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OPERATION AND MAINTENANCE FOR SUSTAINABLE AND IMPROVED WS&S SERVICES IN LDCS- TOWARDS A NEW PHILOSOPHY

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Summary

Operation and maintenance (O&M) of water supplies and sanitation in developing countries are badly neglected, so much so that many schemes have fallen into disrepair and no longer provide the services for which they were constructed. Because of this the actual coverage levels of adequate water and sanitation in developing countries is even lower than statistics would suggest.

In spite of repeated statements resulting from international meetings and a general recognition of the need to improve the operation and maintenance of existing and planned water supply and sanitation systems, progress in establishing viable and successful operation and maintenance programmes is discouragingly slow. As a result, levels of service are lower than planned and access to reliable drinking water and waste disposal systems are not assured on a continuous basis.

A concerted effort is urgently required to improve operation and maintenance as quickly as possible. If such action is not taken, the benefits of improved water supply and sanitation systems will be progressively lost in spite of reported successes in extending coverage and creating more access to improved water and sanitation services in rural, urban and peri-urban areas. New investments do not seem justified if the operation and maintenance issue is not dealt with and if sustainability of existing systems is not guarantied before investing in and constructing new systems which in their turn will rapidly deteriorate.

The provision of water is a service which requires a service orientated attitude by the agencies involved. To ensure long term sustainability, water should be managed as a commodity in the same way as any other resource. Its use and exploitation should be on a financially sound and cost effective basis subject to the same legal and regulatory controls as other resources to ensure its conservation, protection and wise use. Water systems should be managed and operated following the principles of good business practices, based on the principle of effective demand which can be defined as the standard of service that the users are willing to maintain, operate and finance to ensure adequate public health standards.

The policy of authorities responsible for drinking water supply should aim at creating an enabling environment and circumstances which are conductive to the development of efficient operation and maintenance. The policy and strategy of all bodies involved in protecting drinking water supply and sanitation projects will need to concentrate increasingly on the importance of that aspect, as much as on the system itself. Decision makers and managers will have to recognise the adverse effects of inefficient operation and maintenance.

O&M of WS&S systems is a complex issue with linkages and interrelationships to water resources, environmental sanitation and the environment in general. Management strategy should take into account these growing environmental considerations which are becoming increasingly important world-wide. Designs should be chosen which minimise waste and are most economic in the use of chemicals whose disposal could affect the environment.

Inadequate operation and maintenance has been a major factor in the lack of sustainability of past WSS systems. Correcting O&M shortcomings will be a crucial part of future strategies to ensure longterm sustainable water supply and sanitation.
O&M programmes are clearly part of an institutional development process. O&M programmes cannot be implemented in isolation, without the perspective of a long-term development programme.

1. Background

During the International Drinking Water Supply and Sanitation Decade large-scale investments have been made in new facilities resulting in a welcome expansion of service coverage in many countries. However, inefficient operation and poor maintenance of systems continue to present serious problems calling into question the long-term sustainability of the gains that have been made the past years.

The problems are rooted in the continuing weakness of sector institutions in many developing and newly-industrialised countries in terms of development and management of human resources and financial viability. Unless the capacity of sector agencies to deal with these problems is built up, systems will continue to deteriorate resulting in declining levels of service and wastage of investment funds.

This situation has come about for a number of reasons. Among them is the emphasis by developing country governments and external support agencies on trying to quickly make up the large sector deficit by providing services to those without adequate facilities, and hence the emphasis on capital construction and expansion particularly of water services. Another is the previous long standing tradition of some governments and external support agencies to consider water and sanitation as being a free social service for all, the costs of which are not borne by the user.

An approach to ranking of constraints on the water supply and sanitation (WS&S) sector in developing countries, using data from over 100 developing countries, suggests indeed that the three most acute constraints are : (1) inadequacy of cost recovery; (2) operation and maintenance (O&M); (3) logistics. (Dabbagh, 1991)

The operation and maintenance of water and sanitation systems and cost recovery both have therefore become an urgent priority for the sector in less developed countries (LDCs). In spite of repeated statements resulting from international meetings and a general recognition of the need to improve the operation and maintenance of existing and planned water supply and sanitation systems, progress in establishing viable and successful operation and maintenance programmes is still discouragingly slow. Systems are failing at an alarming rate and statistics indicate that more than 50% of the existing systems in LDCs are not reliable, not sustainable or inefficient as a result of poor operation and maintenance both in the rural and urban areas.
As a result, levels of service are lower than planned and access to reliable drinking water and waste disposal systems are not assured on a continuous basis.

It is discouraging that in the rural areas, where supply is frequently provided through point sources fitted with handpumps, a high percentage of facilities are reported as being out of order. Figures of 40%, 50% and 60% have been reported but this is an area where reliable data, perhaps not surprisingly, are not readily available. (WHO, 1990) In urban areas, poor O&M has resulted in unaccounted for water being reported as more than 50% of produced water in many large cities in developing countries. In the served areas of these cities, wastage is very high and tariffs are often subsidized whereas the inhabitants of fringe areas remain unserved and pay the market price for insufficient and unsafe water from private vendors. (WHO, 1990)

Sanitation should moreover be taken into account as a factor affecting the O&M of drinking water supply systems.

