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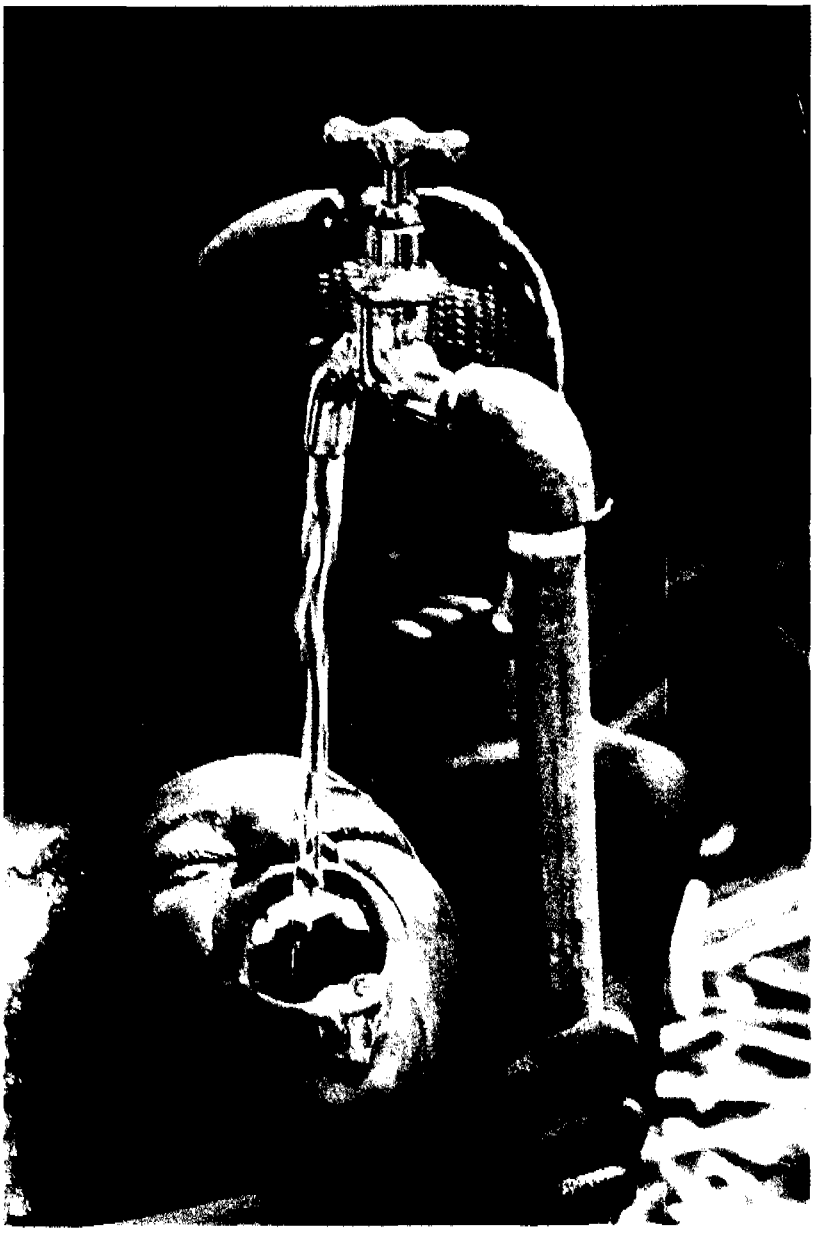
Urban Water Demand Management

— sustainable approaches for developing countries



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WELL STUDIES IN WATER, SANITATION AND ENVIRONMENTAL HEALTH

Urban Water Demand Management

Sustainable approaches for low income countries

WELL Task 349
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Executive summary

Urban water demand management (UWDM) provides a practical strategy for addressing the efficient and equitable use of water. This has the potential to improve water management and delay significantly the need for large investments in new water supplies for towns and cities. However, it is important to set this within the national context of water use. In developing countries, irrigation typically consumes over 80 per cent of the total volume of water used. Whilst managing domestic water demand is important, it is unrealistic to expect it to solve national water resource problems. This requires water reallocation issues to be addressed, particularly in relation to irrigation. Although critically important, these issues remain difficult to resolve and are not within the scope of this report.

In order to implement UWDM, supporting policy and regulatory frameworks need to be in place. An important constraint may be institutional weakness: where local water utilities lack the necessary capacity, autonomy and customer focus, local capacity building is likely to be essential.

UWDM measures have significant potential to impact upon the urban poor, including:

- measures to reduce the amount of water used by existing consumers, creating opportunities to target the saved resources on the poor;
- measures to improve the operational and financial performance of utilities and municipalities, creating the means to invest in extending networks into hitherto unserviced areas;
- institutional reform measures, leading to inclusive, participatory and demand responsive approaches to water supply planning.

UWDM requires a significant degree of political and public support to be effective and sustainable. For UWDM to have a positive impact on poverty, it must be associated with a commitment to invest saved resources in improving access to safe water for the poor.

More generally, consumers need incentives to conserve water; these can include *inter alia:* financial, where the motivation is to reduce a water bill; legal, through enforcement of local by-laws; and social, through a desire to protect the environment or share water more equitably.

Specific UWDM measures include:

- the setting of appropriate tariffs which take into account the needs and willingness to pay of the poor;
- metering and improved revenue collection;
- the formation of water user associations to represent and reflect the demands of local people;
- the development of public awareness raising and education campaigns;
- reducing unaccounted for water including leakage;
- the introduction of water saving devices; and
- water reuse and wastewater minimisation.

These UWDM measures need to be appraised in the local context; it is necessary to define the scope of problem and to forecast the likely future demand. There are then several criteria which can be used to assess the appropriateness of each measure, including:

- estimation of the benefits in terms of the contribution made to meeting the predicted water deficit;
- calculation of the financial and economic costs;
- assessing the impact on the poor;
- the timeframe for realisation of the benefits;
- risk assessment and sensitivity analysis of the outcome to different risks;
- public acceptability and support; and
- political commitment to the measures.

Guidelines for designing UWDM programmes and prioritising UWDM measures are based on the ranking of a number of proposals according to their average incremental cost. These options can then be applied in parallel, up to the point where the either the water savings yielded by UWDM balance the projected demand over the required time period, or a point is reached where there is a need to develop new sources.

List of acronyms

ADB	Asian Development Bank
AISC	Average incremental social cost
AWWA	American Water Works Association
BSRIA	Building Services Research and Information Association
CVM	Contingent valuation methodology
DWAF	Department for Water Affairs and Forestry (South Africa)
IUCN-ROSA	International Union for the Conservation of Nature - Regional Office Southern Africa
IWA	International Water Association
MAWAC	Managing Water for African Cities
NPV	Net present value
NRA	National Rivers Authority (England & Wales)
UWDM	Urban Water Demand Management
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNHCS	United Nations Centre for Human Settlements (Habitat)
UKWIR	United Kingdom Water Industry Research
WACNET	Water for African Cities Network
WDM&C	Water and Demand Management Working Group
WDMRN	Water Demand Management Research Centre
WSSCC	Water Supply and Sanitation Collaborative Council
WEDC	Water, Engineering and Development Centre
WSA	Water Services Act (South Africa)
WTP	Willingness to pay

Table of Contents

List of boxes, tables and figures

1. Introduction

Many urban areas in developing countries are suffering from acute water shortages. The combined effects of population growth, migration and urbanisation present serious challenges to maintaining current levels of service. This has a particularly adverse impact on the urban poor. Urban water demand management (UWDM) offers the potential to improve this situation significantly and is likely to become an increasingly important component of policies to combat water shortages in urban areas.

1.1 Urban water demand management definitions and objectives

UWDM is a practical strategy that improves the equitable, efficient and sustainable use of water resources in urban areas[1]. Specific objectives include:

- treating water as both an economic and a social good which should be managed and priced accordingly;
- stressing the *equitable use* of water, hence the need for UWDM strategies to be designed to improve the provision of water to the poor;
- emphasising the *efficient and sustainable use* of water by balancing the management of losses, consumption, and new or augmented supplies with the needs of the environment; and
- managing a fundamental shift from a supply driven organisational culture towards one that can implement locally focused, demand responsive solutions.

1.2 A rationale for UWDM

There are several incentives to implement UWDM.

- Access to safe water and sanitation for all is considered to be fundamental to the exercise of human rights. UWDM provides significant opportunities to improve the equity of access to safe water for the poor.
- It is increasingly clear that consumption of water is outstripping supply. The impact of water shortages is often felt most directly by the urban poor, both in terms of their livelihoods and their wellbeing.
- The importance of the contribution made by the poor to urban economies is now being recognised. In many cases, the poor make up the majority of the urban population and are responsible for a significant proportion of the economic production of the city. This economic contribution should be supported through provision of resources such as water.
- There is an urgent need to address widespread, preventable disease, resulting from intermittent water supplies, poor water quality, a deteriorating physical environment and inadequate sanitation, all of which particularly impact on the poor.
- Governments are less able and less willing to raise funds for investment or to subsidize the operations of water utilities and departments. This requires that the more efficient use of resources implicit in UWDM needs to be promoted.
- It has been shown that the poor are willing to pay for a reliable service that meets their needs (Whittington and Davis, 1998), which is contrary to beliefs of many officials. Serving the poor need not impose a major financial burden on the rest of the urban population.

[1] Adapted from IUCN-ROSA ,1999.

- With relatively small investments, industries can make significant savings by reducing consumption, recycling and reducing waste, thereby giving them a competitive advantage.

Experience shows that an effective UWDM strategy can reduce the consumption of water by domestic users by 20 - 30 per cent, and substantially more for industrial users (Bhatia, 1995). Ageing urban water distribution systems are likely to lose over 50% of treated water due to leakage. The water saved can be reallocated to unserviced areas and/or defer the need for large-scale investment in supply augmentation by several years.

1.3 Poverty issues

The key poverty issue is to ensure that the poor benefit through reallocation of some of the water saved by UWDM programmes. This requires political and administrative commitment to improve existing levels of service and to extend the water supply into hitherto unserviced areas.

