in this context are the definition of what constitutes the recurrent cost of a scheme to be included in the annual state budgets; the age of the systems; the basis on which O&M cost estimates are made and the establishment of agreed maintenance procedures.

*Definition of O&M costs*
In the Indian system, O&M costs cover only the direct costs of operation, maintenance and repairs. No yearly provisions are included for the depreciation and replacement of parts that get worn out during the design life of the scheme, such as pumps. Also not included are provisions to expand the village distribution nets within the design period of piped water supplies. Officially, costs of the latter fall under the capital costs of the schemes, because they are designed and built for 30 years. The village distribution nets, however, are built for the present population. As far as could be ascertained, no budget reservations are made to regularly update such nets during the design life of schemes. This is one reason why in later evaluations, new settlements are found not to be served and initial coverage levels not sustained (AP-24, p. 5). It will thus either be necessary to reserve some capital funds for the upkeep of the service level after the administrative completion of a donor-financed piped scheme, or make reservations for this purpose within the recurrent cost budget.

For handpump projects the situation is similar. These projects are designed for the actual population (1 pump/150 users). Hence soon after completing a project, it may be necessary to come back and install some more pumps, so as to sustain established service levels and patterns of use. In the NA-projects in UP, some room for manoeuvre still exists, because most pumps have now less than the prescribed maximum of 150 users. However, when people do not settle around the existing pumps but in new areas, additional pumps will have to be built to preserve the established level of utilization of safe drinking water. So far, no policy on the design life of handpump projects and on the financing of the upkeep of service levels has been established.

*Age of schemes*
A second factor pushing costs up is the age of the schemes. At present, all projects discussed are relatively new and O&M costs will be relatively low. They will however go up as schemes get older. This aspect seems not to be taken into account when the financial norms for maintaining a certain type of scheme are fixed.

*Budgeting procedure*
Annual estimates for O&M are not based on requirements of individual schemes, but on what is the norm for a certain type of system and on what the respective circles and divisions were allocated and have spent on O&M in the previous year.

> *Thus, the Central Government gives 4% of the investment costs of a scheme as central norm for O&M. In Gujarat, a norm of 5% seems to be accepted. In UP, the permitted percentage in the plains is 8.22% for piped schemes with tubewells and 7.88% for schemes with surface water. In the hills, 3.67% is allowed for gravity systems and 10.07% for pumped systems.*

Review of O&M costs for similar schemes has shown quite some variation in Gujarat and Kerala (GU-25, p. 29, JRM, p. 23), which is not readily explained.

*O&M procedures*
Another factor which makes it probable that present cost-estimates are on the low side, is that it is not yet standard practice to establish scheme-specific maintenance procedures and budget according to these procedures. Moreover, where field staff have both construction and O&M tasks, as in Gujarat and Kerala and no scheduled maintenance is set, construction work tends to win preference (Shirahatti, 1990, Lavan, 1988).

### 3.3 Indications of actual requirements

From the above it emerges that the real short and long-term O&M costs for the completed NA-schemes are not yet sufficiently known. Indications are that actual requirements to keep up service and preserve scheme conditions are considerably higher than the current practice. A study on O&M in one district of AP showed for example that actual maintenance costs for handpumps were more than twice the state norm (Job and Shastry, 1991). The same situation has been reported for handpumps in Uttar Pradesh (IOV, p. 24). Maintenance requirements of 8 piped water supplies visited under UP-I were also found to be twice the amount budgeted for (IOV, p. 25).

To assess whether established schemes can continue to function it will be necessary to know more exactly what the real O&M requirements and costs are for each type of NA scheme.

It will also be necessary to determine what reservations are needed for the upkeep of established service levels and for replacement of parts that are worn out during the design life of schemes. Only when these costs are known more precisely can the gravity of the situation be determined and activities identified that can help solve or reduce these problems, not only for NA-schemes but also for the other rural water supply systems in the district or circle in which the NA-schemes are situated.

## *4. O&M FINANCING*

### 4.1 Financing methods

A combination of four methods are used to finance O&M costs: direct revenue from private connections; payments for public waterpoints by Panchayats; reservations for O&M from annual construction ('Plan') funds of the Central Government and use of 'non-Plan' funds (Fig. 1).

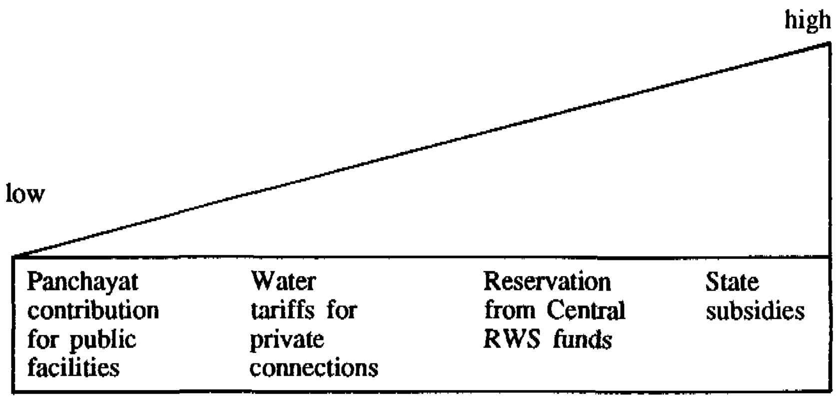



Figure 1: Sources of financing for O&M and their relative importance

***Direct revenue***

Piped systems in Kerala and Uttar Pradesh include paid house connections. The water agencies get some direct revenue from these connections through the connection charge at the time of installation and the monthly tariff payments. New schemes in Andhra Pradesh and Gujarat will also combine public taps with paid house connections.

In Kerala, designs are for 40% house connections and 60% public taps. In UP-I, private connections in NA-systems average 11%. However, income from private taps covered only 6.5% of O&M costs in UP (DHV, not dated) and 20% in Kerala (Indo/Dutch/Danish mission, 1989, p. 24).

Most households with a private water connection pay a flat monthly tariff irrespective of the quantity of water used. The tariffs are far from sufficient to cover the real O&M costs (Table 3).

TABLE 3 ESTIMATED COSTS AND INCOME PER CUBIC METRE FOR NA-PIPED SYSTEMS WITH HOUSE CONNECTIONS

| ***Project*** | ***O&M cost per $m^3$ produced*** | ***O&M cost per $m^3$ consumed *)*** | ***Tariff per $m^3$*** |
|---|---|---|---|
| AP-III | 1,60 | 2,28 | not yet decided |
| KE-I | 0,93-1,86 | 1,33-2,66 | 0,50 |
| KE-II | 0,7-2,03 | 1,00-2,90 | 0,50 |
| UP-I&IV | 2,50**) | 3,40**) | 0,50 ? |

*) Assumed average water loss of 30%
**) Average for all piped systems in UP

Source: RSM reports, Indo/Dutch/Danish mission, 1989, NAP-India Conference, 1992.

Although house connections provide some revenue, they also increase water consumption and raise O&M costs of the schemes. Moreover, flat tariffs favour the better-off households, which have more vessels, clothes to wash, vegetable plots, etc. and so use more water without paying accordingly.

Because the present tariffs do not cover all costs, the net result of providing paid house connections instead of only free public taps may actually be negative. So far, the cost-efficiency of a larger scheme with paid connections under the present conditions against a smaller scheme with only free standposts seems not to have been assessed.

Metering of private connections makes it possible to charge larger and usually wealthier users more. Meters also reduce water consumption and wastage. This may mean that the schemes can cater for a larger user population, provide more water for tail-end villages and put less pressure on scarce water resources (UP-26, p. 28).

However, metering can also bring new problems. For instance, GOI norms on per capita investment costs and regulations to accept the lowest tender necessitate the water agencies to install cheaper meters, which need more frequent repair. The cost of running and maintaining these meters and running decentralized repair shops, as proposed in UP, are not yet known. The organizational efficiency in meter reading, billing and collecting and the level of the water tariffs may also have to be improved before metered house connections can pay off. Gradual expansion of metering, starting with the more urban areas and with regular assessment of efficiency and effectiveness may be a good way to get more insights in these aspects, before installing meters throughout the rural projects.

***Payments by Panchayats***
For financing O&M of public waterpoints (taps, handpumps), State Governments sometimes retain some funds from the annual grants allocated to the Gram Panchayats, or ask the Panchayats to pay a certain amount for maintenance.