Well managed undertakings are dependent upon adequate resources and appropriately skilled staff at all levels.
However, the general acknowledged problem at the water sector level is the broad need to upgrade the managerial capacity of water supply and sewerage agencies with particular attention to operations and maintenance, financial management and human resource development. The

specific problems affecting many sector agencies in LDCs at the present time and which constrain good operation and maintenance performance, include :

(a) inadequate attention to the maintenance of systems resulting in poor service and heavy repair costs;
(b) high costs of renovation of the system or the need for additional investment;
(c) high volumes of unaccounted for water; drop in income from water sales;
(d) water losses due to leakage;
(e) poor quality of water resulting in an adverse effect on public opinion and consumer reluctance to pay for service;
(f) threats to public health, since O&M is essential in safeguarding adequate drinking water supply;
(g) financial weakness of agencies due to low water and sewerage tariffs;
(h) demotivation of the personnel involved by poor employment conditions and a lack of incentives.

The main causes of these problems can be identified as follows :

(a) inadequate policies and legal frameworks;
(b) insufficient awareness of the necessity of efficient operation and maintenance;
(c) political interference;
(d) overlapping responsibilities; lack of definition of responsibility for certain operation and maintenance tasks;
(e) low profile of operation and maintenance;
(f) poor management of water supply facilities; shortage of middle management staff trained in modern management methods, and resulting reliance on out-of-date methods unsuited to present day demands of large utilities;
(g) insufficient maintenance equipment; shortage of spare parts;
(h) shortage of trained and experienced operating and maintenance personnel;
(i) lack of information on successful approaches to the solution of problems; inadequate data on operation and maintenance;
(j) inappropriate system design.
(k) lack of funds; insufficient and inefficient use of funds.

An additional cause of inadequate operation and maintenance can be that a system design is difficult to maintain and has been inappropriately geared to the local circumstances and conditions. In many cases this results from insufficient consultation between planners and designers on the one hand, and the operators on the other.

2. Operation and Maintenance of Urban Water Supply Systems - General Aspects

Strategically planned, systematic, and well organised O&M, afforded a high management priority, is an integral and essential factor in the successful operation of any water supply and sanitation system. The essential relationship between all disciplines of management should be emphasised here; none can be effective in isolation.
Failure to recognise the importance and consequent lack of attention to O&M management is a principal cause for the defective performance of many water undertakings throughout the world.
O&M programmes are clearly part of an institutional development process. O&M programmes cannot be implemented in isolation, without the perspective of a long-term development programme.

It is customary for 'Operation' and 'Maintenance' to be discussed in combination, demonstrating that maintenance is an integral part of successful operation. The reason why efficient operation and maintenance are vital is that only in this way supply systems will function satisfactorily and continue to do so in the future; and equally, satisfy quality and quantity standards of service, meet guide-lines including those of reliability and economic return, and comply with the overall policy laid down by a particular water supply company.

The definition of appropriate requirements is in itself a difficult question. In many industrialised countries the obligations of water supply companies are statutory and therefore outside their control. Each company is required to ensure that consumers receive an uninterrupted supply of drinking water 24 hours a day, in sufficient volume and under stated pressure. Equally, water quality must be maintained to nationally agreed-standards. This is reasonable and straightforward by definition, but far more difficult to satisfy in everyday practice.

It is important to mention here appropriately associated recommendations made at the International Conference on Water and the Environment, *Development issues for the 21st century* (Dublin, January 1992). They include : 1. Evaluate the scope for rehabilitating existing malfunctioning systems as an alternative to investing in new projects; 2. Ensure the technical, institutional and budgetary requirements for future operation and maintenance are provided for in the planning design and implementation phases of new projects; 3. establish preventive maintenance schedules, leak detection programmes, and regular quality surveillance; and 4. develop guidelines and monitor the achievement of sustainable water and sanitation services.

In the following section general aspects of O&M are reviewed focusing mainly on urban water supply systems, being aware of the diversity of systems and the varying conditions world-wide, both managerial and geographical, under which they operate in different countries.

Water resources

The operation and maintenance of water supply and sanitation systems is a complex issue with linkages and interrelationships to water resources, environmental sanitation (solid and liquid waste management) and the environment in general. Operation and maintenance cannot be discussed in isolation or by ignoring these interlinkages. The relationships between water supply, waste and water resources are illustrated in Figure 1.

The operation and maintenance of a water supply system affects and in turn is affected by the water resources which are the basis of supply. Raw water quality influences treatment requirements, available quantity determines amounts which can be provided to users and which need to be disposed of after use. Because most urban domestic water use is non consumptive (except where lawns are watered), the more water is supplied, the more polluted water is being discharged, leading to the contamination of water sources of the community in question or, more likely, of other communities. Conversely, lack of sufficient water makes the operation of a water-borne human waste disposal system impossible.

In the absence of sewage disposal systems, the local environment is being contaminated in direct relation to the amount of drinking water supplied, potentially causing more health problems than presumed resolved with the supply of water. Inadequate drainage and solid waste collection practices aggravate wastewater disposal problems in the absence of sewer systems. As the quantity of potable water supplied increases, this is true even for on site systems because the quantity of sullage water increases to the point that on-site soil absorption capacity is exceeded and excess wastewater flows to public streets and drains.
Operation and maintenance suffers if the issues described are not resolved at the design stage and if there is insufficient coordination and cooperation between the various agencies with responsibilities in water resources and for the environment.