1.4 Wider context of water use: irrigation, industry and domestic

It is important to appreciate the overall picture of water use, where irrigation accounts for 69 per cent of global water use and often much more in developing countries. Small increases in irrigation efficiency would release significant quantities of water for higher value uses. Of the remainder, industry often uses two to three times as much as that used by domestic users (UNEP/UNHCS 1999). Whilst managing domestic water demand is important, it is unrealistic to expect it to solve national water resource problems. This requires water reallocation issues to be addressed, particularly in relation to irrigation; although critically important, these issues remain difficult to resolve. Limited action may be possible through UWDM where food is grown locally and irrigation occurs within the urban boundary. UWDM can help address local water resource problems, where the restrictions are due to lack of infrastructure rather than limited water supplies.

1.5 Structure of this report

This report is divided into seven sections. This introduction considers definitions and the potential scope of UWDM. Section 2 considers the political support and institutional framework that are critically important for UWDM. Section 3 describes the main approaches to UWDM, covering: equity; policy, legislation and regulation; tariffs and cost recovery; water user associations; public awareness and user participation; reduction of unaccounted for water; water saving devices and practices and water management. Section 4 provides guidance on assessment of different approaches within the context of developing countries. Section 5 provides guidance on the practical implementation of an UWDM programme. Conclusions are presented in Section 6. Section 7 lists organisations offering technical support and additional sources of information.

2. Wider institutional issues

2.1 Political support

The underlying theme of UWDM is the change from supply driven to demand based approaches for the provision of services. This is a fundamental change to the whole operating culture of traditional government agencies. UWDM also seeks to influence consumption and the popular perception of water; in this respect it is fundamentally user-centred. Such changes of attitude and culture cannot be achieved solely by procedural and administrative reform; it requires high level advocacy and long-term political support at the national and local levels. Also, UWDM policies (for example concerning tariff setting) may require changes to the law in order to authorise their implementation.

Political champions of the UWDM approach are therefore very important from the outset, both to help secure popular support and to steer it through any number of institutional barriers that may delay its adoption or reduce its effectiveness. This support is particularly important to reduce interference with what may be perceived to be unpopular measures, such as tariff increases.

2.2 Institutional framework

Certain institutional weaknesses can seriously undermine the development and implementation of UWDM strategies.

- The fragmented and overlapping jurisdictions of institutions associated with water provision can result in conflicting policies. A review of the institutions involved in the provision of water and wastewater services may be necessary at national, regional and local level (World Bank, 1993). Co-ordinating mechanisms are required to define responsibilities, resolve disputes and ensure policies are mutually supportive.
- The lack of commercial autonomy and customer focus of many public service providers prevents them attracting and retaining good quality staff, setting and adjusting tariffs, gaining public support and ensuring that their organisational structure is able to undertake UWDM; Box 1 gives an example of this.
- The participation of users is notably absent from most planning processes. This aspect of institutional management, which applies in particular to the poor, is covered in more detail in Section 3. For more information on institutional development, see WELL (1999).

Box 1. External assessment of a local water authority in Tanzania

A recent external assessment of a town water authority in Tanzania identified institutional weaknesses in the capacity of the town's water service provider to undertake UWDM. These included its non-commercial status, an inability to set and adjust tariffs and a lack of financial autonomy. The water service provider was dependent on Government to pay electricity bills and staff salaries. This acted as a strong disincentive to implement UWDM. The following recommendations were made in relation to the capacity of the water service provider to undertake UWDM:

- Clarify the mission statement to summarize its aims and aspirations related to the new commercial and customer-orientated approach.
- Appoint a personnel manager to introduce a staff development system.
- Develop a management information system that promotes the use of initiative and accountability in planning and decision making.
- Review manpower needs.
- Recover outstanding debts from water kiosk agents and institutional customers, taking legal measures if needed. Poor debt recovery was retarding the commercial culture of the authority.
- Assign an engineer and the procurement /stores unit head to produce a complete and realistic costed inventory of all tools and equipment which are urgently required in order for the authority's objectives to be met.
- Quantify the extent of leakage from pipelines to show the degree of the problem. The authority could hire a short-term specialist to carry out this assignment if it does not presently have such capacity.

Oxfam, 1998.

3. Approaches to UWDM

This section describes different approaches for UWDM in developing countries. Note that any strategy for UWDM will involve combining a number of these approaches according to local circumstances; guidance is given in Sections 4 and 5.

3.1 Equitable access for the urban poor

One of the principal aims of UWDM is to promote the equitable use of water, given that many urban poor people do not have access to city supply networks. Different approaches to demand management vary in terms of creating opportunities for improving access to water and the impact this has on the poor. These approaches can be grouped as follows:

- measures to reduce the amount of water used by existing consumers linked to the formal city infrastructure networks, and lost by leakage, thus creating opportunities to target the saved resources towards the poor;
- measures to improve the financial performance of utilities and municipalities, creating the means to invest in extending networks into hitherto unserviced areas; and
- institutional reform measures that recognise the contribution of the poor to the economic and social fabric of urban areas and can reflect their needs and aspirations through a more inclusive and participatory approach to water supply planning.

Table 1 gives a general indication of how the different approaches considered in this section are likely to impact on the three key measures above.

Table 1. UWDM approaches and likely impact on the poor

Approaches described in Section 3	**Key measures**		
	Reduce consumption / leakage	**Improve financial performance**	**Institutional reform measures**
Policy & legislation		X	X
Tariffs, metering & revenue	X	X	
Water user associations			X
Public awareness & user participation	X	X	X
Reducing UFW	X	X	
Low use appliances & promoting efficient use	X		
Water management skills	X	X	X

UWDM creates opportunities by freeing up resources. This has to be supported by a strong political and administrative commitment to increase the customer base by improving and extending services to the poor.

3.2 National and municipal policy, legislation and regulation

UWDM requires institutions to move away from unsustainable supply side solutions to those that include conservation and the management of demand. This requires both national and local policy support.

3.2.1 Policy

Four key areas of policy are relevant to UWDM strategies.

1. Commitment to organisational autonomy

It is important that authority is delegated to the lowest appropriate level. Moves towards greater decentralisation of responsibility are therefore important national policy goals. This translates into a number of relevant actions at national level that can help create the appropriate environment for UWDM programmes. These include the following.

- The authority to set and adjust tariffs; this requires knowledge of the users' demand for water (often expressed as willingness to pay) and the costs that must be recovered.
- The authority to set by-laws relating to water use and pollution. By-laws must reflect national policy whilst being tailored to meet local needs. Provision for monitoring and enforcement must be built in to the system.
- The authority to adjust the organisational structure and operational budgets to best suit the adoption of an UWDM strategy. Frequently this is a problem, as non-commercial attitudes and supply driven practices are entrenched.
- The authority to contract private service providers to undertake specific tasks, such as standpipe management and water vending, leak repair and detection, and training.

2. Commitment to the management of abstraction and discharges

The control of abstraction and discharges is an essential part of water demand management. The associated legislation reflects society's view of water ownership. Where this is vested in the state, this provides an opportunity to introduce requirements that support UWDM policies being implemented at lower levels. Where it is politically difficult to introduce abstraction licences that control use, an alternative may be to register all existing abstractions to protect existing uses and associated water rights.

3. Commitment to effective participation.

There needs to be effective involvement of users in planning, implementing and monitoring a UWDM strategy. Processes should be transparent and accountable to avoid being dominated by one or more elites. Particular attention needs to be paid to marginalised groups, for example women headed households. Women are largely responsible for fetching, using and managing domestic water (in many cases paying for it on a day to day basis), as well as family hygiene and many of the surrounding health issues. Local water user associations may provide a useful way forward (see Section 3.4)

4. Commitment to charging for services.

Paying for water consumed is a fundamental principle of UWDM and there has been much debate around issues of the willingness of consumers to pay. There is a tacit assumption that the

problem lies with consumers. However, recent work from South Asia[2] has pointed out that there is little 'willingness to charge' on the part of many water service providers who are unwilling or unable to increase prices. Where charges are made, they seldom reflect the full cost of water services. There is an important political dimension to this as increasing charges is regarded as unpopular; this illustrates the need to ensure broad political and public support as an essential prerequisite to UWDM programmes.

3.2.2 Legislation

Policy is translated into action through legislation, which is often accompanied by guidelines to assist interpretation. This should clearly define institutional roles, responsibilities and authority. In some cases Government Orders may subsequently be issued to clarify operational issues. Legislation can provide the key incentives for change provided it is fully backed up with political support. For example, in South Africa, previously reluctant local councils are considering cost recovery policies for water supply. Individual councillors are to be held personally liable (and even taken to court) if this is not done. An example of recent legislation that makes specific requirements relating to demand management is the Water Services Act in South Africa.

Box 2. Water Services Act (107, 1997) of South Africa

The objective of South Africa's Water Services Act (Act 107,1997) is to assist municipalities and regional local government in their function of water service provision to ensure effective, efficient and equitable access to water services.

The Water Services Act defines roles and responsibilities of water services institutions whilst allowing a number of delivery options:

- it requires the setting of national norms and standards for water services;
- it allows for tariff setting by water service providers appointed by local government;
- it defines the regulatory and intervention functions of municipalities, regional government and national government; and
- it requires that municipalities draw up and monitor water services development plans that specifically include details of existing water conservation, recycling and environmental protection measures.

One fundamental issue still to be resolved is how the existing national standards for water supply, which define a minimum level of service, can coexist with municipal and local government requirements for ensuring adequate cost recovery and for identifying cost effective alternatives.

3.2.3 Regulation of water services

Regulation provides a mechanism for exercising control by an independent public authority within the established legal framework. Experience from developing and developed countries has shown that, in order to be effective, the functions of regulation and service provision should be separated (WELL, 1999).

[2] A recent UNDP field note identified unwillingness to charge for water as a major issue affecting the sustainability of several urban water supplies (UNDP, 1999)

In terms of UWDM, regulation is needed to protect both the rights of all water users and the environment. The following major issues should be addressed:

- overall institutional behaviour including accountability and transparency;
- influencing minimum service standards including reliability of the supply;
- influencing tariff levels and increases;
- ensuring equity through service provision for the urban poor;
- influencing building codes and water efficiency specifications that promote water conservation;
- targets for unaccounted for water, including leakage;
- environmental standards including those concerning abstraction and the discharge of effluents; and
- incentives for compliance and penalties for non-compliance.