*For handpump schemes, GOAP, for example, deducts Rs. 180/handpump/year. As this amount is recovered 'at source', it is not clear if the users are aware that they indirectly pay 50% of the O&M budget.*

This policy is however not carried out consistently in all states and areas.

*While the Government in AP makes deductions for the maintenance of handpumps, it does not do so for maintenance of public taps in piped schemes.*
*In Uttar Pradesh, the State Government now allocates Rs. 400/pump/year for handpump maintenance (UP-28), but it is not clear whether deductions for this purpose are made from annual GP grants. In Gujarat, Panchayats are required to make direct payments of Rs. 5 per person per year to the GWSSB for O&M of piped water schemes, but in most cases this amount is not collected (GU-19, p. 54). In Kerala, a recent Government order instructs Panchayats to pay Rs. 875 for each standpost (SEU, 1991, p.8), but this has not yet been effectuated. In addition, Panchayats are expected to collect the water charges for private connections, keeping 7% of the amount collected for general village use. A review of actual practice showed that in only 2 of 10 NA-schemes reviewed collection was taking place (Lavan, 1988, Table 15).*

***Central funds***
A further source for O&M financing is funding by the central government. GOI regulations prescribe that 10% of the capital funds allocated under the Annual Plan for RWS construction must be reserved for O&M of systems completed under this and previous Plans. Water supplies built with foreign funds do not fall under this 10% regulation.

***State funds***
Because combinations of the sources of revenue listed above are insufficient to cover O&M costs, the State governments have to make additional ('non-Plan') funds available every year to operate and maintain rural water supplies. This state subsidy has to increase every year.

## 4.2 Shortage of O&M funds

Revenue from private connections only covers a very limited part of the agencies' expenditures on O&M.

*In Kerala, consumers, Panchayats and others contributed 38% of total O&M expenditures in 1989/90 and 67% in 1990/91. For 1991/92, a cost recovery of 33% is expected (Fergusson, p. 22). In Uttar Pradesh, cost recovery from house connections to piped systems in UP-I was 25% in 1990/91 (Evaluation mission, p. 17). As the total number of connections planned had been reached, no further increase in cost recovery can be expected for these schemes under the existing tariffs. In fact, as O&M costs are to likely to increase when the schemes grow older, the cost recovery percentage is likely to go down.*

Actual conditions are likely to be worse, because as seen in Chapter 3, amounts allocated to O&M are lower than what is actually required. Indications are that the deficit for O&M of rural drinking water supplies is already large and is likely to grow further in future.

*In Andhra Pradesh, the 10% reservations from central plan funds amount to some Rs. 15 m. per year. For special repairs and rehabilitation the State Government adds some Rs. 30-40 m. per year. Estimated requirements are now Rs. 150 m., a difference of between Rs. 95 and 105 m. (AP-III, p. 103). In Uttar Pradesh, the required O&M budget for maintaining all rural water supply systems in 1987 was estimated at Rs. 263 m., while Rs. 100 m. was allocated (Rs. 16 m. from revenues, Rs. 44 m. from the 10% reservation, Rs. 40 m. from state funds). This left a deficit for O&M of Rs. 163 m. for 1987 (UP-18, Table 2.2).*

Assuming that in future the whole rural population will be served and O&M costs per capita remain the same, O&M requirements in Uttar Pradesh will be eleven times the present allocation, or twice the current Plan allocation for construction and O&M together (UP-18, p. 9).

The increasing gap in state financing for O&M of drinking water supply is illustrated by Table 4, which shows the situation of the Kerala Water Authority.

It has been calculated that to fully cover costs monthly water tariffs in Kerala have to go up to Rs. 15 for the first 10,000 litres and should be increased every year by 15% (Fergusson, p. 4). As a result, GOK has raised the basic monthly tariff to Rs. 10. An automatic annual increase is however politically unlikely, so that the state subsidy will have to continue to grow.

TABLE 4 INCOME AND EXPENDITURE OF KWA IN MILLION RS.

| | 1988/89 | 1990/91 | 1991/92 |
|---|---|---|---|
| | ACTUAL AMOUNTS | | REVISED ESTIMATES |
| Income | 164,4 | 315,6 | 182,8 |
| Expenditure | 435,2 | 467,2 | 590,5 |
| Operating loss | 270,8 | 151,6 | 407,7 |
| GoK subsidy | 250,5<br>93% | 235,0<br>65% | 258,5<br>63% |

Source: Fergusson, p. 22

Some more funds for O&M are now available from the central government, because the budget for the construction of rural water supplies has been increased from Rs. 4.4 crore under the VIIth Plan to Rs. 11.4 crore under the VIIIth Plan. Nevertheless, it is unlikely that a fixed allocation of 10% for O&M will suffice to finance all recurrent costs of the growing number of completed schemes, the more so since figures represent current prices and will be affected by inflation.

When other sources of revenue (tariff payments and Panchayat contributions) continue to lag behind, State Governments will therefore have to meet a growing deficit in full, or accept increasingly substandard functioning of completed schemes.

### 4.3 Coping mechanisms

Mechanisms which the water agencies use to cope with the lack of O&M funds are: overbudgetting of O&M costs to compensate for the lower-than-required fund allocations; reduction of pumping hours in piped systems; reduced mobility of O&M staff; postponing maintenance and repairs until schemes break down; and undertaking new construction schemes and diversifying some of its resources to O&M of already completed water supplies in the area.

While the efforts to keep the schemes running are commendable, none of these measures provide adequate solutions in the long run, while most will worsen the situation in the longer term, e.g. by reducing people's willingness to pay for lowered service levels and increasing costs of rehabilitation.

### 4.4 Capacity and willingness to pay

The VIIIth Plan recognizes the shortage of Government funds for the rural water sector. Supplementation through public investment and mobilization of funds from Panchayats and users are therefore included in the new strategy.

*Capacity to pay*
Preliminary investigations on the capacity of the users to pay for recurrent costs indicate that those with house connections are quite able to pay more.

> *In Uttar Pradesh it is estimated that the 30% users with a house connection are able to pay a monthly tariff of Rs. 60. This would constitute 3% of their estimated monthly income. The income would not only cover the additional costs for private connections, but also cross-subsidize the cost of public waterpoints for the poor (UP evaluation, p. 25). In Kerala, the proposed basic tariff of Rs. 15 for the first 10,000 liters would constitute 1.5% of the poorest households with a house connection. This is considered affordable (Fergusson, p. 4, 65).*

To increase the economic capacities of the users, the Government of the Netherlands supports income generation projects for women in the project areas of AP-I, AP-III and GU-I. The success of these projects relies partly on an accessible and reliable water supply, as the women need sufficient time for their handicraft and for other economic activities (milk cooperatives) can use piped water (see illustration).

It has been said that these projects increase considerably the income of the women concerned. However, so far it has not been investigated what income is realized on what scale and how much piped water is used productively. Also not known is the variation in income, e.g. for those with only one or two milch animals and no private land for growing fodder compared to those with more animals and a secure fodder condition, and whether the income is high and reliable enough to justify water charges. Finally, it has not been assessed what the economic effects are when the water supply does not function adequately or is out of order.

***Willingness to pay***
Because families with a serious need for water are known to pay much more for water than 1.5 - 3% of their income, willingness to pay is nowadays considered to be a more important indicator for cost recovery than capacity to pay. Investigations in Gujarat, Andhra Pradesh and Kerala indicate that this willingness is higher than often assumed and that it would be even better when local management of the supply and accountability to the users are improved.

> *In Gujarat, Bhatt reported that 83% of those interviewed were willing to pay. Rates are already collected in three-quarters of the villages with a regular piped water supply, but not transmitted to the water agency (Bhatt, 1990). Mehta (1992) reports that users are paying to the Panchayats for water and prefer local management of small piped water systems over central management by the GWSSB. In AP, payment of water rates to the Panchayats is also acceptable and has started in a number of cases. Local water management of village schemes and accountability for service and financing need to be improved, however (PRED, 1991, Job and Shastry, 1991).*

In Kerala, use has been made of bidding games, a technique whereby consumers or potential consumers are asked to indicate how much they are willing to pay for water under varying conditions. The investigation showed that irrespective of the sub-optimal service, those with a connection are willing to pay on average Rs.19 per month, almost twice the proposed new tariff. When the service is improved, they are ready to pay four times the present charge (Singh et al., 1991).