Fortunately, the relationships between water supply water resources and the environment are increasingly being recognized. The activities of agriculture, forestry and industry are important. Both agriculture and industry require water and are often the major users. They return the non-consumed water to the environment often in a very polluted state containing a range of industrial and agricultural chemical contaminants. This pollution of water resources in the developing world by agriculture and industry is well documented and in many developing countries has reached alarming proportions.
To combat these harmful pollutants water supply systems must install sophisticated treatment methods which are costly to operate and maintain and require advanced technical skills.

Water resources are fundamental to any water supply system and must provide the highest degree of reliability. This is why protection of water resources against pollution is vital. Frequently, however, water resources are not owned by the water company and management's control over them is therefore circumscribed. In such cases national or even international agreements are required to provide the necessary protection.

Surface water resources are particularly vulnerable. Where a river source flows through industrial or densely populated areas, maintaining quality is a continuous problem, accentuated by the risk of incidental pollution whose likely effects must be anticipated and planned against. When pollution does occur it may be necessary to suspend the intake source for a period.

Monitoring of surface water resources is particularly important, not only at the intake point, but by regular inspections upstream. This is necessary so that quality problems can be assessed and if deterioration has occurred action can be taken to protect supply, by whatever appropriate means, possibly by suspension of water abstraction. This demonstrates the need for adequate storage provision which is a basic requirement in the situation where water comes from surface supplies. Storage may be achieved in open reservoirs or underground by means of artificial infiltration. Protection of these storage resources and quality control are main management responsibilities.

The importance of protection and quality also applies in the case of major reservoirs even when they are located in remote areas. Quality must be the criterion of whether or not, or to what extent, leisure activities are permitted on reservoirs.

Groundwater resources are less vulnerable to pollution than surface water. Catchment pollution is only likely to infiltrate abstraction wells after a protracted period.
Nevertheless, protection zones around wells are necessary in which certain activities are prohibited or regulated. The flow of water in the direction of supply resources must be consistently monitored.

Some potential damage to groundwater supplies is very long-term, and in this respect even more serious, because once adverse effects are detected, there is no immediate counter solution. The concentrated use of nitrates for agriculture, for instance, has an accumulative effect on groundwater resources. It may take years for harmful build-up of nitrates in the soil to become sufficiently penetrative to be detected, but once this has happened, there is no method of protecting water resources. The neutralisation of nitrates in water supply by treatment from an affected source is extremely costly, and brings into question whether it is right that a water supplier, and therefore its customers, should have to bear the cost rather than agriculture which causes the problem. It is a vexed question, but clearly prevention is preferable, and more economic, than cure. For this reason monitoring and control in the catchment area of an underground source is of the utmost importance.

Underground water resources may be extensive, but if they are to be exploited effectively and without detriment to other environmental factors, their levels and flow patterns should be monitored to gain knowledge of their character and fluctuations over a period of time.

Design

Operation and maintenance concerns should be included in the project design right from the projects' initiation. Legislation should be enacted to restrict the discharge of pollutants and to restrict the use of materials that would cause operation and maintenance problems.

When planning a water supply system, the method of supply is determined by the available source and on the basis of a number of fundamental requirements - capacities, quality, catchment area, population to be served.

The essential basis for long term and smoothly operating supply systems is indeed good initial design and the importance of operation and maintenance should be taken into account at the design stage of a water supply and sanitation system. This will influence both the choice of system components and the materials to be employed, which must be selected with great care. Saving on initial outlay may increase maintenance costs subsequently. Experience supports the need to keep unit operations in treatment and functional units separate from each other for ease of maintenance or repair. Initial costs should not be the sole or most important criterion in the selection of units.
Generally speaking it is recommended to apply the best available technology in order to achieve an optimum blend of 'appropriate' and 'advanced' technology. A choice should reflect an assessment based on practical experience of O&M requirements from different countries and under varying conditions. Best available technology also implies that in addition to being technically best suited for a specific problem, the technology is well understood by the users, can be operated properly, with availability of spare parts, and selected according to the capacity of the institution to purchase it, operate it and to maintain it.

Genuine consultation between planners, designers and operation and maintenance management and at community level, is needed to realise a design which is optimally geared to economic use, practical operation and financial return.

Automation options are virtually limitless. It is difficult to define general rules as to what extent automation should be implemented. The human factor will always be important. The operator must not become too detached from the production and distribution system. Even in a situation where there is a high degree of automation the operator will always have to accept ultimate responsibility.

Human resources

Operation and maintenance not only require the appropriate technical resources, but also trained and qualified personnel. The management framework of the organization depends on the size and the complexity of the water supply system. The direct responsibility for operation and maintenance lies with the company's technical department. Generally the technical department is subdivided into at least two sections: Operations and Engineering, In that case 'Operation' includes production, distribution, quality control and maintenance. Often these activities are organised in separate sections with their own responsibilities and competencies.

Equally as important as a good organization is the availability of highly qualified and motivated personnel. The number of employees of different levels of education must be well-balanced.
One of the major problems is that in some developing countries, the institutional environment of the water sector is unable to attract suitably qualified personnel.