Box 3 gives an example that protects the rights of the user and the environment.

Box 3. Example of an independent regulator: La Paz – El Alto Concession

The La Paz - El Alto concession is regulated by a relatively independent national organisation, *Superindendencia de Aguas* (SUA), established in 1994. The regulator monitors and enforces compliance with the concession contract, including obligations in regard to quality and expansion of the supply to marginal areas. SUA also must approve all tariff revisions over the life of the contract, which also sets maximum connection fees.

In this case, the regulations prohibit the resale of water by connected households and allow the concessionaire to charge a fee for private groundwater abstraction. The contract also requires that standpipes are removed. Restricting the options for some households is likely to do more harm that good, especially in *areas no servidas*, where the concessionaire is not obliged to provide in house connections in the near future.

Source: Komives and Cowen, 1997

There are a number of constraints to effective regulation which need to be overcome; for example:

- pressure from politicians trying to realise short term political objectives, which may be incompatible with the longer term strategies for UWDM such as tariff raising;
- shortages of experienced staff to carry out the regulatory role effectively; and
- pressure from utilities to relax standards as a means of putting off investment .

The need for effective, independent regulation to protect both public interests and those of the environment is especially important when either the private sector is involved or when authority is being decentralised to local government. The complexity of regulation should not be underestimated. To take the extreme case of the UK, which opted for complete divestment of

assets as its privatisation model, it has taken almost 15 years for the regulatory system to fully develop to its current state.

3.3 Tariffs, metering and revenue collection

3.3.1 Tariffs

Setting appropriate tariffs is one of the most important elements of UWDM; there is strong evidence that increasing the price of water reduces the consumption. The price of water sold by many utilities is often considerably less than its true cost, measured in either financial or economic terms. The result is that those fortunate enough to be connected use more water than they otherwise would if they had to pay a higher and more realistic tariff, thereby depriving others who could benefit. Forced to buy water from vendors who may charge up to 20 times the utility tariff rate, the poor suffer most (World Bank, 1988). Meanwhile, the utility makes a financial loss and needs to be supported by government. If the government is unwilling or unable to pay, the result is a decline in the quality and reliability of water supplies

3.3.2 The economics of tariff setting

Setting the price of water to reflect its full cost gives the incentive to use water in the most efficient way for the economy (WELL, 1998, p101). The full cost is determined in economic rather than financial terms, as the latter do not take account of tax, subsidy arrangements and intangible costs and benefits to society, such as environmental impacts. The full cost of water has three components:

- long-run marginal cost, which includes capital costs, running costs and takes into account the costs of expanding the supply;
- external costs, which take into account the influence the provision of water services has on the environment, on public health (imposed on others) and on others who are 'upstream' or 'downstream'; and
- opportunity costs, which reflect the costs to the economy when water which is used in one way (for example irrigation), pre-empts its use for a higher value purpose elsewhere (for example, a certain industrial process).

3.3.3 Tariff structures

In urban areas, variations in service levels and types of consumers introduce new possibilities and complexities into cost recovery and the setting of tariffs (WELL, 1998, p113). Many customers are from 'middle' or 'high' income groups, or are commercial or industrial users of water who are usually able to pay the full cost of supply. Typically only a small proportion of the total costs are recovered and the utilities are financially very weak; in these circumstances the poor are unlikely to benefit because is difficult to finance extensions into unserviced areas. Clear objectives for cost recovery need to be set; tariff structures need to meet revenue objectives and provide an incentive for consumers to conserve water. This is a crucial part of any demand management strategy. The basis for tariff reform is complicated; it requires determination of consumers' willingness to pay coupled with analysis of the utility's financial costs and the economic costs of supplying water (WELL 1998).

3.3.4 Protection of the poor

Meeting poverty objectives within the context of improved cost recovery strategies for the utility needs careful consideration. It is important to remember that many poor people are not

connected to the city supply, but obtain their water from vendors or other sources which may be of poor quality and be unreliable. They may actually pay more per unit for water than do better off people who are connected to a system. Nevertheless it is important to consider the following issues when charging poor consumers:

- the poor should not have to spend so much on water that there is insufficient to spend on other basic needs such as food;
- tariff levels should not result in the poor leaving the market altogether and switching to a poorer quality, less reliable supply, which endangers their health;
- full account is taken of the gender sensitivity of water supply; men and women may have very different perceptions of water in terms of its value and their willingness to pay; both must be consulted in order to capture their demand for water;
- demand for water is highly dependent on how it is paid for; poor people may live day-to-day and budget accordingly; they may find it difficult to pay a monthly bill;
- poor people do not end up paying more than those who are better-off; and
- the timing of payment does not discriminate against the poor; the rich may pay monthly in arrears, obtaining credit, whilst the poor have to pay in advance if buying from water vendors or standpipes.

Options for the design of tariffs include:

- cross subsidies, where better-off users are charged more than it costs to supply them;
- 'rising block' tariffs which charge higher rates for large volume consumers;
- 'lifeline' tariffs which charge a low, flat rate tariff for poor consumers; and
- mechanisms to enable poor households to finance the cost of a connection

The following measures have proved effective in protecting the interests of the poor:

- ensuring that the poor are effectively represented in water user associations;
- prioritising the extension of the distribution system and facilitating the purchase of direct connections;
- establishing water user groups or facilitating NGOs to manage standpipe water supplies; and
- licensing water vendors to ensure that the poor are protected from poor water quality and the effects of rising block tariffs; problems arise if vendors buy in bulk at a high rate and sell small quantities (Collignon and Vezina, 2000).

3.3.5 Revenue collection

Metering and price setting policies are of little or no consequence if monies are not collected. This is a major problem for many service providers. An indicator of the problem is the value of *accounts receivables*, the money owed expressed as the equivalent number of months of sales. A value less than three months would suggest that the problem is manageable in the short term (ADB, 1997). Some examples are shown in Table 2.

Table 2. Accounts receivables from Asian cities

Municipality	Accounts receivables (months)
Mumbai	19.7
Karachi	16.8
Faisalabad	12.0
Shanghai	11.1
Dhaka	11
Chittagong	10

ADB, 1997

It is particularly important to target those government institutions which default on payment for the water they use, otherwise this sends the wrong messages to the general public who are being targeted by UWDM measures.

The following factors need to be taken into account to promote better revenue collection:

- the payment system has to be convenient for and understood by all users, who need to know how, where and when bills are to be paid;
- an agreed system to deal with non-payment of bills;
- user complaints and appeals are acknowledged and dealt with promptly;
- accounting systems and associated procedures are established to reduce the possibility of corruption and ensure transparency;
- maps and registers of all users are accurate and regularly updated; and
- targets for collection efficiency and accounts receivables are set and monitored.

It is important that revenue collection staff are trained to carry out their duties, that their area of responsibility is reasonable and well defined, and they get an adequate salary, possibly linked to their own performance. Revenue collection staff who regularly visit households may be able to promote the need for water conservation.

3.3.6 Meters and metering

The use of meters to measure water consumption and bill for its use is an integral part of many water pricing policies and UWDM strategies. An average reduction in consumption of 5 -15 per cent is not unusual[3]. Monitoring flows across a distribution network is also fundamental to managing unaccounted for water (see Section 3.5). There are a number of important points to be taken into account when planning to install meters.

- Grit, air, reverse flows, very low/very high flow rates all contribute to meter error which accumulates over time.
- Water meters need regular re-calibration and replacing after five to eight year's use. It is reported that in 1996 about 70 per cent of the domestic meters in Mumbai were non-functional; hence many users were billed on a flat rate (ADB, 1997). By comparison, in

[3] In the UK, the introduction of domestic metering resulted in household consumption of water falling by 6.7% (NRA 1995).

Singapore water meters are replaced every 5 years as a matter of policy and are field tested to ensure that they are accurate to 3 per cent (Ng et al, 1997).

- Errors can easily be made when reading a meter and recording the volume of water used.
- The replacement cost of a meter and the cost of reading can be included in the tariff.

Water meters may be a relatively expensive method of cost recovery for households that only use small quantities of water, or if there are relatively few house connections in a particular area.

The cost of meters adds to connection charges, making access to higher levels of service more difficult for the poor. This could be improved by providing access to finance based on an affordable deposit and repayment of a connection charge over an adequate period of time. Alternative options to metering may also be considered. Three innovative approaches to metering developed in South Africa are shown in Box 4.

Box 4. Alternative metering in South Africa

Prepayment systems

The development of electronic and mechanical prepayment systems in South Africa stemmed from the need to change the attitude of non-payment for services. A number of individual and community meter systems based on smart card technology have been developed. These can be programmed with a local tariff structure, and also give managers information about potential leaks and other problems. The latest meters developed include provision for lifeline tariffs, emergency credit and maximum daily credit as well as a rising block tariff.

In practice, the potential of the prepayment system has been undermined by insufficient attention given to operator training. More fundamentally, several communities were not adequately consulted before the systems were installed. In the township of Tamboville, adjacent to the town of Hermanus, the resulting resentment resulted in many meters being vandalised. Nevertheless, with the right level of support and proper consultation with users, prepayment systems have the capacity to significantly reduce administrative and billing costs.

Automated Billing

Consolidated African Technologies supply meter reading systems for individual household connections. The utility would not need to enter meter readings manually to produce bills. An optional add-on portable printer allows on the spot billing. The system is being tested.

Trickle feed drums

The trickle feed drum is a water-rationing device. The householder pays for what is in effect a daily allocation of water. The system is based on a 200l drum, inside which is installed a smaller feed tank. This is connected to the supply pipe and is fitted with a float valve. The flow of water from the feed tank into the drum is restricted by an orifice. The householder pays a flat rate depending on the size of the orifice. The system can be manufactured and maintained locally. Being trickle fed, it suits low-pressure systems, unlike many meters. The drum acts as a small reservoir, which attenuates peak factors. Disadvantages include a lack of flexibility (the householder cannot exceed the fixed amount he or she is rationed), the user is charged whether or not the allocation is used and the possibility of tampering.