The main bottleneck seems thus not to be the users' attitude, but political will. In Kerala, the Government has recently raised the basic water tariffs to Rs. 10. In UP, a rural tariff of Rs. 20 is under consideration. This is better than no increase, but is insufficient to bring maintenance up to standard and when not coupled to yearly tariff reviews will soon be caught up by inflation. Policy makers, politicians and public will have to become much more aware what the causes are of a deteriorating domestic water service and donors should make a firm stand not to rehabilitate and expand completed water systems financed by them without a sounder policy on O&M and covering of recurrent costs.

## *5. ORGANIZATIONAL ASPECTS OF O&M*

### 5.1 Constraints to execution of O&M

In addition to a lack of financing, the reports reviewed list quite a number of organizational problems which limit the optimal execution of O&M of completed water supplies. A general problem is the low appreciation of O&M in the organizational culture of the water agencies. Staff for design and construction are overrepresented and a shortage of staff exists for O&M (Shirihatti, 1990, p.36; Indo/Dutch/Danish mission, p. 22; UP-25, p. 27). Staffing is also carried out according to set standards rather than to actual O&M requirements in the particular scheme (Indo/Dutch/Danish mission, p. 23, UP-26, p. 29).

In the operation of O&M, the absence of general and established O&M procedures, standards and manuals has been noted (Internal evaluation AP, Lavan Consultants, p. 3, Updesco, p. 72-86, UP-24, p. 15). Field staff often have to combine O&M tasks with the more valued construction work and O&M tasks and schedules are not always defined (Hasko, 1990, para. 5, Bhatt, 1991, p. 104). There seems also to be no registration of time, manpower and costs actually spent on O&M (Lavan, 1988, p. 29). In executing O&M, preference is given to curative over preventive work (Indo/ Dutch/ Danish mission, p. 20).

Higher level staff have very limited scope to delegate for O&M work and expenditures, so that they cannot react rapidly to problems (Indo/Dutch/Danish mission, p. 24, Updesco, p. 79). O&M activities at village level are not recorded and frequency, scope and duration of breakdowns are generally not recorded (Updesco, p. 76-86, UP-26, p. 76; Shirahatti, 1990, p. 38). And where field records are kept, condensation, analysis and use of data at higher levels is lacking (Haskoning, 1990, p. 6; MIS identification reports for AP and UP). Finally, a shortage of training in O&M related aspects is noted at both field and managerial levels (RSM reports).

Many of these problems can be ascribed to the fact that the existing procedures and structures are no longer adequate to deal with growing O&M demands. Changes are required but especially organizational adaptations will require much effort. In shifting the emphasis from construction to sustainability, NA-projects are gradually taking up a pilot role in this respect. The following section summarizes the actions taken to improve the situation in areas with NA-schemes.

### 5.2 Development measures in NA-schemes

Organizational development activities undertaken as part of the NA-projects include the establishment of special O&M divisions; the design and application of O&M manuals; training for O&M and decentralization of authority.

***Establishment of special maintenance divisions***
In AP, Gujarat, special divisions have been created to look after O&M of NA and other projects in the zones concerned.

> *In AP-I, a special division looks after O&M of comprehensive piped systems, including those of AP-I. For AP-II, 4 more subdivisions will be formed (AP-24, p. 23, 26). In Gujarat, a special division and 4 sub-divisions looked after the construction of GU-I and a few smaller schemes in the area. After the completion and evaluation of GU-I a rough estimate was made of O&M staff requirements and an O&M plan prepared. It foresees in higher level staff spending 30-60% of their time on O&M, while at lower levels, full-time O&M staff will be employed (O&M manual, Vol.II, p. 5-6). In Uttar Pradesh, a new maintenance system for NA-schemes is set up, based on the experiences of UP-I and with handpump maintenance (UP-26, Annex E and F).*

As these organizational arrangements are still recent, it is not yet clear what their effect is on the maintenance of the schemes. It is however noted that the centralistic character of O&M with standard staffing and costing patterns and little autonomy for decentralized staff means that field staff do not have to make cost-revenue analyses for the various schemes under their authority and have little incentive and scope for creative efforts to improve O&M and O&M financing (UP-26, p. 29).

***Introduction of O&M manuals and procedures***
A general O&M manual for piped systems has been prepared in AP by an Indian consultant and in UP by Jal Nigam staff (UP-26, Annex E). In addition, an O&M manual for specific NA-schemes has been prepared in AP (AP-24, Annex 10) and Gujarat (Haskoning, 1990).

> *Field-testing is planned in Gujarat, while in AP the manual will be introduced together with a review by a special study team of the PRED of all experiences and insights on O&M. (NAPO, 1991). This team will formulate guidelines for all RWS schemes and will also include a policy on community involvement in curative maintenance, repairs and financing (see also section 6 below).*

A preliminary review of the available material (Haskoning, 1990) showed that the manual focuses especially on the organizational structures, tasks descriptions and reporting procedures for operation and repairs. Preventive maintenance is recognized, but features to a lesser degree and may require a special revision. Furthermore, lower-level staff may need descriptions or illustrations on how to implement the listed tasks and materials on community-executed O&M for both agency staff. Tasks and authority of village water committees and standpost or handpump attendants are also not yet generally included.

Completed NA-schemes function, but their reliability can be improved.

Record-keeping on functioning of completed schemes at village level has started, but data need to be condensed and used as a management tool.

***Training of O&M staff***
Training of field-level O&M staff working in NA-schemes is taking place in all states.

> *In Andhra Pradesh, scheme-specific training workshops are held for scheme operators (AP-III, p. 106). In Gujarat, linesmen (and one lineswoman) are trained for maintenance and repair of the pipelines (GU-18, p. 33). In Uttar Pradesh, training will focus especially on handpump maintenance (UP-26, p. 17). In Kerala, no account is available of training of KWA staff for O&M. However, a pilot experiment has been carried out in one Panchayat where voluntary standpost attendants (SPAs) chosen by the Ward Water Committees are trained and given a tool kit for minor repairs (SEU-South, 1991, p. 5). In addition, all SPAs (now over 1100 and usually women) carry out preventive maintenance and report breakdowns (SEU, 1991, p. 12).*

For higher level staff, no specific training on O&M-related aspects (management, monitoring, evaluation) has been reported. The only training for them is to attend the IHE international course in Delft (2 engineers/state/year). Some engineers and social staff have taken part in the MDF/IRC Sustainability course.

***Development of more structural training plans***
A plan for more structural training adaptations is being prepared in AP by the PRED with an Indian consultant. In the other states, more structural training needs are still in the identification stage. Consideration is further being given to upgrade the Dutch training fund for NA-project staff and have more training, especially short courses, in India and by Indian organizations. Reasons are a greater flexibility to meet new training needs, a larger number of participants at equal costs, less interruption to the labour organization and the projects and contribution to the further development of Indian training centres. An aspect to be looked into when expanding the training programme is whether the trainees are able to apply the contents of their training in their actual work.

***Delegation of authority for O&M***
Only limited information was found on the degree to which decentralized maintenance units can function autonomously and for what decisions they need authorization from higher levels. There are indications that more autonomy at executive level can improve the cost-effectiveness of O&M.

> *In UP, for example, it is recommended that the division responsible for maintenance can authorize and execute any new house connections in schemes where a demand exists and the scheme capacity is adequate (Updesco, p. 79). In Kerala it was noted that the Assistant Engineers in charge of O&M have little financial power for purchases or repair work and first need to get permission from the AEE, EE or CE. (Indo/Dutch/Danish mission, p. 24).*

## 5.3 Future organizational adjustments

Organizational issues will grow in importance when more NA-schemes become completed. Evaluations of Indo-Dutch water projects in Uttar Pradesh and of the programme as a whole place priority on development of sustainability and improvement of service in completed schemes (IOV, 1992, viii, 1; UP evaluation report, p. 76). Within the Indian context, emphasis will for some time still remain on construction, to complete the aim of the VIIIth Plan. This means that areas with Indo-Dutch projects, which form only a small percentage of the total Indian programme, play a valuable pioneering role in developing and testing new approaches to O&M and O&M financing.

The latter applies to new projects and also to improving earlier financed schemes, through so-called in-service projects. The latter projects should not just include technical improvements, but also organizational and financing adjustments required to improve the overall performance and sustainability of the schemes.