Most O&M functions are generally carried out by in-house employees, particularly in the case of operational requirements. Certain maintenance activities are sometimes contracted out to third parties. But the main consideration in the choice between internal and external maintenance must always be the aim of continuity and quality of the water supply service. It is a situation where the cheapest is not always the best, nor the most economic in the longer term.

Reliability

In order to comply with requirements, a water supply system must be reliable from source to consumer. Only than can management satisfactorily meet its obligations, and this is one of its most important responsibilities.
The correct assessment of 'reliable' will depend on the management policy of the water supply undertaking involved and will substantially determine the level of reliability required.
The more consumers depend on the reliability of parts of a system, the higher the degree of reliability needed for those parts. The acceptable degree of reliability decreases from source to tap.
Design-out maintenance programmes for improvement of reliability and maintainability of installations gain importance to-day. Figure 2 reviews the factors which can be studied in such programmes where the human factor receives increasingly primary attention.
This growing attention for the contribution and interaction of the human factor forms one of the main challenges for industrial engineering in the 90's.

Water quality control and laboratory

Water quality monitoring is a comprehensive and vital element in operation. Surface water supplied by means of extensive distribution networks demands that numerous samples are taken and that a wide range of parameters are monitored. Chemical, bacteriological and biological testing must be widely executed. Water quality can easily deteriorate in a distribution system and systematic testing is essential if the most important aim of bacteriological reliability of water supply is to be safeguarded.

Water quality investigation needs fully equipped laboratory resources and qualified personnel. Normally water supply companies maintain their own laboratory services, though some are shared with other utilities. It is important that water quality monitoring is organised on an independent managerial basis so that its objectivity is absolute in assessing the needs and requirements for the protection of consumers.

Rehabilitation

The deterioration of valuable physical assets is a major loss to national economies which should be avoided and although most external support agencies do not fund operation and maintenance, rehabilitation projects have become an increasing part of many country support programs.

Rehabilitation is the extreme form of operation and maintenance which would not have been required, or would have been postponed if regular maintenance had taken place.

Maintenance and repair of systems can prolong their operational life but only for a finite period. Ultimately the cost of maintenance will become uneconomic because of frequency of faults, and replacement will be necessary. This cost evaluation is important, but the most efficient and planned maintenance and replacement policies which keep systems in working order over extended periods, should not preclude, if appropriate, the replacement of a system that has become dilapidated, though still functional.

This radical assessment needs to be made periodically, for in many cases the practical and technically functional span of a system exceeds its economic relevance, this happens particularly where maintenance has been carried out diligently and correctly. Systems may become obsolete earlier than expected because of quality requirements or reliability needs, and management must always be sensitive to the balance between technical and economic consideration.

Preventive Maintenance

It is self evident that maintenance involves much more than merely making emergency repairs in the event of faults or malfunctions. Systems and installations will only perform reliably and consistently when preventive maintenance is carried out regularly.

Preventive maintenance involves carrying out a programme of work according to a predetermined schedule for each section of the water supply system, and on a regular calendar basis. The design of an effective maintenance schedule requires experience and practical expertise. This means that the practical operators of the system should have a considered input into, and influence on, the design of a schedule and on its re-assessment; it should not be static, but must be varied with experience, being tested regularly against practical circumstances. For this reason it is impractical to provide standard set rules in perpetuity.
Naturally the directions for maintenance provided by the suppliers of systems components, for instance mechanical and electrical equipment, will be incorporated in any maintenance schedule. However, even these need to be tested in practice and consequently the schedule must be dynamic and flexible.

The important criteria for evaluation of any schedule are the level and number of faults in production and distribution. This requires accurate recording and analysis of malfunctions; no more so than in the cage of technically complex and sensitive purification systems with a multiplicity of components and extensive metering devices which are prone to operational defect.

Preventive maintenance to achieve optimum operational efficiency of an installation is a precondition for success.

Materials Supply

Without a planned and comprehensive supply of the required spare parts and repair sets, effective, timely and technically correct maintenance is not possible. The quantity of spare parts available for each of the countless technical components which are part of the water supply system must be assessed so that: (1) they are always available at the time they are needed; (2) inventories are kept at a sensibly larger level than immediately required.

The inventory of spare parts should be determined by the frequency of the occurring malfunctions of a component and the delivery period of spare parts. Excessive stock occupies space and is expensive. It goes without saying that not only quantities must be assessed correctly, but that the quality of spare parts also demands close attention.
Spare parts and repair sets can be stocked either centrally or strategically, or in a combination of the two. This must depend on the size and the organization of the water supply company. With large companies, the purchase of materials, and stock management, are often the responsibility of a separate section within the organization, to achieve proper economics of scale in purchasing.

An important aspect of materials supply is standardization. The number of spare parts can be reduced substantially when less dissimilar components of the water supply system are chosen. Standardization is most effective when applied to components of the distribution network, which are large in quantity : pipes, water-meters, valves, stand-pipes. Standardization of system components means reducing costs, higher quality of service, and increased reliability. Material and spare parts management is therefore a specific and important activity in operation.

Standardization of technologies and local production of quality spare parts in LDCs should be pursued to attain sustainability in general, and in particular in water supply and sanitation.