DWAF, 1997 and Turton, 1999

3.4 Public participation

Whilst technological and financial improvements to systems can make a significant contribution to water demand management, these are of little value if they are rejected by people because they do not take user perceptions and demands into account, and are perceived as irrelevant or inappropriate. Most aspects of UWDM are people rather than technology focused, and necessarily require public participation.

Public participation is central to ensuring that the overall strategy, policies and individual measures are fully informed by people's perceptions, needs and capacities. This applies very much to the poor, who may easily be excluded from such a process. Many decisions concerning service levels, cost recovery and management systems can and should be made by informed users either individually or collectively, rather than by outsiders making assumptions on their behalf.

Effective public participation is therefore needed at different stages throughout the project cycle in order that:

- the approaches adopted are informed of peoples perceptions, needs and capacities and appropriate;
- people are able to make fully informed individual and collective decisions about the service they are to receive and how it is to be delivered;
- planners are able to draw on the capacity of people to contribute to a UWDM programme, in terms of developing appropriate strategies, policies and measures; their local implementation and financing; and monitoring and evaluating performance; and
- users are able to voice their opinions concerning the service they receive, and the utility is able to respond accordingly.

In practice, effective (rather than notional) participation may be difficult to achieve. This may be because there is no mechanism which ensures that all people can participate, individually or collectively, on an equitable basis. Sometimes one or more elites will attempt to dominate the process, underlining the need for transparency. Poor people may be unable or unwilling to participate in a consultative process, and service providers may be unwilling or lack the capacity to identify and establish a meaningful dialogue with people and the poor in particular. People may be reluctant to participate if they perceive that their participation will not lead to anything. Strategies must take into account such issues and overcome them.

Examples of individual and collective participation include the use of demand assessment techniques to establish user demands (preferences and willingness to pay); the creation of water user groups to develop and manage UWDM measures; and the establishment of feedback systems. These are outlined below.

3.4.1 Establishing user demands for services

Service options and tariffs should be informed by people's willingness to pay for a particular level of service. A variety of methods have been used to assess this (MacGranahan et al, 1997) including contingent valuation surveys and a variety of techniques based on group discussions.

Contingent valuation methodologies (CVM) have been used to inform policy on people's willingness to pay for a particular service level. It has been shown that assumptions about what people want and how much people are willing to pay are often wide of the mark. CVM attempts to establish people's preferences and how much they are willing to pay for them through household interview.

In order to do this, people must be presented with a number of service level options and are asked to state how much they would be willing to pay for each. Often this can take the form of a bidding game. A number of interview techniques are used to minimise the various biases that can easily influence results. Statistics are then applied to aggregate results and indicate inconsistencies.

A number of participative techniques focused on groups rather than individuals have also been applied to establish people's preferences. The water ladder, adapted from a PHAST[4] tool originally designed for rural sanitation projects, is one example. Different options and their characteristics are represented on cards. People are then facilitated to discuss these in terms of their perceived costs and benefits, before individual or collective preferences are indicated. The process can be extended to developing a participative action plan.

3.4.2 Water user associations

Water user associations are local level organisations that can take on a variety of roles ranging from representing users' interests to the water service provider, to the local management of a water supply. As such, they can play a key role in developing and implementing certain local components of a UWDM strategy. They are primarily regarded as a way of improving the voice of poor consumers.

Water user associations need legal recognition and authority that defines their function and safeguards their independence if they are to be effective. This is particularly relevant if they are seen as a vehicle for promoting the interests of the poor, many of whom may inhabit informal areas outside the jurisdiction of urban authorities. In practice, local NGOs can play an important facilitating role, forming a triangular partnership with the association and service provider.

Water user associations can take on a number of important roles in developing and implementing a UWDM strategy to promote improved equity as indicated below. This is likely to require investment in local capacity building and training. Roles include:

- Collecting information on the use of water and the demand for improved services, especially for poor people and women in particular. This in turn can be used to provide baseline data and identify impact indicators.
- Providing information to the public to both explain why UWDM is necessary and educate communities in order that any consultation can take place with informed participants.
- Developing plans for UWDM with the service provider, discussing these with members of the community and representing their views to the service provider.
- Monitoring the impact of UWDM measures in poor communities.

[4] PHAST: Participative Hygiene and Sanitation Transformation, is a generic technique of primarily graphical tools designed to facilitate collective learning and behavioural change. It was developed in the early 1990s by UNDP in East Africa.

- Managing aspects of local service provision; this can be direct (e.g. recovering costs at the point of delivery), or indirect (e.g. monitoring the sale of water by water vendors or the performance of staff employed by the service provider).
- Developing and implementing locally appropriate aspects of public awareness campaigns associated with UWDM.
- Protecting the rights of individual users (e.g. taking up complaints and related issues with the water service provider).

Whilst there are clear advantages to this approach, there are a number of generic issues relating to community based organisations in general which need careful attention when water user associations are established.

- Poor people, including not only the 'money poor' but people who are marginalised on ethnic, social or cultural grounds, may be effectively excluded from participating in a meeting or committee. In some cases, such groups may have to be identified and empowered in order that they feel confident to voice an opinion. It is also important that others feel that this opinion has value. Social empowerment has led to women being able to participate in taking decisions and formulating policy.
- Roles, responsibilities and authority, particularly in relationships with external organisations should be as simple as possible with clearly defined communication channels.
- Independence from political and commercial interests may be difficult to achieve.

Effective partnership with the water service provider needs to develop on the basis of mutual trust, understanding and respect. UWDM is above all user-centred and this must be reflected in the importance given to water user associations by service providers. This relates back to the problem that the organisational culture in many service providers in the public sector has little customer focus.

3.4.3 Fault reporting and complaint lines

The potential for users to report faults in the service they receive is of considerable value to the service provider. Accurate, timely information concerning the service supplied or relating to the payment of bills is very useful to a service provider implementing UWDM and trying to improve its operational efficiency and customer responsiveness. Individual and collective participation can very useful in this context, and systems may be established to encourage and facilitate this. Clearly, if people are to report a fault or complain, there must be an efficient response to investigate and deal with the issues raised.

How to link an individual customer to those responsible for the response requires some thought, especially when the individual concerned is unlikely to have access to a free phone number and may be unwilling or unable to complete a postage paid form. It may make sense to route the fault reporting / complaints procedure through a local water user association. Fault reporting may facilitated by using simple picture based report cards, which also allow the response to be monitored.

The use of card based reporting systems can be extended to monitor the overall performance of a service provider in terms of the use of facilities, user satisfaction and associated problems. An example of the application of this idea is described by Paul (1996).

3.5 Promoting public awareness

The involvement of stakeholders in developing a public awareness strategy is key to its success and sustainability. Participation, already discussed above, ensures that the views of different user groups are reflected in acceptable policies, which can then be marketed accordingly. By comparison, a lack of awareness can result in a policy being rejected.

People's awareness should not be considered as a "blank sheet" that messages can be written on. In practice, a number of negative perceptions may have to be overcome by a utility considering UWDM:

- intermittent, unreliable services and poor water quality reinforce the notion that water services are not worth paying for;
- previous policies and traditional beliefs reinforce the notion that water is free and should not be paid for;
- environmental issues are seen as neither relevant nor important; and
- users may be unaware of why they should and how they can save water.

The following points need to be considered in planning a public awareness or information campaign.

- the purpose of the campaign: for example; to maximise public support for retrofitting meters to domestic properties.
- specific objectives; for example:
    - to ensure that all users understand why metering is needed and how it will affect them;
    - to ensure that users understand the need for cost recovery through tariffs and the penalties for non-payment;
    - to ensure that users know of any benefits that they will receive in terms of an improved level of service (the incentive);
    - to ensure that users know how to reduce their water bill by conservation;
    - to publicize details of an amnesty for pirate connections.
- the target audience, divided into key segments.
- the messages that need to be reinforced: appropriate messages can only be identified through consultation with the market segment involved.
- the methods to be used to disseminate information.
- monitoring impact; it is essential to know how effective the campaign is in terms of meeting its objectives. If the objectives are not met, the strategy will be at risk. Effective marketing methods need to be developed, tried and improved.

UWDM is a long-term response rather than an emergency measure and this should be reflected in its marketing. One-off promotion will not be as effective as a sustained campaign that is

constantly being reviewed and improved. Any campaign can benefit from support from respected and popular individuals and associations. Backing from opinion shapers and leaders at all levels can have a significant impact on a public awareness programme, and should be sought accordingly.

3.6 The reduction of unaccounted for water (UFW)

In many towns and cities in developing countries, over 50 per cent of the water that goes into the distribution system may be unaccounted for; that is, nobody knows what happens to it. The reduction of unaccounted for water is thus a key approach for UWDM. It is made up as follows:

- leakage from the treatment system, the distribution system, the supply pipes connecting premises and from water devices within premises;
- meter under-registration or failure;
- illegal connections; and
- unmetered withdrawals, for example, from standpipes.

This represents an economic loss for the country and a large financial loss for the utility. It also undermines the credibility of the utility in the eyes of the consumer and the legitimacy of a metered water bill. Thus reducing unaccounted for water is central to any water demand management strategy. The principles of reducing unaccounted for water are relatively straightforward. Putting them into effect is more difficult; utilities need the flexibility to re-deploy their human and financial resources. These principles include:

- setting achievable objectives and establish monitoring systems;
- ensuring water production, distribution and consumption are adequately metered;
- ensuring every connection is registered, and that action is taken against illegal users;
- ensuring all visible leaks are located and repaired promptly;
- metering all public standpipes and establishing systems to manage them (e.g. water user committees); and
- monitoring flows and following up any water usage results that are abnormal.

(Adapted from McIntosh, 1994)

The key to implementing a programme for reducing unaccounted for water is to measure it by installing bulk supply meters throughout the system. Two measures which can be adopted to reduce leakage are firstly to reduce the operating pressure of the distribution system (although users 'at the end of the line' may receive poorer service) and secondly to instigate a programme of pipe replacement. Initial reductions in unaccounted for water produce a high return on the investment required; this decreases as leakage is reduced. Nevertheless there needs to be a long-term commitment to this strategy.