Both new and in-service projects supported by the Netherlands can include reviews of existing organizational constraints and proposals to improve organization and financing of O&M. Field-testing such improvements on a small scale, with structural support from the Netherlands, can provide very valuable experience and data from which the majority of other schemes can benefit.

Just because Indo-Dutch projects are small when seen against the total efforts from India, they can more easily acquire the required support and political scope to try out new elements in the field. Review and Support Missions and Project Offices can play an important role in this development, by helping identify such pilot projects and experiments, as they are already doing (e.g. village management study in Andhra Pradesh, bulk metering for water loss detection in Gujarat, community-based O&M monitoring and reporting in Kerala, decentralized handpump maintenance in Uttar Pradesh).

## *6. COMMUNITY PARTICIPATION IN O&M*

Community participation in O&M of Indo-Dutch water supplies takes three different forms: volunteers doing only preventive maintenance at public waterpoints; trained villagers carrying out also skilled maintenance and repairs, and Panchayats which fully manage single or small village piped water supplies.

### 6.1. Preventive maintenance by village volunteers

In all NA-schemes, piped or handpump, local water committees are being set up to control tap/pump damage and water wastage, preserve hygiene and report breakdowns.

In Kerala, female standpost attendants (SPAs) are trained in each ward. They keep a record on the functioning of taps and report breakdowns through the Ward Water Committees (Fig. 2).

| SEU | Kollam | KWA |
|---|---|---|

Reporting format for repairs of public standposts
1. Panchayat . . . . . . . . . . . . . 2. Ward . . . . . . . . . . . . . . . . . . . .
3. Location SP . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
4. Date breakdown . . . . . . . . . . . 5. Problem . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
6. Date report to KWA . . . . . . . . . SPA/WWC name & signature

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
7. Date attended to repair
week 1 . . . . . . . . . . . . . . . week 2 . . . . . . . . . . . . . . . . . . . .
week 3 . . . . . . . . . . . . . . . week 4 . . . . . . . . . . . . . . . . . . . .
Signature of Plumber . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Fig. 2 Format used by SPAs to monitor and report standpost breakdowns (original in Malyalam).

In UP-VI, 6500 handpump caretakers, many of them women, will be trained. Upkeep of local waterpoints in the other projects in UP and in AP and Gujarat is one of the tasks of the local water committees.

Table 5 shows that more participation can undoubtedly contribute to better maintenance and hygiene of local facilities. It indicates the conditions at public standposts in one project before community participation and involvement of women were introduced.

TABLE 5 MAINTENANCE OF STANDPOSTS IN NA-PIPED SCHEMES IN 3 DISTRICTS OF UTTAR PRADESH

| | *Varanasi* | *Rae Bareli* | *Allehabad* |
|---|---|---|---|
| no. public taps planned | 83 | 140 | 52 |
| no. actually installed | 84 | 145 | 52 |
| % standposts with missing: | | | |
| pillar | 7 | 12 | 12 |
| tap(s) | 29 | 31 | 44 |
| platform | 2 | 6 | 10 |
| drainage | 31 | 14 | 39 |
| % standposts with damaged: | | | |
| pillar | 8 | 19 | 17 |
| tap(s) | 24 | 15 | 31 |
| platform | 12 | 17 | 31 |
| drainage | 4 | 14 | 8 |
| % standpost with poor hygiene | 11 | 77 | 4 |

Source: UPDESCO, 1989, Tables 4.6.1, 5.6.1, 6.6.1

Subsequent comparison of schemes in UP with and without community participation and involvement of women showed that participation makes a noticeable difference (Evaluation mission, 1992). Observations in systems with and without caretakers in Kerala also showed that with participation, standposts are better kept (van Wijk, pers.obs. and ill.). KWA engineers said that problem reporting enables them to better manage maintenance staff because the forms give the dates of breakdown, reporting and repair (see fig. 2 in section 6.1). As a result, repairs are done faster (the estimate is within 2 days) and confrontation of KWA staff by angry villagers has been reduced. Discussions with women in the scheme concerned confirmed this information. The women said that they now knew whom to report to and that repairs were generally made within 1-2 days.

There are indications that appreciation within the water agencies for functioning of village distribution nets and hygiene at waterpoints is increasing. In the past, village level preventive maintenance was not budgeted for and no data were kept on service and hygiene at community level, only on pumping performance at scheme level. Monitoring systems are now being established at village level, in which standpost attendants (Kerala) or local maintenance staff (AP, Darsi scheme, Gujarat, Santalput scheme) record the days when villages or wards got water or not and the frequency and duration of problems. Areas of further strengthening of these local monitoring systems are discussed in Chapter 7.

Regular monitoring and quantification of conditions and performance of the schemes at village level are of value, because the achievements of preventive maintenance through community members have to be set off against the extra costs that have to be made, such as for organization of the community and training of the caretakers.

Water agencies and users will be more supportive of preventive maintenance when this brings measurable and economically viable results, such as lower loss of unaccounted for water, less damage and better hygiene at taps (which means less risks of the spread filariasis, malaria and hookworm), a more regular service and shorter duration of breakdowns. A first quantitative evaluation of the cost-benefits of standpost attendants is planned to be available in Kerala by August 1992. This assessment will focus especially on frequency and duration of breakdowns. Involvement of local men and women in the upkeep of waterpoints and reporting of problems seems to make a significant difference and needs to be quantified more generally to show its impact on scheme functioning and environmental conditions.

It would further be very valuable to assess whether voluntary maintenance reduces agency water losses. These losses now amount to some 30% of all water produced, but could be reduced through earlier reporting and speedier repair of leaking taps and broken pipes. So far, however, none of the schemes where the communities participate in maintenance have got the bulk meters needed to measure water loss. Measurement of water losses is being initiated in Gujarat. To this could be added an assessment of the effect of community participation and health education on reducing water losses in the village distribution nets.

## 6.2 Maintenance and repair by trained villagers

In Uttar Pradesh and Kerala, initial experiments have been started to train selected villagers, many of whom are women, not only to do preventive maintenance, but also simple repairs. In Kerala, KWA and SEU have trained and equipped some standpost attendants to also execute basic repairs to standposts. In a pilot project in UP Jal Nigam trained and pays female handpump mechanics. The project was designed after the Government of the Netherlands had sponsored a female superintending engineer from Jal Nigam together with 3 female engineers from the other states to take part in the INSTRAW/ESCAP seminar "Women, Water and Sanitation" in Bangkok.

Experiences with training and employment of female handpump mechanics under contract with Jal Nigam have been very positive. The system allows the agency to pay several trained women at village level instead of a single block mechanic, which eliminates the latter's transport costs and increases the speed of repair and regularity of maintenance. For the women it also seems beneficial, as it provides them with an income and raises their status in the village. A monitoring system is in place to measure the results of the scheme and expansion to other areas is considered, but hard data have not been produced so far. It would be useful, not only for other handpump schemes in India, but also internationally, when data on the cost-effectiveness of this pilot project would become available, and if positive, should be published in a case study. RSM and PSU could provide support in preparation and review, with IRC giving support to publication and distribution.

## 6.3 Community-managed piped systems and handpumps

While delegation of maintenance tasks to village workers seems to be fairly successful (though still lacking in quantitative data), this is not the case for full management of village water systems. Panchayat-managed small water supplies exist in Andhra Pradesh and Gujarat. In Kerala, the KWA has taken over 1000 such systems. As they all make losses and are expensive to operate, they are a heavy burden on the organization (Fergusson, 1992). Handpumps have in the past also been managed by local Panchayats, but have now been taken over by the central water agencies.

Small piped water supplies in AP (and Gujarat, but these are not NA) are handed over to the Gram Panchayats for O&M after construction. Prior handing over, communities are not involved in choosing the type of system which they later have to maintain and finance. They also are not oriented and organized for these tasks and get no particular technical and managerial training. In this form, local management has therefore not been a success.

*In AP, sooner or later the Department has to step in to carry out corrective maintenance or rehabilitate the scheme (Kondala Rao, 1991, p. 103). In Gujarat, Panchayat-managed schemes function very poorly (Streefkerk, 1986). In UP and Kerala, maintenance of handpumps and piped systems has been taken over completely by the central water agency Jal Nigam because of poor O&M.*

Maintenance of standposts without community participation . . .

. . . and with participation in drainage construction, maintenance and reporting.