Costs

It is technically impossible to achieve 100% reliability even if finance were no object; however, inevitably finance is always a factor to take into account. As in most management decisions, technical standards are important but are invariably influenced by financial considerations. Management has the responsibility to operate a company with financial prudence, no matter whether it be public or private. Water tariffs must be accepted as reasonable and fair by consumers, but set at a level to enable management to operate effectively and plan for long-term investment.

The desired degree of reliability largely influences how operation and maintenance are executed. The higher the standard, the more money must be spent on design as well as operation and maintenance. Total investment costs and the costs of operation must be optimised in conjunction. Economy in maintenance generally results in higher costs of operation ultimately. Equally, sound design can substantially reduce maintenance costs.

A widespread practice that is becoming increasingly unsatisfactory in LDCs is that of calculating the cost of O&M as a percentage of the total investment made, which often leads to misleading conclusions. More realistic calculations of the cost of O&M need to take into consideration the availability of skilled personnel, the expected frequency of breakdown over the life-span of the plant, the availability of spare parts, the source of required manufactured goods, the presence and reliability of local agents, and, important, the ability to purchase materials and goods in foreign currency and the adequacy of the procedures involved. (Dabbagh, 1991)

Financial policy should take into account that initially new systems may cost more to operate because of starting-up problems. These exceptional costs should be included as part of capital installation expenditure. Once established, the operating costs of new systems should decrease with experience. They will however, start to rise again with the age of the plant and resulting need for increased levels of maintenance

To implement O&M with a lasting success, it is very important that the financial part of O&M is clearly established including all items of operations involved. For every new year a new budget has to be established, adapted to the varying needs, special planned repair and renewal works. This yearly budget has to be presented, together with a position paper, to the decision maker, either political or technical, or both. It has to be presented early enough, so that there is plenty of time to discuss it and to get it approved. It has to be made clear that O&M has the highest priority.

3. Towards a new philosophy and approach

Inadequate operation and maintenance has been a major factor in the lack of sustainability of past WSS systems. Correcting O&M shortcomings will be a crucial part of future strategies to ensure longterm sustainable water supply and sanitation.

Experience shows that institutional weaknesses and malfunctions are a major cause of ineffective and unsustainable water services. This requires urgent attention to building institutional capacity at all levels. Pressure for improved local delivery of water services suggests that development of institutional capacity be more demand-responsive. Also, the need to better manage overall water resources coherently and facilitate allocation of water among all users suggests an expansion of national, integrated planning. The critical new institutional challenge is to become much better in developing policies, rules, organisations and management

skills to address both needs simultaneously without constraining the major aims of each. (The Delft Declaration, 1991)

In order to improve operation and maintenance a number of fundamental changes must take place in the agencies responsible for providing these services. First, water and sanitation agencies should change their orientation and begin to perceive of their primary role as the provider of a service to people and not the constructor of physical works. Second, the agencies themselves, which could range from a public utility to a community group, should become autonomous in efficient management and financing of the services. Third, these agencies should provide integrated water and sanitation services only in response to the effective demand of the consumer. That is, the level of services for which the consumer is willing to pay for in order to ensure good public health and environmental standards for the community.
In order to ensure the long term sustainability of water and sanitation services an awareness should be created which recognizes that maintenance is an essential component of successful development and resource utilization. Furthermore, the above principles should be embodied in the projects, policies and practices of the agencies responsible for providing water and sanitation, and the external support agencies who assist them.

The complexity of arrangements and great number of activities involved in the formulation and implementation of Operation and Maintenance programmes requires very well concerted efforts amongst the involved organizations at the country and international levels.

The importance of adequate operation and maintenance in order to ensure the sustainability of water and sanitation systems was increasingly recognized by external support agencies (ESA's) and stressed in a series of major consultations of ESA's which began with the Asian Regional Consultation in Manila in 1985. This meeting concluded that "while analysis has shown improvement between 1980 and 1984 in the percentage of people having access to safe water supply and sanitation, the functioning of water supply and sanitation systems was often disrupted by inadequate operation and maintenance."

Succeeding consultations - the African Regional Consultation in Abidjan in November 1986, the Interlaken meeting of 1987, the first collaborative council meeting in The Hague in 1988 and the Asia Regional Consultation in Manila in June 1990, stressed the need for operation and maintenance. A preoccupation at the Global Consultation in New Delhi in September 1990 was a concern with sustainability and this consultation reaffirmed and focused on the need to ensure the long term operation and maintenance of water supply and sanitation facilities.

A *working group on operation and maintenance* of water supply and sanitation systems was established by the World Health Organization (WHO) in 1990, on an ad hoc basis, as a result of the above deliberations involving ESA's (bilateral donors and NGO's) and representatives of selected water and sanitation agencies and organizations.

The working group was endorsed by the WS&S Collaborative Council (WSSCC) at its meeting on 20 September 1991 during the Global Forum conference in Oslo (Norway) and received the Council authority to initiate activities in line with their terms of reference.

The objective of the working group is to assist the WSSCC in the preparation of guidelines and promotional messages which will help developing countries to improve the effectiveness of operation and maintenance in both urban and rural WS&S programmes.