A number of computer software packages are now available to assist with the management of unaccounted for water. One example has been developed by the Water Research Commission in South Africa. Further details are included in Section 7.

3.7 Water saving devices and practices

There is considerable potential to conserve water in domestic and non-domestic premises through the adoption of water saving devices and practices. These are likely to focus on higher income households with multiple tap connections, institutional and industrial users. The impact can be considerable in terms of the quantity of water saved (see table below).

3.7.1 Incentives to save

There are three potential incentives for a user to save water:

- financial, driven by the desire to reduce a water bill;
- legal, driven by the existence and enforcement of by-laws/regulations that influence non-domestic users directly or indirectly through building regulations and design codes; and
- social, driven by the desire to allocate water equitably or to protect the environment; the latter is unlikely to offer a convincing incentive in many less developed countries, although governments are increasingly recognising the economic value of the natural environment, for example for tourism.

The key point is that there must be an effective incentive. Conservation will not happen if users are not billed for the water they use, if by-laws are not enforced, or if the public do not know about environmental concerns.

3.7.2 Water efficiency audits

A water efficiency audit provides a starting point for saving water in both domestic and non-domestic premises. A quick survey can identify leaks, wasteful practices and opportunities to save water through retrofitting water saving devices[5].

There is considerable wastage from institutional buildings and government offices may be the worst offenders. Ensuring these users are metered, receive and pay bills can be an important first step to encourage the use of water saving technologies, the cost of which can be repaid by the resulting savings in a matter of months or weeks.

For water audits to be effective, information and in some cases specialist training will be needed. This may be the responsibility of the water service provider, the local authority or the user, and should be tailored to suit the particular needs of the situation. Audits can be promoted at different levels:

- At household level: an audit can be undertaken by householders to identify how they can save water. A simple information sheet can inform the household auditor of what to look out for, who to call to fix leaks, and how to replace washers and seals. Typical measures focus on leaks, flush toilets (leaking flap valves and reducing the flush volume) and leaking taps. As the proportion of households with washing machines and other appliances increases, so does the importance of promoting water efficient models.
- For institutions, commercial and industrial premises, there is considerable scope to save water. In this case, a nominated individual may have to receive special training to audit water use and monitor consumption levels thereafter. Alternatively, this could be the responsibility of a trained auditor employed by the water service provider. Typically the focus is on leak

[5] For more details see AWWA (1990)

detection, flush toilets, taps, urinals and air conditioners. The use of grey-water and rainwater for toilet flushing may be suitable for institutional users although it incurs additional plumbing costs.

Some water saving devices that may be appropriate in the context of developing countries are compared in Table 3. Additional sources of information relating to water saving technologies are identified in Section 7.

If a significant quantity of water saving devices are needed it may be necessary to facilitate their local manufacture. Low flow shower units, spring fitted faucets and WC cistern conversion kits (from single to dual flush, or simply to reduce the flush volume) are relatively simple to manufacture. It important to check that the existing regulations allow for water-saving devices to be installed.

Table 3. Water saving devices and options

Water saving device / measure	Remarks
Replacing seals and conversion of existing WCs to low or dual flush	In many higher income areas, WCs may account for a substantial proportion of domestic and institutional consumption. Many flush WCs fitted with a flap valve leak. The flush volume of many existing WC's can be reduced by 20% or more with a water filled bottle or similar. Cisterns can be converted into dual flush with a simple kit that may be suitable for local manufacture.
Installation of water efficient washing machines	Washing machines are a major water user in many higher income areas. Promoting their eventual replacement with water efficient models is a long-term strategy funded completely by users.
Leakage control	Leakage control in user supply pipes alone may account for a significant proportion of leakage losses, especially where there are many unauthorised connections.
Water saving urinals	Flush controllers may be a highly cost effective water saving measure for institutional users in particular. Waterless urinals have been developed need special filters that may not be locally available.
Metering consumption	Metering consumption provides the key incentive for users to conserve water.
Low flow shower installation	A shower kit that plumbs into the bath taps is a cheaper option. The average shower uses about half the volume of a bath. Many premises in developing countries may not have a bath anyway.
Water efficient air conditioning	Air conditioners use a significant volume of water that can be recycled by the installation of a simple kit. For hotels, commercial and institutional users in Beijing, this measure proved a cheaper option than the installation of water efficient WCs.
Rain water harvesting	Rainwater is often used to supplement a household water supply, but may also be of benefit to other users. The city of uses rainwater collected from the local airport as its principle water supply. Storage is often a critical factor.
Recycling of grey water	For households, grey water (from sinks, baths and showers) can be used directly to irrigate a vegetable garden. With minimal treatment it can also be used to flush WCs. This may be cost effective for hotels, commercial and institutional users.

3.7.3 Water reuse and waste minimisation

The two forms of water reuse which are most relevant to urban water demand management are the direct reuse of water by industry and the reuse of treated grey water or sewage effluent to augment a potable water supply.

A combination of three measures has proved to be highly effective in encouraging the reuse of water by industry:

- water tariffs;
- abstraction licences; and
- discharge licences.

In order to enforce discharge licences, it is necessary to establish appropriate water quality standards. An additional incentive is the recovery of chemicals and other materials in the water that would otherwise be lost. A great deal of effort has been expended in many industrialised countries to develop water saving processes, ranging from the recycling of cooling water to more advanced multistage treatments. The savings made can be considerable, as illustrated in Box 5.

Although not common, the reuse of treated sewage effluent to augment a potable water supply has been adopted by a number of utilities where water is particularly scarce. An example of this is the city of Windhoek in Namibia, where 19 per cent of the potable water supply is derived from treated sewage effluent. The cost of the tertiary treatment needed is high, but less than the cost of developing new resources.

Box 5. Industrial water saving in China

China is facing severe water shortages in many urban areas, where industrial water demand can exceed 70 per cent of the total supplied. Although in 1990, wasteful factories (using between 3 and 10 times the water used by similar factories in developed countries) were still being built in some cities, in others conservation measures were being adopted. These included:

- water allocations and quotas;
- penalties for over use;
- industrial water audit programmes; and
- economic incentives to use less than the water allocated by quota.

By 1995, the cities of Da-tong, Zibo and Baotou now reused between 88 and 92 per cent of industrial water. Cooling water accounts for 70 per cent of industrial water demand, and significant efforts have been made to reduce this particular use. This has led to a fertilizer factory in Luzhou City cutting effluent levels by 94 per cent.

(Source: Bhatia et al, 1995)

3.8 Service provider capabilities and skills

One of the possible obstacles to the successful adoption of UWDM concerns the capacity of water service providers, which are often supply driven and have a highly bureaucratic culture that is resistant to change. The global tendency towards decentralisation, privatisation and improved accountability is providing opportunities to reorganise or restructure these organisations in order that they are not only more efficient and more accountable, but they are better prepared to implement UWDM. The key areas that need to be sorted out in order to facilitate this process are described below.

3.8.1 Clearly defined responsibilities

As already mentioned, responsibilities must be clearly defined for service providers. This should drive human resource policies and the allocation of resources. A degree of regulated autonomy is desirable, as it can facilitate local responsiveness to users and create internal incentives to improve performance.

3.8.2 Setting long-term goals and objectives

UWDM is a long-term strategy that requires long-term commitments. The strategy should be articulated through setting long-term goals and objectives and be judged according to performance measured against them. Many service providers will need guidance if they are to accomplish this process themselves. Externally set targets may not achieve the sense of ownership required.

3.8.3 Overall user focus

It is very important that water service providers have a strong user focus that enables them to talk and listen to both current and potential users. Without this, a UWDM strategy will lack public support and is unlikely to succeed. In many cases, a sea change in organisational culture may be needed. Every employee should realise that role is to provide a service. At other levels, systems must be established to monitor user opinion and deal promptly and effectively with issues as they arise.

3.8.4 Human resources

In order to meet the overall objectives, service providers implementing UWDM will need non-engineering staff to ensure that sufficient attention is given to establishing an effective customer/client rapport and introducing pricing reforms. Technical staff will themselves need to become user rather than technology focused, something that goes against the grain of conventional engineering training.

Human resources may require to be restructured to implement UWDM. In practice, the operations and maintenance section of a service provider may need reinforcing, possibly at the expense of the supply side. Opportunities are also presented to contract out certain services. At the individual level, staff selection, development, assessment procedures and incentives are likely to need adapting to reflect the longer term, user focused objectives of UWDM. Considerable emphasis on human resource development is a prerequisite for sustainable change and therefore a priority.

3.8.5 Monitoring water use and losses

One of the greatest challenges concerning UWDM is the need to monitor water use and losses. This implies not only measurement, but determining and implementing appropriate measures as necessary. This area is usually under resourced in terms of manpower, resources and budget, and is likely to require substantial reallocation of resources. In recent years many tools have been developed to assist service providers manage water resources, often involving computers. These are only effective if training is provided and the organisation is structured and equipped so it can feed in reliable information and utilise the results.

3.8.6 Effective management of information and resources

In many utilities and local government departments, performance data is entirely lacking. It is therefore necessary to review the information requirements; in general, this involves defining the minimum requirements in order to inform specific actions, rather than generating a large amount of information for its own sake. As already suggested in the context of water use and losses, systems must be developed to monitor progress, both in terms of the service provided and organisational performance. Undoubtedly information technology has an increasing role to play here. In the particular context of developing countries, paper is more reliable than an unserviced computer operated by a partially trained employee. It is more important that effective systems exist in the first place. Too often, it seems this is not the case.

3.8.7 Responding to changing demand

Water service providers must be able to anticipate and respond to future demand. This implies they must have the ability and authority to adjust tariffs, modify by-laws and change policies. It also implies that sufficient timely information is available to inform such decisions, complete with the managerial skills required to plan change. The complex interactions between supply and demand must be understood. This reinforces the fact that UWDM, above all, cannot be achieved overnight but is a process of continuous monitoring, assessment and refinement.