There are many reasons for the low effectiveness of village-managed water systems. Most important is that the villages are not involved in the choice of system and planning of the water supplies they are expected to run. Choice of technology and service levels are not adapted to the varying capacities and needs of the villages, and villagers are not involved in the planning of the local maintenance, management and financing systems required to run their water supply. In addition, local water management capacities and organization are not build up to enable the local administration to look after day-to-day O&M and O&M management, which includes financing, financial management and monitoring of service. No training is given for local O&M and system management and administration and there is no clear agency system which regularly monitors the performance of decentralized schemes, gives support to village management organizations and draws lessons for improving the agency's approaches.

### 6.4 Involvement of women in O&M

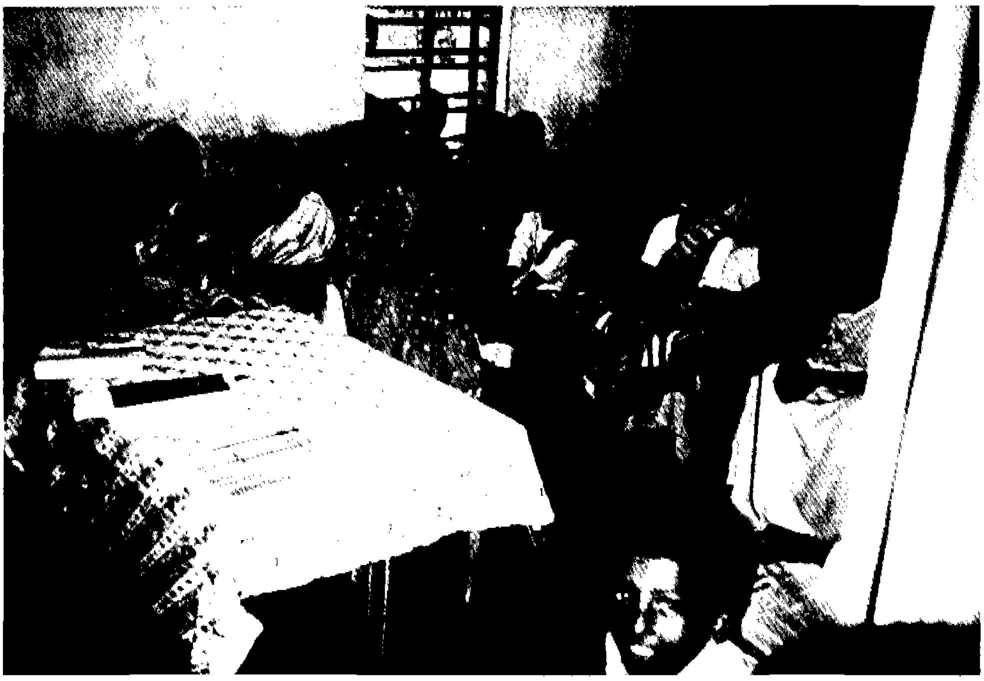
In the NA-projects, village women are increasingly involved in O&M (see illustration). Most of the voluntary work in looking after village waterpoints and reporting problems is done by women. In UP, women have been successfully trained as handpump mechanics. In all newer NA-projects, women are also members of local water or tap committees. It would be valuable to know what the effect of this involvement is on the quality of the water service and on the work and position of the women. The extra tasks taken on by women volunteers for example may increase their work, but also lead to a better water supply and a lower burden in water collection for all women.

Another point for investigation would be whether the women, next to doing the physical work, also have influence on management decisions in the local water committees to which they are associated or of which they are a member.

Finally, it would be valuable to find out whether the stipends earned by female handpump mechanics cover the opportunity costs of their labour (a woman's opportunity costs are the costs she has to make for someone to do her household chores or look after her children, while she goes out to earn a salary). When more data have become available on the impact of women's involvement in O&M on the water service and on their own work, status and living conditions, it will be possible to develop a more general strategy paper on women and O&M in NA-projects.

### 6.5 Planned experiments with community management

New experiments with community-managed systems are now planned, in which the omissions mentioned above can be taken into account. This development is in line with both the Indian national policy under the VIIth Plan and the New Delhi Declaration at the closing of the IDWSSD. Both advocate a greater community management of rural water supplies, with the agency taking care of technical, managerial and training support to the Gram Panchayats and doing the monitoring of the functioning and quality of village water systems at district (area) level. Room for implementation at state level is not yet feasible everywhere, however.



Women have been trained as voluntary standpost attendants (here meeting with the community organizer in Kerala.

In UP they are trained as agency-paid handpump mechanics (Lakhimpur Kheri, UP).

*In UP, Jal Nigam has proposed to replace on a pilot basis the expensive 3-tier system for handpump maintenance by three different models with increasing community management. The main obstacle is permission from the State Government to decentralize O&M authority to Panchayat level (UP-26, p. 18).*

Devolution is less a problem in AP, where in accordance with the statements of the VIIth Plan an experiment will start with more community involvement in technical, managerial and financial O&M tasks at village level (NAPO, 1990).

*Experiments in AP will be carried out in both single village and comprehensive schemes under Netherlands' assistance. For the latter, responsibilities will be divided between the water agency, which will operate and maintain the main parts of the scheme and the villages, which will look after day-to-day maintenance and repair of local parts and also take part in financing of local costs (NAP, 1991).*

A simpler arrangement (maintenance of public taps in a comprehensive scheme by SPAs under management of WWCs) is being pilot tested in Kerala (SEU-S, 1991). Furthermore, an experiment is planned, whereby KWA and SEU will help 3 local ward water committees to run their own small scheme, using the funds which otherwise go to the KWA for centralized maintenance.

No experiments are yet planned in Indo-Dutch schemes in Gujarat, but as part of his MSc training at IHE, an engineer of the GWSSB has carried out an evaluation of technical and managerial problems experienced by Gram Panchayats in maintaining of other, non-Dutch financed schemes. The study concludes that it is more cost-effective for the Board to strengthen local institutional capacities for O&M of Panchayat-managed schemes, than to take over O&M of these systems (Mehta, 1992).

From the earlier experiences it can be concluded that community management of village handpumps, small piped supplies or distribution nets of comprehensive schemes offers considerable potential, but requires more involvement in local planning and more training and support for especially the managerial tasks.

A further major condition for successful community management is a different approach to the communities from the very start of the project (treatment as future managers of the system) and a different O&M culture in the water agencies themselves.

When O&M has a low priority and status, the risk exists that its burden is merely transferred to the communities without the necessary adaptations and support at agency level. A renewed and improved system of village water management requires not only technical but also managerial training for the communities. If the village has to do the day-to-day local maintenance, management and financing of recurrent costs, the type of technology and level of service should be such that they can meet community needs and at the same time fit local technical and managerial capacities. This means that ideally, a community gets an informed choice about the types of water supply and local maintenance, management and financing systems that are possible and is assisted to choose those options which are most appropriate in its particular circumstances.
This will require training for the water agency field staff in different planning techniques as well as more cooperation of technical agencies with social organizations and institutes that have specific experience and skills in preparing villagers for local management work.

## *7. PERFORMANCE OF COMPLETED NA-WATER SYSTEMS*

### 7.1 Operational problems

Evaluations of the first-generation projects show that nearly all systems completed so far are working, but that their performance can generally be improved (Lavan, 1988, Shirahatti, 1990, Updesco, 1990, NAPO, 1991). Frequently mentioned operational problems are unreliable energy supply, high water losses and inadequate chlorination and water quality control. In addition, some problems occur with water treatment systems.

***Energy supply***
Although piped schemes are designed for a 24-hours supply, in practice a number of systems function only 16 hours. Stand-by generators and exempted feeder lines (a separate electricity line for the water pumps which is exempted from cut-offs due to rationing) by themselves seem not to solve the problem, e.g. because of financing problems or because the electricity board allows others to connect to the special line as well or cuts off energy supply despite the agreed exemption (UPDESCO, 1969, Chapter 7).

***Water losses***
Loss of water in piped systems, reported to be sometimes 50%, has severe impacts on O&M financing and can undo the benefits of more paid connections, because the prices charged per $m^3$ of water delivered take no account for the amount of the water that gets lost through leakage and illegal water use between the place of production and ultimate consumption.

> Studies in Kerala and UP give a 30% water loss for the urban water supply in Trivandrum (Visscher, 1988, p. 7) and up to 50% in a pilot village in UP (UP-24, p. 19). In Gujarat, measurement is in progress, but estimates of actual losses are between 46% and 52%, while 22% loss is designed for (GU-23, p. 35). The O&M cost per $m^3$ delivered may thus be up to two times higher than the production cost per $m^3$ given in table 3.