Four major principles for operation and maintenance were adopted by the working group which may be summarized as follows :

1. The provision of water is recognized as a service which requires a service orientated attitude by the agencies involved. To ensure long term sustainability, water should be managed as a commodity in the same way as any other resource. Its use and exploitation should be on a financially sound and cost effective basis subject to the same legal and

regulatory controls as other resources to ensure its conservation, protection and wise use.

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

3. Water systems should be managed and operated following the principles of good business practices. The form of management will vary depending on the local situation: i.e. rural, urban, peri-urban, location, demographic structures etc. The responsible agency will be autonomous from government but manage the system under technical, financial and administrative guide-lines set by national governments.

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

Four sets of priority activities were proposed in order to improve the performance of operation and maintenance :

1. To contribute to the creation of a favourable policy environment in participating countries, as well as the overall enabling legal and regulatory framework which is a major determinant of institutional performance;
   The policy of authorities responsible for drinking water supply should aim at creating circumstances which are conductive to the development of efficient operation and maintenance.

2. To enhance the profile of operation and maintenance at global and national levels : promotion of an awareness raising campaign and promotion of a higher profile for operation and maintenance to professional associations, training establishments and other organizations through guide-lines, workshops, seminars and conferences;

3. To improve management and to support the strengthening of agencies to enhance their ability to sustain adequate operation and maintenance activities; the basic objective is to improve the quality of decision making and of managerial performance by strengthening institutions at all levels and the creation of a favourable policy environment.

4. To implement monitoring systems for operation and maintenance costs and performance at the national level, and to develop international methodologies for the establishment of O&M performance indicators, as tools for O&M assessment in order to allow a rapid comparative analysis, and the definition of constraints and needs; to improve data collection and monitoring of operation and maintenance.

Five priority proposals were developed to translate the activities suggested by the working group into concrete actions. These were :

- Preparation of a global position paper on operation and maintenance;
- Assessment of operational and maintenance status of water supply and sanitation systems;
- Assessment of needs and resources, for training and human resources development in operation and maintenance;
- Development of implementation strategies for operation and maintenance in rural and urban water programmes;
- Development of guide-lines for improving operation and maintenance in the water supply and sanitation sector.

These proposals when implemented, will provide valuable basic data which will assist external support agencies and national governments to better plan their operation and maintenance programmes. They will also contribute to raising the level of awareness of sector professionals and agencies as to the urgent need to improve operation and maintenance performance.

4. Conclusions

4.1. There is widespread evidence that though Operation and Maintenance is generally recognized as one of the major constraints for sector development, inadequate support has been provided to water agencies for improvements in this field during the past decade.
Achievement of improved O&M of WS&S systems has been discouragingly slow, and as a result, levels of service are lower than planned and not continuous.

A concerted action among all parties involved is urgently required to improve operation and maintenance as quickly as possible. If such action is not taken, the benefits of improved water supply and sanitation systems will be progressively lost in spite of reported successes in extending coverage and creating more access to improved water and sanitation services in rural, urban and peri-urban areas.

4.2. The provision of water is a service which requires a service orientated attitude by the agencies involved. To ensure long term sustainability, water should be managed as a commodity in the same way as any other resource. Its use and exploitation should be on a financially sound and cost effective basis subject to the same legal and regulatory controls as other resources to ensure its conservation, protection and wise use.
Water systems should be managed and operated following the principles of good business practices, based on the principle of effective demand which can be defined as the standard of service that the users are willing to maintain, operate and finance to ensure adequate public health standards.

4.3. The policy of authorities responsible for drinking water supply should aim at creating an enabling environment and circumstances which are conductive to the development of efficient operation and maintenance. The policy and strategy of all bodies involved in protecting drinking water supply and sanitation projects will need to concentrate increasingly on the importance of that aspect, as much as on the system itself. Decision makers and managers will have to recognise the adverse effects of inefficient operation and maintenance.

4.4. Operation and Maintenance is frequently undertaken at the project level on an ad hoc basis. It is rarely implemented with any lasting success and there are many associated problems and constraints. There is a clear need for a number of actions to be taken in an effort to improve the situation. The implementation of these actions will be facilitated if a participatory approach involving developing countries and external support agencies is adopted.

4.5. More than in any other industry, a WS&S undertaking has to give service to the people in the literal sense of the word. In this respect service from a water supply company means a continuous sustainable supply of drinking water in sufficient quantity, of safe quality and at reasonable cost. To meet those targets, four basic requirements are necessary :

1. appropriate design of the water supply system;
2. optimised operation of the system;

3. intensive maintenance of the system;
4. qualified human resources to manage the system.

None of these conditions is less important than the others. A water supply system although designed with the utmost care, but ineffectively operated or insufficiently maintained, will fail sooner or later.

4.6. It is important for the success of any policy that the best available technology is selected, being the most appropriate to prevailing local conditions and to the task that it has to perform. This requires consultation at community level and between managers of technical and financial disciplines, and also those who will have responsibility for operating the system. It means being able to consider all available alternatives, and not being restricted to any particular recommended solution.

4.7. A most influential factor however in O&M and other management improvements is, and will remain, finance. Equally, good operation and maintenance protects investment and encourages better return on that investment through greater efficiency. The two must be considered inseparable. New investments do not seem justified if the operation and maintenance issue is not dealt with and if the sustainability of existing systems is not guarantied before investing in and constructing new systems which in their turn will rapidly deteriorate.
The development of capacity will not be possible without sound financial policy and management. Such development on an institutional scale thus depends on these three spheres - human, technical and financial - being treated with equal emphasis and priority.