4. Guidelines for assessing approaches to UWDM

Any strategy for UWDM will involve a combination of some or all of those approaches outlined in the previous section. The particular approaches adopted will be determined by the specific local circumstances; this requires the exact nature of the problem to be defined. The following methodological steps are recommended:

- assess and define the scope the problems to be addressed by the strategy;
- analyse current water use;
- forecast future water demand; and
- establish assessment criteria in relation to local objectives for UWDM.

Consultation and participation should run through all these stages.

4.1 Assessing the scope of the problem

The general scope of the problem to be addressed by the UWDM strategy needs to be investigated. The following should be considered as part of the scoping study:

- the geographical area to be covered by the strategy both at present and in the future;
- the approximate size of current and projected imbalances between supply and demand;
- the way in which the imbalances will develop with time;
- the perceived causes of these imbalances, for example: current water use patterns, excessive unaccounted for water;
- issues of equitable access to water resources, focusing on the use of water by the poor and by poor women in particular;
- the existing legal and regulatory framework within which UWDM could operate; and
- the current institutional arrangements and constraints to implementing a more demand based approach.

4.2 Demand forecasting

Any proposals for augmenting the water supply will require demand-forecasting studies to be carried out. These are required to help to quantify those areas and aspects of the urban water supply that will benefit from UWDM.

Assessing current water use requires a detailed programme of flow measurement at all of the key points within the water production and distribution systems over a period of 12 months in order to establish a clear pattern. Figure 1, based on WRC (1994), is a useful tool for presenting the results of the analysis that allows one to see:

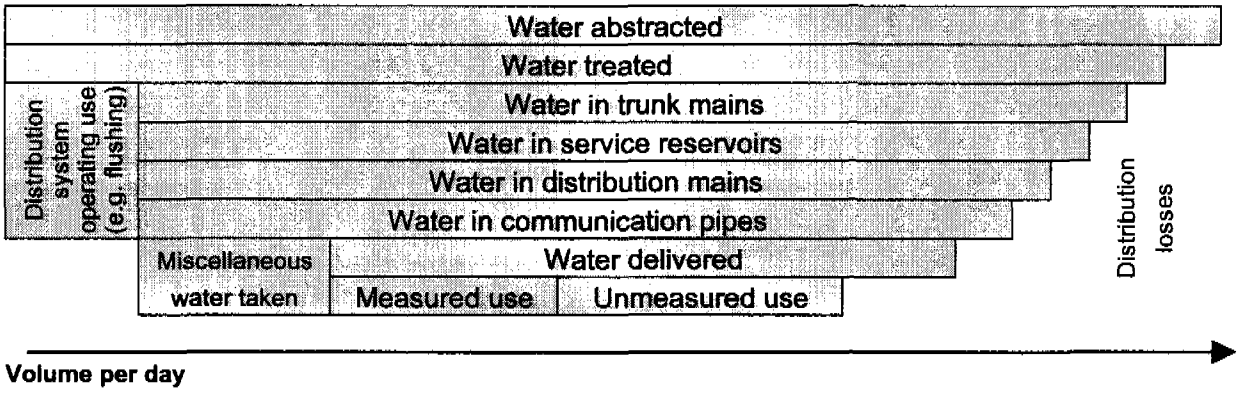
- how water is actually being distributed and consumed;
- how much water is needed to operate the system (e.g. flushing, cleaning service reservoirs); and
- how much is unaccounted for or 'wasted'.

It also points towards possible solutions that can 'free up' water[6].

It is important to keep the underlying objectives of UWDM in focus. Whilst Figure 1 provides a valuable 'at a glance' picture of the existing supply situation it does not make any links to demand. The next stage is to attempt to forecast future demands on the water supply system. This assessment must not be treated as just a technical study which reviews future demands of existing consumers; it also provides an opportunity to quantify lack of equity by identifying where deficits exist in relation to actual demands, for example, in unserviced informal settlements. Key sources of information to assist in demand forecasting include:

- structure plans and masterplans for the area including those for general urban development as well as sector-specific studies; and
- economic development plans.

Note that these plans may not include informal areas or slum pockets; for example in Karachi, up to 50 per cent of the population lives in settlements that are not officially recognised. A separate mapping exercise is likely to be necessary to identify urban poor areas. Within these areas pilot demand assessment studies need to be carried out in order to ascertain indicative levels of service and willingness to pay.



(Source: adapted from WRc 1994)

Miscellaneous water = hydrants, illegal use;

Note: standpost supplies would be included as unmeasured use

Figure 1. Analysis of water supplied

4.3 Criteria for assessment

The following criteria can be used to assess the appropriateness of the range of UWDM approaches and to draw up a list of workable options for the specific situation under consideration. Within each of the criteria listed below it is important to reflect the overriding objectives of efficiency and equity and to consider nature of the local problems identified by the scoping study and demand forecasting studies.

[6] For further details on water supply and use charts see WRc (1994)

4.3.1 Anticipated yield

The main benefit offered by each approach is the quantity of water saved over a particular time period that can be reallocated; different approaches can be considered in three broad groups.

- Savings made through physical improvements: this includes reducing unaccounted for water and introducing water saving devices and practices. It is relatively straightforward to estimate possible savings, for example by using the method of analysis of Figure 1 for unaccounted for water.
- Tariff and charging policies: the effect of simple measures such as improving bill collection efficiency is relatively simple to predict, but changes to tariffs and cost recovery will have a less predictable effect on demand. Possible approaches include looking at the effects of similar policy changes in other areas and/or carrying out a pilot investigation into the effect on demand and extrapolating the results across the whole area.
- Public education and awareness measures: it is similarly difficult to predict the effect on demand; again, looking at the effects in other areas and/or piloting the approach may be necessary.

4.3.2 Costs

The cost of each approach needs to be estimated; these costs are likely to be incurred over a period of time and this must be allowed for in the analysis. It is usual to carry out both an economic and a financial analysis.

- Financial analysis restricts itself to the actual financial costs incurred in carrying out the UWDM programme of work; costs are usually discounted back to the present.
- Economic analysis includes assigning monetary values to the wider environmental and social costs (and benefits) of the work in addition to the actual implementation costs; it requires inputs to be shadow priced, with costs discounted back to the present.

4.3.3 Poverty focus

In addition to establishing the overall financial and economic costs and benefits, it is essential to analyse the potential poverty impact in relation to who pays the costs and who gets the benefits. This requires a thorough understanding of the existing situation faced by the poor; this information can only be captured through their active representation and participation in identifying and discussing various options. Most importantly, the options discussed must be based on reality. For example, if it is proposed to investigate demand and willingness to pay amongst the poor, there must be a high level commitment to equity whereby some of the resources saved through UWDM will be redirected to serve hitherto unserviced or poorly services areas.

4.3.4 Time scale

Time scale has two important effects that are related.

- Firstly, the timeframe for implementation and production of benefits associated with alternative measures can vary considerably. For example, improving bill collection may have an immediate effect, whilst the introduction of by-laws to promote water efficient devices will have a far longer time scale.

- Secondly, there is an effect of diminishing returns and market saturation associated with the introduction of a particular measure. For example, measures to reduce unaccounted for water will initially target those parts of the system that will yield the most 'saved water'. This needs to be reflected in the impact and cost/benefit analyses, for example through discounting the benefit streams (see Section 5.1)

4.3.5 Risks

The risks and uncertainties associated with each proposed measure need to be evaluated. The first stage is to identify possible risks, which should include wider issues such as the need for political support for particular measures. Some risks can be quantified by carrying out analyses of costs and benefits under a range of different conditions that are indicative of varying degrees of success. This form of sensitivity analysis can be used in conjunction with piloting a measure and monitoring its impact in order to obtain a clearer picture of the likelihood of success and the implications of failure.

4.3.6 Public acceptability and support

Measures which influence the use of water by the public, or which effect the public's perceptions of the water service provider need to be supported by measures that ensure public acceptance. Pilot surveys using a range of techniques such as questionnaires, interviews and focus groups can give indications as to the public acceptability of particular measures. It is important to cover the range of existing and potential consumers, including poor groups who may not have access to the formal infrastructure networks.

4.3.7 Political commitment

Measures such as tariff reform require political commitment and it is important to engage with politicians and senior bureaucrats in order to assess the extent to which particular measures will be supported. This involves assessing the level of support for revisions to wider policy; there may be a subsequent need for changes to national/state legislation and local by-laws as part of the implementation of specific UWDM approaches. Equally important to assess the commitment to improve access for the poor; that is, agreement that the priority for reallocation of water saved through UWDM will be targeted to hitherto unserviced and poorly serviced areas. Although this may be very difficult to undertake, it has to be attempted in order help to assess risks.

4.3.8 Co-ordinating policies

There may be important beneficial links between different UWDM measures that can be developed as part of the implementation process, for example improved billing may encourage. adoption of water saving devices. Links may also exist with other policies, such as environmental education programmes or improved billing for other urban services. These should be identified.

5. Guidelines for the implementation of UWDM

This section focuses on prioritising UWDM measures into a programme of action; it also considers the need for performance evaluation, promoting public support for UWDM and looks at possible sources of funding for UWDM.

5.1 Prioritising and programming

An initial ranking of the different measures can be done according to:

- average incremental cost (AIC), as measured by the cost per unit volume of water saved; and
- benefit, as measured by the yield (volume per day).

This is illustrated in the following hypothetical example, which ranks four different UWDM options. For each option, the anticipated yield is estimated and the implementation costs calculated; the average incremental cost can be estimated from the discounted costs and yields (benefits).