Furthermore, losses which are greater than taken into account during design greatly affect the design life of the schemes and may be a reason why completed systems such as UP-I need earlier expansion than planned for. (The other reason is the unrealistically low population growth figures used for scheme design).

Several measures to detect water losses have been recommended or taken, including a greater community involvement in preventing water wastage and reporting leakages. However, leak detection and measurement of its impact seems not to get a high priority in all cases, perhaps because incentives for loss reductions are rather low and clear responsibilities for scheme management, including financial management, are lacking (GU-23, p. 36, UP-26, p. 29). Water agencies get little earnings from water actually delivered and do not have to pay the capital cost of upgrading schemes that can no longer meet the calculated water demand, e.g. in GU-I and UP-I. Hence, incentives to reduce existing water loss are low, unless they are stimulated by external support and the economic benefit of reducing water loss is quantified and made generally known.

*Water quality preservation and control*
Evaluations of the first-generation Indo-Dutch projects show further that present chlorination practices in piped schemes are both inefficient and ineffective. Chlorine consumption was found to be high in Kerala (Indo/Danish/Dutch mission, 1989, p. 21) and Gujarat (Shirahatti, 1990, table 4.4), yet residual chlorine was negligible in the schemes of GU-I (Shirihatti, 1990, Table 3.4) and AP-I and II (NAPO, 1991). In UP-I, water samples from the taps were satisfactory, but samples taken after transportation to the homes were bacteriologically contaminated (Updesco, 1989, p. 95). In a study in non-NA schemes, the Centre for Environmental Studies of the Anna University in Madras found that water which was of high quality in the beginning of the distribution system, deteriorated proportionally father down the lines (Govindan and Pitchai, 1992).

In addition to the measurement of residual chlorine, special water quality control laboratories have been established in UP and AP, but no information was found on their functioning.
A point for further discussion is how valuable sophisticated water quality control systems are when operation and maintenance of the schemes are not improved. Piped schemes, for example, are not always kept under continuous pressure, so that backsiphoning of dirty water into the pipelines can easily occur.

Moreover, recontamination of drinking water in the homes is not assessed and not all projects yet include hygiene education. Home storage of drinking water is common in all projects, because most families have no connection in the home and/or the water supply is irregular and unpredictable. Hence the risk of recontaminating safe water during transport, storage and drawing is high. A review of studies on water handling shows that recontamination is a common phenomenon and that health education programmes are not always effective, because they are not practical and behaviour-oriented and do not include monitoring and evaluation of their impacts on water use conditions and practices (van Wijk, 1985).

*Water treatment*
Apart from chlorination, some surface water is also treated through rapid or slow sand filters. A national study on the performance of water treatment plants in India found that only 39% of the plants met the standards for turbidity and bacteriological quality. The study concludes that "the present scenario of water works management in general is less than satisfactory, if not gloomy" (NEERI, 1989, p. 39). Some of the SSF plants in NA-piped water supply projects are also not functioning well. At the initiative of the RSM and NAP Office, NEERI has therefore been called in. No information on performance is available of other plants.

*Operation at village level*
At village level, the quality of installation of waterpoints has not always been optimal. GOI norms on per capita investment costs and tender regulations sometimes force water agencies to install lower quality facilities. Drainage at handpumps and public taps leaves much to be desired (Table 4 and Shiravatti, 1990, p. 22). Data from the first-generation schemes show that potential benefits from user involvement in standpost upkeep and health education are high. Observed problems suitable for community-managed prevention and repair include damaged pillars, taps, platforms and drains, poor hygiene around the facilities and contamination of originally safe water during transport to and storage and drawing in the homes.

## 7.2 Monitoring of scheme performance

The above findings on performance of completed NA-schemes are rather general. Evaluation of the actual reliability of NA-schemes has not been possible, since records on the downtimes are not generally kept and used. Where field records on regularity of service exist, e.g. in Gujarat (see illustration) and AP-I, they are not yet condensed and analyzed for the overall evaluation of the performance of the schemes. Field data are also not yet utilized for the higher-level management of the rural water supplies in a particular area.

*Of the 22 schemes visited in UP-I, for example, 16 were not maintaining any O&M records. For the other 6 no information was given on record keeping (Updesco, p. 72-86). When meters in GU-I are working, they are read and results recorded systematically. However, data are not condensed and used to monitor and manage the scheme. The records are kept in the field until the recording book is full, after which it is brought to the offices and filed (Haskoning, 1990A, p. 6). The same is the case with the (daily) records in which the linespersons report which villages have and which have not had water that day (Shirahatti, 1990, Table 5.2). A similar lack of data condensation and use is reported in AP and UP (Lavrijsen, 1990; UP-27).*

Improved reporting methods have been proposed in all states. The purpose is to make it possible to monitor and analyze the reliability of NA-piped water systems and handpumps, perhaps with the involvement of the communities in keeping or checking local records. The introduction of a new systems is only likely to succeed, however, when higher level staff appreciate the importance of a community-based monitoring, support its introduction and use the data for O&M management. These conditions seem not yet present at the moment.

*In AP, the introduction of an improved system on a pilot basis did not yet succeed, because the required support from the Department was not forthcoming. In UP, an O&M monitoring which had been dormant for 3 years has been introduced and is functioning well in Lakimpur Kheri district, but has not yet been expanded to the other handpump districts (UP-26, p. 76).*

## 7.3 Longer-term reliability of water sources

In addition to these direct O&M problems, longer-term functioning of some of the schemes seems to be endangered by the falling water table, pointing at a growing need to expand present water supply projects with a component for water resources management and control.

## *8. UTILIZATION OF COMPLETED NA-WATER SYSTEMS*

### 8.1 Access to improved water supply

Evaluations on the use of completed systems have been carried out for piped systems in UP-I and IV and in GU-I. A study on the utilization of handpumps has been recommended for UP (Evaluation mission, 1992).

In AP-I and KE-I and II, no evaluation on system utilization was carried out, because a more general assessment found that the installed village distribution nets served only part of the project communities. Moreover, the high density of private wells in Kerala means that many people use this water during the rainy season and only turn to the taps when wells are salty or fall dry.

> *A study in 3 Danida-supported schemes of the Indo-Dutch-Danish supported projects found that women continue as long as possible to collect well water, especially for drinking, until the dry season forces them to turn to public taps or handpumps (2-4 months). Main reasons for disliking tap and pump water are distance, irregularity, quality (muddiness; high iron content) and low pressure/ discharge. However, if the service is good, willingness to take a house connection is high (50% in the wet season and 98% in the dry season) and 98% of those interviewed are willing to pay for piped water from a house connection (Zachariah, 1987).*

In both states, the low access of especially the poorer parts of the Panchayats is now being corrected and procedures for improved siting with direct involvement of the users have been established (though with important cost consequences, see below). Utilization studies in the two States can show whether these measures have indeed had the required effect.

### 8.2 Utilization of piped water

The utilization studies in UP-I and IV and GU-I showed that also with good access, the use of other water sources is continued after the introduction of piped systems.

> *The evaluation in GU-I states that 93% of those interviewed say that they use tap water for drinking. However, variation in the wet season is not taken into account and 26% also uses other water sources than public taps, but whether this is only for washing and bathing or also for drinking is not clear (Shirahatti, 1990, Table 6.3 and 6.4). In UP-I, only 8% use of tapwater for drinking is reported (Updesco, 1989). UP IV has a reported utilization of 38% (Evaluation Mission, 1992).*

Reasons why tap water is not generally used are the irregular service and low pressure, poor distribution of tap sites (no user involvement in site selection in previous projects) and competition from other, nearer water sources.

In UP, an experiment is now planned to convert piped systems to house connections only, which will bring some revenue and be generally used. Public taps will be replaced by handpumps, which give a 24-hours service. Involvement of users in site selection and hygiene education on the difference between open and closed (protected) water sources should bring general use of only safe drinking water (tap or handpump).

Unprotected well in continued use for drinking water.

Upgraded traditional neighbourhood water source.

Such a combination of pipelines and handpumps is not possible in all NA-projects. Groundwater is sometimes absent, salty or contains high concentrations of fluoride. Moreover, to compete with already existing traditional water sources, especially during the monsoon season when these are more abundant, handpumps or taps have to be very close to the people's homes. As experienced in Kerala, this means that village distribution nets (or numbers of handpumps) have to become much more extensive. This raises the capital and O&M costs of the schemes and limits the replicability of the approach in other projects and will be a reason to look also at other alternatives for full coverage and use.