4.8. Operation and maintenance are continuous activities which need qualified personnel and special and everlasting attention of the management. The question of O&M should thus not be seen or perceived as a technical/financial problem only, but its human dimension must be considered if sustainable solutions are to be found.
Information, education and communication (IEC) should be utilized at all levels to enhance the profile of O&M both within and outside the sector.

4.9. Principal management strategy should adopt the complementary aims of improving and more efficiently utilising existing facilities and resources including manpower, and where necessary, expanding services and systems to improve inadequately served areas and to bring supplies to new ones. These aims demand the interaction of a wide range of individual management responsibilities and technical skills, since none in isolation can achieve significant improvement.

4.10. O&M should be established as a management function in its own right and O&M practice must be systematically developed one step at a time. Nevertheless it should be an integral part of the overall management strategy of the water undertaking, complementing other management responsibilities. Its function is to contribute to the effective and economic management of the organization with the result of providing a safe consistent water supply service at the most economic price, to as many consumers as possible.
The practical operation of maintaining service, monitoring standards, and providing water at consistent levels is greatly facilitated by regular and planned maintenance. The level and degree of this maintenance, the policy of replacement of new parts, the assessment of when the cost of maintenance reaches uneconomic levels compared with replacement expenditure, are management decisions requiring experience and technical knowledge.

4.11. O&M of WS&S systems is a complex issue with linkages and interrelationships to water resources, environmental sanitation and the environment in general. Management strategy should take into account these growing environmental considerations which are becoming increasingly important world-wide. Designs should be chosen which minimise waste and are most economic in the use of chemicals whose disposal could affect the environment.
In the context of broad environmental management there is little doubt that the future will require an integrated management approach embracing the problems of water supply, sewage disposal and sanitation, and solid waste disposal. This is inevitable if the problems of pollution are to be contained and the world is to enjoy a more wholesome living environment.

4.12. Finally, O&M programmes are clearly part of an institutional development process. O&M programmes cannot be implemented in isolation, without the perspective of a long-term development programme.

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Nomenclature

ESA :	External Support Agency
IEC :	Information, Education and Communication
IWSA :	International Water Supply Association
LDC :	Less Developed Country
NGO :	Non-Governmental Organization
O&M :	Operation & Maintenance
UNDP :	United Nations Development Programme
WHO :	World Health Organization
WS&S :	Water Supply & Sanitation
WSSCC :	Water Supply & Sanitation Collaborative Council

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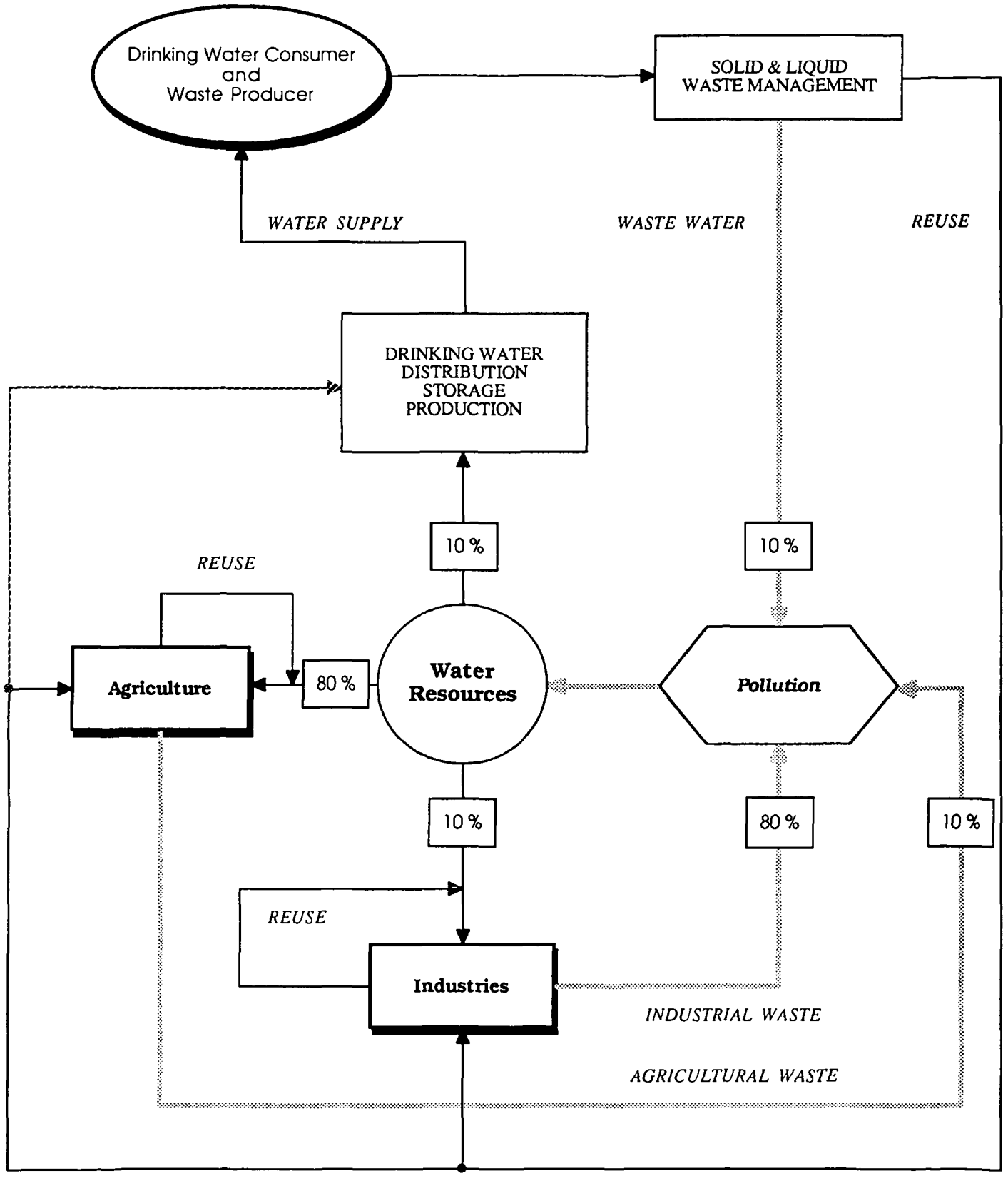