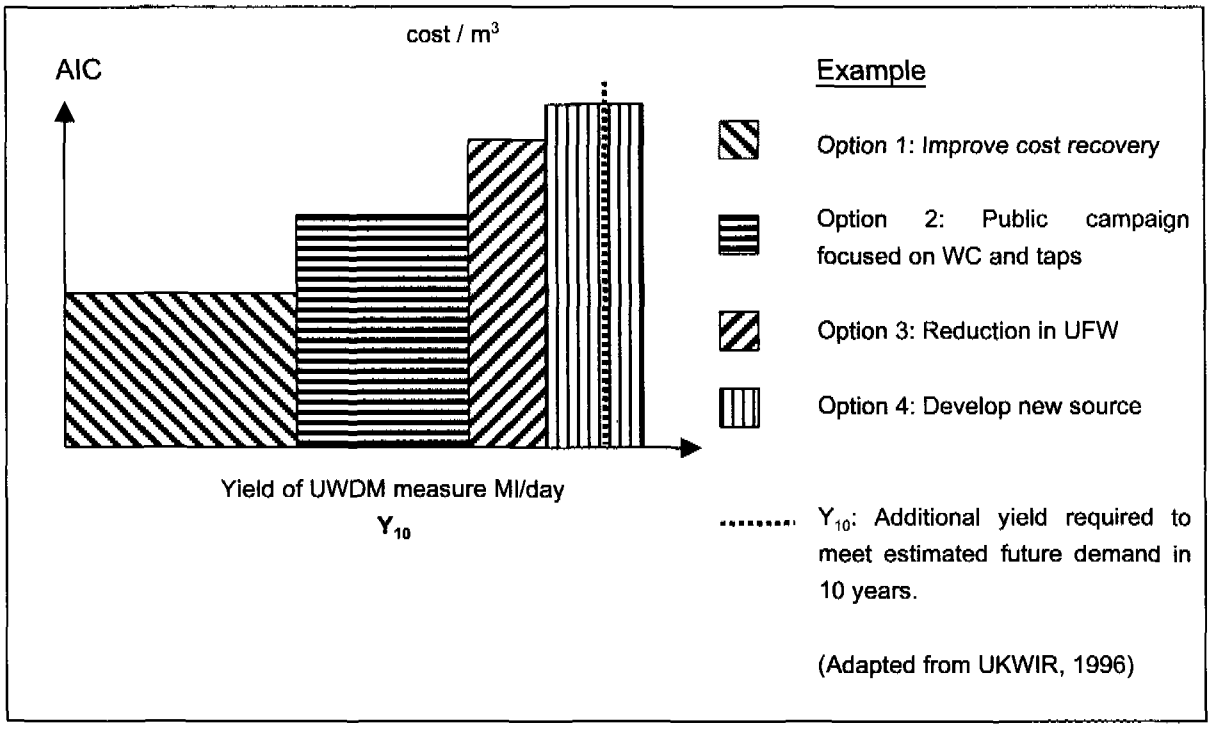


Figure 2. Applying demand management measures

The options in this example are as follows.

- Option 1: a programme to improve cost recovery, with all private connections being mapped and registered, unauthorised users being required to be metered (the cost of which is added to the water bills in 12 monthly instalments), and a series of incremental tariff increases over five years. Willingness to pay surveys have been used to design the tariff increases and meter repayments. Following a series of public consultations, it has been agreed that standpipes are to be managed by private vendors, although the selling price will be regulated to avoid profiteering. The number of standpipes is to be increased with a number of additional areas

being covered. Water user groups will be established, based on each standpipe, to monitor their use.

- Option 2: Water audits have shown that a considerable volume of water is being lost by leaking WCs and taps, and many WCs have unnecessarily large cisterns. A public campaign to conserve water and reduce water bills, focused on leaking taps and leaking WCs is therefore planned. Methods of reducing the cistern volume to about 6 litres will be promoted. Note that this is closely linked with options one and three.
- Option 3: a programme to reduce unaccounted for water based on leak detection and repair, supply pipe losses and reducing unauthorised connections.
- Option 4: the development of new water sources based on the lowest cost supply that can be identified.

The assumed outcome of the cost benefit analysis is shown in Figure 2, which plots the average incremental costs against the yield. Note that the yield of the UWDM measures represents additional water that is freed up from existing resources. Figure 2 illustrates how costs can be saved by starting with the option with the option with the lowest cost-benefit ratio, and continuing until demand balances supply. The adoption of UWDM solutions enables the high development costs of a new source to be deferred. Without UWDM, Option 4 involving new source development would have been used at the outset.

Figure 2 also illustrates the important point that the yield from UWDM is limited and that development of new water sources may eventually be necessary. In this case it has been illustrated by showing a hypothetical ten-year additional yield above current supply levels.

Note that the time scale for implementing the options may affect the order in which they are programmed and that this may not correspond with the optimum cost benefit sequence. If the options in the previous example were developed for different cities, it may be the case that Option 2 (public awareness campaigns) could be implemented more rapidly than Option 1 (effective cost recovery).

The importance of assessing the equity of measures has been discussed in the previous sections.

5.2 Setting up project management procedures

5.2.1 Background

UWMD needs specific arrangements for project management, because unlike supply augmentation, it concerns the long-term application of a number of interrelated measures. Many of these concern changing people's attitudes rather than the provision of hardware. Furthermore, it is likely that the service provider will have little or no experience of implementing UWDM, and will lack the data which could inform and monitor the impact of policies and specific measures. UWDM should be seen as a process that evolves through a continuous learning process and regular review (WELL 1998 p224).

Whilst UWDM may be developed as a new programme, it is important to link it as closely as possible with existing activities. From the utility manager's perspective, it will increase the chances of mainstreaming the concepts and offer a way of introducing change. Many of the

technical activities are related to the operations and maintenance functions and the procedural principles are essentially those of good management practice. However it is important to emphasise the non-technical activities which are central to UEWDM strategies.

Figure 3 illustrates the project management cycle in relation in relation to UWDM.

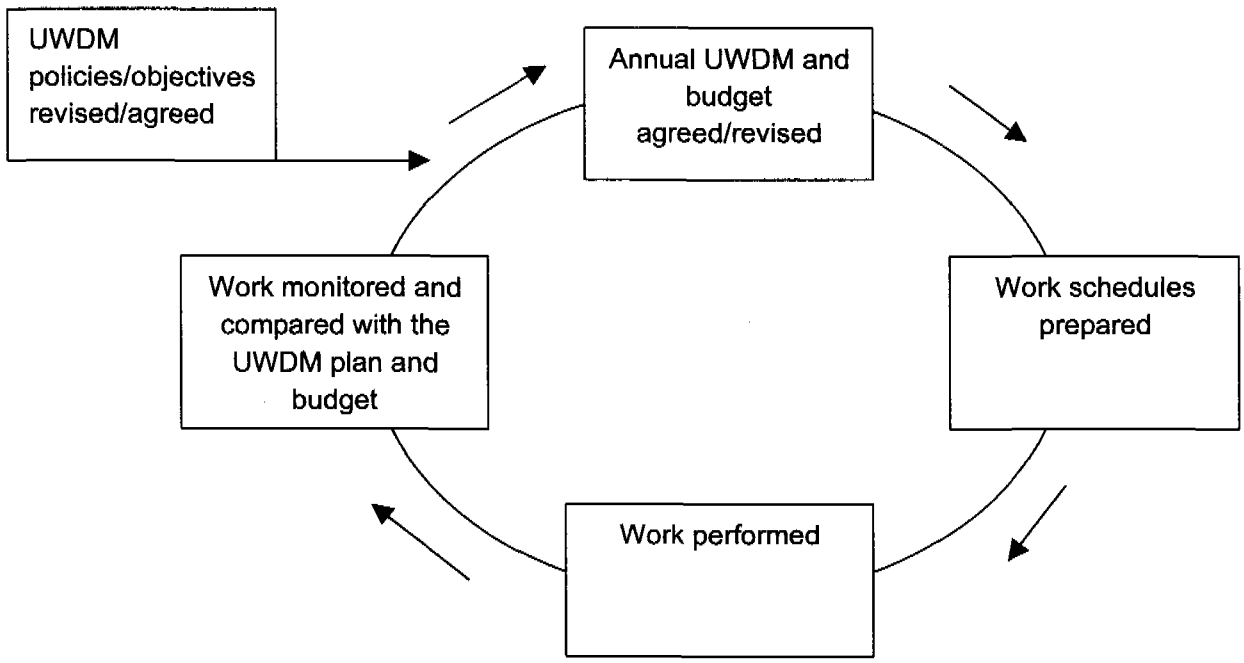


Figure 3. UWDM management cycle

Adapted from the American Water Works Association (AWWA), '*Basic Management Principles for Small Water Systems'*, undated.

Policy and setting of objectives has been covered in Section 3; other procedural aspects are covered below.

5.2.2 Use of planning frameworks and annual workplans

Planning frameworks and annual workplans can be useful tools to assist in achieving objectives. The planning framework should ensure that links between individual objectives, activities and tasks are recognised and taken into account in the overall strategy. It should also ensure that verifiable indicators are used to monitor progress, whilst remaining sufficiently flexible to permit the experiences gained to be incorporated in the future.

The use of annual work-plans is also recommended. Each measure should have an associated work-plan, detailing the inputs required, the associated budget available, the indicators to be measured, the standard to be maintained and the overall target, all within a fixed period. A one year time frame is sufficient for impact to be measured, whilst being short enough to reinforce a

sense of ownership among those responsible for implementation. Such responsibilities do have to be clearly defined and associated with incentives. As UWDM is a long-term process, progress must be formally reviewed and if necessary, policies adapted or changed to improve performance. Changes should be incorporated into subsequent work-plans. The planning framework should also be reviewed as necessary.

These tools are quite complex and will not be familiar to many utility staff; their use needs to be set very carefully in the local context. Training and back up support is essential; this must emphasise the fact that the overall objective is implementation and that planning frameworks are merely tools to assist in the management process and are not ends in themselves.

5.2.3 Work schedules

These essentially describe *who* will do *what*, *when* and *where*, in accordance with the UWDM plans. The schedules should be sufficiently flexible to allow for unforeseen circumstances such as unscheduled activities, including breakdowns. The work should be undertaken in accordance with the work schedules and with reference to the appropriate manuals and manufacturer's instructions (Njiru, 2001).

5.2.4 Performance monitoring and evaluation

Monitoring of progress and expenditure should be undertaken at regular intervals and comparisons made with the plan and budget, which may need to be amended, particularly in preparation for the next year. Monitoring should be viewed as a learning process in which approaches are assessed and if necessary adjusted or changed in the planning framework..