## 8.3 Integrating improvement of traditional water sources

Because of the high cost to achieve year round use of safe drinking water by some 80% of the households, it becomes relevant to assess whether improvement of traditional sources in use for drinking alongside or instead of the introduction of new water systems is in some cases more cost-efficient and effective than constructing larger piped schemes or drilling more wells.

On a small scale such improvements are carried out in Kerala (see illustration). Traditional water sources are improved instead of constructing a new water system, or are treated as a supplement to a piped scheme.

> *In the backhills of the coastal strip, where the piped schemes cannot reach, except at a very high cost, traditional water sources are upgraded. Springs are capped and wells covered and a tap, handpump or pulley and fixed bucket is installed. The investment cost of these alternative water systems is Rs. 90 per capita (PASSS, 1991). In addition, in one area with a piped system the SEU has helped a local women's groups start a chlorination scheme for household wells. This ensures the safety of the water when wells are continued to be used for drinking and is a valued means of income-generation and health education (see progress reports SEU and 1992 mission report C. van Wijk).*

Protection and treatment of existing water sources is however not yet part of any comprehensive plans to serve a project area with safe water through a combination of various systems, including the protection and treatment of existing sources for drinking water.

## 8.4 Capacity building for evaluation of completed water systems

Looking at the evaluations on functioning and use in the first-generation NA-projects, it is noticeable that all studies were carried out by external Indian consultants.
It could be a point for consideration whether to continue this practice, or whether to involve staff from the water agency's planning and design department or monitoring unit, from other relevant agencies (health, social affairs, NGOs) and representatives from the communities concerned, such as Panchayat members and village water committees.

Evaluation by consultants has the advantage of easier implementation, especially when terms of reference are standardized and guidance documentation or training for these type of studies (e.g. WHO's Minimum Evaluation Procedures) are available. More participatory evaluations have the advantage of contributing directly to an internal learning process. It helps the implementing organizations to design for better functioning and use, provides an active learning opportunity for the village bodies and contributes to the building of evaluation skills within all organizations.

## *9. OPTIONS TO ENHANCE O&M AND UTILIZATION OF NA-WATER SYSTEMS*

### 9.1 Introduction

In the years to come more and more rural water supplies will be completed which do not generate much revenue for exploitation and upkeep. With limited government resources, problems of O&M, also in NA-schemes, are therefore likely to increase. Although Dutch support for the construction of new schemes will be continued, strengthening of O&M capacities will become more important. Because donor-supported projects form a small (6%), but representative segment of the Indian rural water supply programme and can more easily get additional funds, they can play a valuable role in experimenting with new O&M and O&M financing systems that are more cost-efficient and effective. The following are some of the actions that could be undertaken as part of the NA-programme.

### 9.2 Better insight into O&M cost and financing

As discussed in chapter 2, no complete picture exists of the full recurrent costs of completed NA-schemes. A first step would be to define these costs and get a full overview of their size, variation and coverage by the present revenues and financial allocations. A comparative review in a sample of the various types of NA-schemes could be carried out in all states to collect this data and draw more pertinent conclusions.

Because completed NA-schemes are all relatively new and O&M costs increase with the age of a scheme, it would be valuable to also include some older but comparable schemes in the sample. This would in addition show if NA-schemes are in a more favourable position with regard to O&M and O&M financing than schemes which were built using other sources of finance.

### 9.3 Strengthening organizational capacities for O&M

***Undertaking in-service projects***
Already some years after completing the first NA-schemes it has been found that their capacity is inadequate and needs to be enlarged. Next to new construction projects, improvement of existing NA-schemes will therefore be undertaken, the so-called in-service projects. These projects can provide a good opportunity to not only correct previous design errors (e.g. a too low population growth), but also improve O&M and O&M financing.

Subject areas that can be made part of proposals for in-service projects and a condition for their financing are adaptation of the manpower arrangements for O&M, establishment of O&M norms, manuals and procedures, strengthening of community organization and training for local maintenance, management, financing and repairs, the inclusion of a hygiene education component on safe water handling practices, and establishment of community-based monitoring systems on functioning and hygienic use. Particular emphasis will have to be placed on measures to make the water supplies more sustainable, so as to avoid that improvement of completed schemes becomes a recurrent process.

*Organizational development*
An area where more NA-support could be given concerns the organizational culture for O&M. Objectives and targets for Indo-Dutch water projects should not only include design and construction of improved water systems, but also reliable functioning and general and hygienic use. Specific norms may be formulated to determine when a completed scheme can still be rated as performing acceptably and indicators set to assess scheme performance and hygienic use.

Areas which emerge for further strengthening in the development of O&M procedures and manuals are preventive maintenance, incorporation of tasks and authority of village institutions (caretakers, water committees) and field testing.

*Monitoring and evaluation*
Monitoring data on scheme performance need to be condensed and executive staff come to appreciate their usefulness as a higher-level management tool. Costs and results of innovative monitoring systems on O&M, such as the participatory system on standposts maintenance in Kerala and the monitoring systems on handpump maintenance in UP and scheme performance in Santalpur in Gujarat and Darsi in AP, should be summarized and reported, as monitoring of local O&M is internationally very new and an important area for progress. Where monitoring of O&M is done by agency-paid staff, as in Santalpur and Darsi, countersigning of records by water committee members or another system of cross-checking will be important to enhance reliability of results.

Evaluations of completed systems could be more participatory. They can be valuable eyeopeners for all parties and provide a basis for adjustments in design and maintenance procedures in the agency as well as improvements in local upkeep and use in the communities.

*Training*
Training is obviously an important tool to raise awareness on issues of sustainability, and more high-level staff should get access to short courses, seminars and conferences on this issue. Management level staff can be stimulated to undertake more pilot projects to improve maintenance and hygienic water use in completed schemes, as was the case with the Lakhimpu Kheri pilot project (female handpump mechanics) following the INSTRAW/ESCAP training seminar in Bangkok. Staff should also be assisted to quantify and publish the results of such pilot projects.

Awareness problems on sustainability of completed schemes appear to be highest among political leadership and politicians determining manpower and tariff policies.
They will have to become convinced that when the present approach is continued and no experiments tried with alternative strategies, the existing schemes will continue to degenerate and very costly rehabilitations will become necessary. This group will have to become a more explicit target group for awareness raising and education through various information methods, such as project briefs, orientation visits and press publications.

## 9.4 Improving the financial balance of completed schemes

Two ways to improve the financial balance of the schemes are the reduction of recurrent costs and the increase of revenue.

***Reduction of recurrent costs***
To reduce costs while retaining or improving scheme performance, it may be possible to formulate and test scheme-specific strategies with the help of the Review and Support Missions. Possible areas which emerge from the previous chapters are: quantified reduction of water leakage and wastage with the help of the communities; more training and freedom to operating staff and Panchayats to run schemes as efficiently and effectively as they can within given norms and allocations; and allowing the use of higher quality construction materials and tendering by basing maximum per capita investment costs not on the administrative population of a project area, but the real number of people living within reach of the system (this point is discussed further under 9.6, planning and design).

Enhancement of preventive maintenance will in the short term increase recurrent costs, especially when not yet accompanied by organizational adaptations such as staffing patterns. In the longer run, it will pay off, however, and should therefore receive strong emphasis in O&M manuals and procedures.

Reduction of O&M costs to water agencies in the longer run may also be achieved through a greater involvement of community members in local maintenance and repairs. This will require more quantitative information however and is discussed in more detail in the next section.

***Increased revenues***
Allocations from government resources are likely to remain insufficient to close the growing gap between revenue and costs. More revenue from the users will thus be required if service levels are to be preserved at an acceptable level. The policy regulations of the Central Government do allow such contributions, especially for higher than standard service levels. They also encourage experiments with community and user financing of recurrent costs (GOI, 1986 and VIII FYP). It now lies with the State Governments to operationalize these guidelines and allow innovative experiments with alternative local financing systems and/or full community management.

An initial option, which is in line with the national water policy, is to incorporate in the tariffs for house connections all extra investment and O&M costs which distinguish a piped scheme with house connections from a system with only public taps (the officially set service level). Thus, families who belong to the wealthier section of the population would contribute more equitably to the higher-level service they receive and Government subsidies could be used to maintain the basic part of the service.