Figure 1 : O&M Activities and Water Quality (adapted from WHO, 1990)

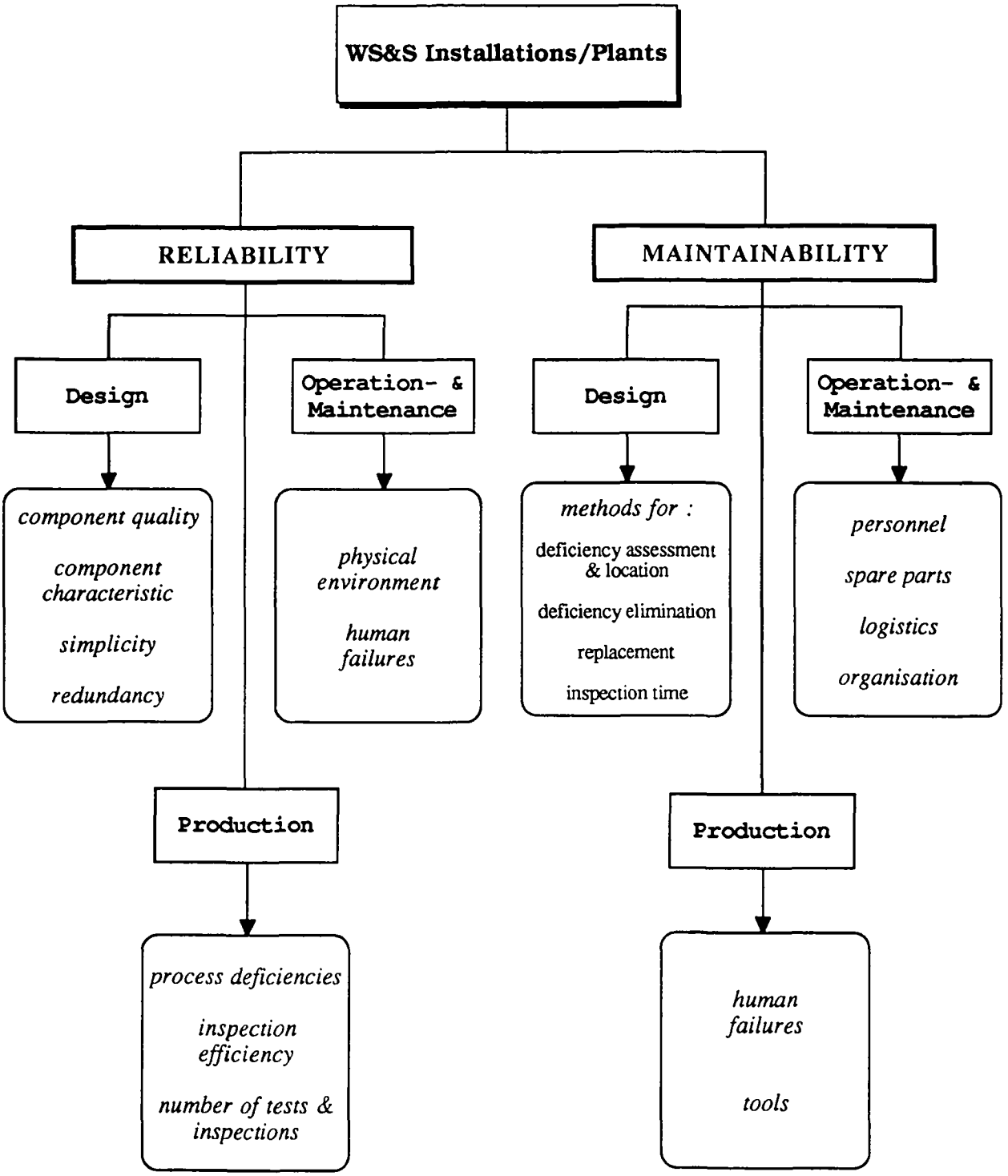

Figure 2 : Items for improvement of maintainability and reliability of installations (after Pintelon and Gelders, 1991)