Performance can be measured through the use of appropriate indicators. Performance indicators can be defined as *variables whose purpose is to measure change in an organisation, process or function*. They provide the information from which performance reports are compiled, in order to assist in answering the questions posed by performance evaluation. Characteristics of a good performance indicator are:

- a valid link between the indicator and the question being addressed;
- the information required to define the indicator is readily available.

The selection of appropriate indicators is key to reviewing performance and achieving the stated objectives of UWDM. Indicators should be both objective and verifiable, and focus on impacts and the processes involved.

It is advisable to test the monitoring system in representative pilot areas. Particular thought should be given as to how to measure less tangibles outcomes such as public awareness and user satisfaction. This is likely to require the use of qualitative indicators, including results from participative assessments. Examples of impact and process indicators are shown in Box 6.

Box 6. Possible impact and process indicators

Impact Indicators

- reduction in unaccounted for water;
- improvement in revenue collection;
- reduction in accounts receivable;
- reduction in per-capita water consumption by private tap users ;
- extension of services into previously unserviced areas; and
- improvements in frequency of supply.

Process indicators

- higher level of participation of primary stakeholders particularly the poor;
- improved awareness of need to conserve water; and
- improved perception of service provider as an accountable, customer focused organisation.

Adapted from WELL 1998 p 278

5.2.5 Performance targets and reporting

Associated with each performance indicator is a performance target; the status, or performance of the activity is then assessed by comparing each indicator with its respective target. This enables performance comparisons to be made, such as:

- between different time periods for a programme or organization;
- between different programmes or organizations.

An international task force has produced an agreed standard set to facilitate comparisons (IWA, 2000).

Performance reporting provides the essential input to performance evaluation. It not only reveals whether planned actions have achieved their objectives, but identifies common problems and allows improvements to be built into the system for the future. The development of a sound performance reporting system, along with the choice of appropriate indicators, are important elements of the UWDM programme. Details of systems for performance evaluation and suitable performance indicators are given by WHO (2001).

The use of performance incentives as a management tool by water service providers to achieve particular targets may be highly effective, both at an individual and organisational level. Public accountability and support may be increased by ensuring representatives participate in the review process.

Care needs to be taken in the use of indicators and targets; they need to reflect the 'law of diminishing returns' which is characteristic of many measures. For example it is significantly harder to reduce leakage from 20 per cent to 15 per cent than it is from 50 per cent to 45 per cent.

Spreadsheets provide an efficient means of recording and comparing data relating to indicators and facilitate the compilation of accurate, timely reports. Progress can be represented graphically in formats that are easily understood, demonstrate transparency and facilitate discussion.

5.2.6 Information needs

Base line data is needed to assess impact. This applies to both monitoring indicators and to periodic evaluations which may investigate issues in more depth. The data gathered to establish a baseline may include parameters which are not monitored but which are used in the course of an evaluation. If UWDM is to be piloted in a particular area, the baseline survey can be extended to other areas outside the project boundary to assess and investigate changes in people's attitudes and practices.

It is important that information is shared between stakeholders and within organisations and that the necessary systems are in place to achieve this. The need for information exchange is critical in UWDM where there are so many linkages between different measures, possibly being implemented by different organisations. Thus, the development and review of the planning framework and associated work-plans should be participative, involving all the stakeholders involved.

5.3 Promoting public support

The importance of public support for UWDM measures has been emphasised throughout this paper. Section 4.3.6 refers to the need to assess the likely level of support through various survey techniques, as this is an important criterion in the assessment of specific UWDM measures. The wider role of public awareness raising and education is been addressed in Section 3.5.

Perhaps the most important factor is the need for the UWDM implementing agency to accept that public consultation, participation and support across the full range of existing and potential consumers needs to be integrated into all stages of the process. It is essential to the success of the programme and it will fail without it. The implementing agency has to involve the public in:

- assessing feasibility of different UWDM options and the strength of public feeling;
- development of the public awareness and education strategy;
- assessing the willingness of existing consumers to respond to measures;
- focusing on needs assessment and willingness to pay within poor communities and groups;
- setting targets, monitoring and reviewing the progress of the UWDM programme.

This may be difficult for traditional institutions that are rooted in supply-based approaches to accept.

It should be noted that public support needs to be across a range of social groups. Although the UWDM programme may be designed to create opportunities to deliver services to the poor, an important group to involve in the process is the richer, existing customers. Only with their support can wasted water be re-allocated to groups without access to the current supply.

5.4 Funding streams and budgeting

There may be a number of funding options available for UWDM.

- Option 1: inclusion of UWDM in existing or planned projects. Action can be taken by lending agencies or government to ensure that the fundamental principles of UWDM are reflected in all new capital and operational projects, and are supported and encouraged by the existing planning process. To some extent it may be possible to refocus work in hand. Finance may be internal or from bilateral or multi-lateral funders. The fact that an UWDM programme leads to deferment of large investments in new sources provides a powerful financial argument.
- Option 2: UWDM as part of a private sector participation strategy. The private sector can be encouraged to adopt and fund UWDM, given the right incentives and regulatory framework. For example, remunerated performance targets and penalties may be set to reduce leakage and expand the service into previously unserviced areas.
- Option 3: Funding of pilot projects. A successful pilot project demonstrating UWDM or a component of it may be highly effective in promoting change, whilst providing invaluable data for replicating or scaling up a programme. Being smaller scale, there are likely to be more funding opportunities available.
- Option 4: Water consumers. By ensuring adequate cost recovery and capturing demand through a well designed tariff system, UWDM measures can be part or fully funded by the users themselves. This is particularly attractive if relatively low cost measures are adopted that improve the local level of service whilst encouraging conservation.

6. Conclusions

Urban water demand management (UWDM) provides a practical strategy for addressing the more efficient and equitable use of water and thereby has the potential to delay significantly the need for large investments in new water sources. More importantly, it can introduce a paradigm shift in the management style of water utilities which give better opportunities to provide a more equitable service.

UWDM has offers a way of addressing the needs of the unserviced urban poor as follows:

- measures to reduce the amount of water used by existing consumers creates opportunities to target allocation of the saved resources towards the poor;
- measures to improve the financial performance of utilities and municipalities create the means to invest in extending networks into hitherto unserviced areas; and
- institutional reform measures that lead to more inclusive and participatory approaches to water supply planning.

One of the most important UWDM measures is the setting of appropriate tariffs; increasing the price of water reduces consumption. It is equally important to ensure that there is widespread public understanding and political support for such measures if they are to be successful. In particular, there needs to be commitment to invest saved resources in extending services to the poor. Public awareness raising and education is also essential.

Appraisal of criteria and the design of UWDM programmes can be based around analysis of the costs and benefits of each approach. This needs to incorporate assessments of risk and account for the differing timescales over which benefits can be realised. A ranking procedure can then be carried out to prioritise different measures.

7. Technical advice and support organisations

Key organisations involved in UWDM and their particular field(s) of expertise are listed below. The list is not exhaustive but provides a good starting point for further solid basis for further contact.

7.1 Research organisations

Water Engineering and Development Centre (WEDC) Loughborough University Leicestershire LE11 3TU UK; http: //www.lboro.ac.uk/wedc/ E-mail: P.A.Deverill@lboro.ac.uk

Information on urban infrastructure development, institutional development, public private partnerships and demand assessment techniques.

Water Demand Management Centre, Environment Agency, Guildbourne House, Chatsworth Road, Worthing, West Sussex BN11 1LD; http://www.environment-agency.gov.uk E-mail: nwdmc@environment-agency.gov.uk

Water resources, UWDM policies and programme formulation, regulation, water saving devices and conservancy and environmental protection.

South African Water Research Commission, PO Box 824 Pretoria 0001 South Africa. http://www.wrc.org.za/

Information a range of issues and technologies related to UWDM including water resource allocation, prepayment systems and leak detection and reduction.

UKWater Industry Research (UKWIR) 1 Queen Anne's Gate London SW1H 9BT http://www.ukwir.co.uk

Information concerning a range of issues including the economics of demand management, valuation of costs and benefits using average incremental social cost pricing.

Intervention and Operations Support Directorate, Department of Water Affairs and Forestry South Africa. E-mail: Sussensh@dwaf.pwv.gov.za

Development of prepayment systems, automated billing and trickle feed systems.

WRc Group, Frankland Road, Blagrove, Swindon SN5 8YF Tel: ++44 1793 865000 http://wrcplc.co.uk/

Information on a range of issues including leakage detection and reduction.

Building Services Research and Information Association (BSRIA) Tel: ++44 1344 426511, Fax: ++44 1344 487575, http://www.bsria.co.uk

Information on water saving devices and practices and associated building technology.

7.2 International networks

International Union For the Conservation of Nature (IUCN) Regional Office for Southern Africa (ROSA) 6 Lanark Road Belgravia PO Box 745 Harare Tel: ++263 4 728266/7 Fax: ++263 4 720738 http://www.iucnrosa.org.zw/water.htm.

Policy development and implementation. Links to water demand management projects across Southern Africa.

Water Demand Management Research Network (WDMRN) Middle East and North Africa IDRC 3 Amman Square, 5th floor, Dokki, Cairo Tel: ++202 336 7051/2/3. E-mail: wdmrn@idrc.org.eg

Policy development and implementation of UWDM and water resource management throughout the Middle East and North Africa.

Managing Water for African Cities (MAWAC) http://www.un-urbanwater.net.

Strategy development and practical implementation of UWDM and associated environmental conservation measures in 7 African cities. A joint initiative of United Nations Environment Programme (UNEP) and United Nations Centre for Human Settlement (Habitat). Links to the Water for African Cities Network (WACNET).

Water Demand Management and Conservation Working Group (WDM&C) Water Supply and Sanitation Collaborative Council http://www.wsscc.org/

International forum and resource centre advocating water demand management and conservation.

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About this report
The effects of the world water crisis are particularly severe in urban areas in the developing world, where demographic change and industrialisation are forcing planners and policymakers to look beyond conventional supply side solutions.

This report describes urban water demand management in this context: what it is; the need for a supporting framework; tools and techniques; and designing a programme.

Task Management and Quality Assurance:
Dr Andrew Cotton

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