A second option is to expand the range of paid connections to also include group connections and neighbourhood taps. This would not only bring additional revenue but also give poorer households greater access to a private taps. Both in India and elsewhere, experience with the socio-economic and administrative aspects of such connections already exist. The reports on these projects are available through IRC and can be a good basis to develop experiments in NA-piped systems.

Allowing more private and group connections may also create new problems, however. Demand for private connections is high and willingness to pay seems higher than the tariffs asked (see section 4.4). Existing schemes are therefore likely to get more connections than they can cater for, while the revenue raised will be insufficient to meet all costs, including those of regular expansion of the systems. Moreover, users seem to be insufficiently aware that allowing house connections without optimal exploitation can easily create new problems in quality of service, especially for those at higher elevations and tail-end villages. Users now seem to think that they can just leave their tap open for the water to come at any time, without having to walk to and wait at a public tap, but do not seem to realize the effect of this practice on general water distribution and pressure.

***Charges for handpump maintenance***
For maintenance of handpumps it will be less easy to get direct user payments. Alternatives to increasing government subsidies are annual payments by Panchayats to a Government maintenance service, or financing by the Panchayats of the local costs. The latter would include the payment of a basic maintenance fee to the village handpump mechanic, plus any additional payments for time spent on repairs, if these are not included in the basic fee, and the cost of tools and spares. The Government subsidy then only covers a scheduled monitoring and back-up service (which may include training on-the-job) and any large repairs or replacements.

***Income-generating projects***
Where income generating projects for women have been established to enhance economic capacities, it could be investigated what the effect of these projects is on the household payment capacities and priorities of the women. It should further be investigated whether an irregular functioning water system has any impact on the women's time management and their use of water for productive purposes and whether this in turn has an effect on their income.

## 9.5 Enhancing community involvement in O&M

***Cost-effectiveness of voluntary maintenance***
At present, community and women's involvement is mostly limited to doing voluntary labour: upkeep of communal waterpoints, preservation of hygiene, reporting of problems, prevention of misuse. More quantitative data is needed to learn whether the extra cost of organizing and supporting community participation leads to better village conditions, more reliable services and lower costs, e.g. through quicker repairs, lower water losses and a delay in the need to expand the capacity of the scheme. More data is also needed on the impact of the projects and the participation of women in these projects on their status, living conditions and control over these conditions.

***Training for local repairs***
More costs can probably be saved by training villagers to also carry out simple local repairs, such as replacement of taps on standposts and repairing leaks in pvc pipes. Positive experience with this type of community involvement exists in other countries. It is also comparable to the positive experience with the use of trained youth and women mechanics for village handpump repairs in Lakhimpur Kheri in UP. In both cases, overall responsibility for the schemes remains with the government water agency.

***Community management of simpler schemes***
The next option, community management, goes beyond individual or Panchayat payments for O&M or doing local maintenance and repairs as volunteers or on a contract basis. Options for community management include full management of handpumps and other point sources, full management of single village piped systems, and shared management of comprehensive piped systems.

With community management of handpumps or single piped schemes, the local management organization (Panchayat, water committee) not only employs the village operator and/or mechanic, but also supervises him/her, selects and manages the local financing system and monitors the regularity and quality of supply. It is very likely that this system can be more successful than in the past, when the system and service level are within the management and financing capacities of the community and technical workers and committees are trained and have some kind of backstopping service for technical and managerial tasks.

***Shared management of comprehensive systems***
In comprehensive piped systems full community management is seldom possible. Here the most common solution is that individual villages maintain and finance the maintenance and expansion of the local distribution net, while the water agency produces the water and maintains and finances the upkeep of the other parts of the system. In some schemes, communities buy the water in bulk from the water agency. The agency delivers the water to a metered valve or cistern at the community border, whereafter the local council or water board is in charge of all further distribution.

## 9.6 Adaptating planning and design

***Comparing technology options on O&M***
In the development of new water projects or the expansion of existing ones, O&M implications and provisions should be an important part of project decision-making. More attention should be given in particular to comparisons of various technology and design options with reference to their O&M implications in the project proposals and to include also the upgrading of traditional sources into local feasibility studies. Especially staff who attended the one year IHE training could play a role in the preparation of new proposals, as comparison of various options and preparation of integrated area water master plans has been part of their training.

***Rehabilitation projects***
Projects which are formulated to rehabilitate existing schemes should not be limited to physical rehabilitation and expansion, but also include the establishment of effective O&M systems, improvement of financing systems and payment capacities, enhancement of community participation and hygiene education and, where necessary, linkage with activities for environmental protection and water resources management and control.

***Basing designs on willingness to pay studies***
Socio-economic studies which use bargaining techniques to assess people's willingness to pay for house connections at varying tariffs can give insight into the economic feasibility of a scheme. They will also make it easier to match designs more closely to local demands. Once willingness to pay has been established, it may be possible to start an authorized experiment with higher tariffs when this can be coupled to a better (more cost-covering) service.

***Upkeep of coverage and service level***
An item requiring particular attention in piped schemes is the establishment of a policy on the upkeep of coverage levels in completed projects. At the moment, project accounts for construction of piped systems are closed on the completion of the scheme. At this time, the village distribution nets catering for the design population have not yet been fully built. As these costs still fall under the investment costs, it may be necessary to make financial and administrative arrangements for this process.

The issue does not occur in handpump projects, as these are built for the present population. Hence, any additional wells to cater for new population growth in a project village becomes the automatic responsibility of the State authorities, although it is not clear whether there is a particular policy on this which is also implemented.

*More realistic investment ceilings*
A final point requiring action to improve O&M of completed systems is to get an adjustment in GOI norms on maximum per capita investment costs for rural water supply projects. At present these norms are based on the (large) number of persons living within the administrative boundaries of the scheme, rather than the (smaller) number of people living within actual reach of the system. The resulting maximum per capita investment costs are sometimes unrealistically low, especially in areas with dispersed settlement and they force water agencies to limit distribution nets and use lower quality materials. Both factors have a subsequent negative effect on the later maintenance and use of the systems.

## 9.7 Functioning and use of completed systems

*Leak detection and wastage reduction*
With regard to operational aspects, it is suggested to undertake integrated demonstration projects on leak detection and control. Aim of the demonstration projects would be to test the effect of both technical and social measures on water consumption and loss and to assess whether through better O&M and community involvement, upgrading of scheme capacity can be postponed and service to tail-end villages improved.

It is further recommended that before installing more private water meters in piped schemes, the economics of metering are investigated in more detail, including the costs of maintenance, repair and control of the meters, the managerial feasibility and the required adaptation of water tariffs to cover at least the direct O&M costs.

*Water quality control*
Concerning water quality, the efficiency and effectiveness of chlorination could be improved and the efficiency and effectiveness of external quality control assessed. Testing of home stored water could be carried out on a sample basis with simple equipment, such as Millepore or Delagua kits by trained community health workers, community nurses or NGO field staff and be used in local hygiene education programmes.

*General use of safe water*
Better O&M of completed water systems will not automatically lead to more general utilization of tap or pump water. It is yet to be seen whether just adding health education changes this, as many households seem to prefer using other, and often unprotected, water sources when these are located more conveniently and their quality is considered to be acceptable. To achieve general use of safe water sources for drinking, the protection, chlorination and hygienic use of existing water sources may have to be taken into account as well, as part of the local design and management of water supply projects and as part of hygiene education and action programmes.

## 9.8 Water resource protection

To improve all water sources in use for drinking in a community, it may be possible to prepare more general water master plans in and with each project village. Villages can further be assisted to develop a comprehensive water management system for all water resources in their community. The latter would also prevent that traditional water sources get neglected and are no longer preserved. Local water resource development and management can, however, only be successful when this forms part of a larger water resources management and control system, especially in areas with a declining groundwater table.

## 9.9 Financing of O&M improvements

Financing and execution of O&M-related activities can be undertaken in several ways: as part of the shortly to be expanded training fund, under ongoing implementation projects, or as part of the so-called in-service projects in areas with already completed NA-systems. While Netherlands' support to new construction will go on, in line with the shared target of safe water for all by 2000, the challenge will shift increasingly to keeping the established systems functioning and used. It is in this area that the long-established cooperation and mutual trust between project implementors and supporters can make an important contribution in the coming years.

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