Urban Water Demand Management in Southern Africa: The Conservation Potential

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Sida

Department for Natural
Resources and the Environment

Publications
on Water Resources: No.13

Publications on Water Resources

This series covers issues on water resources from a development cooperation perspective. Sida's Department of Natural Resources and the Environment believes that the publications will be of interest to those involved in this field of work.

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FOREWORD

Southern Africa is a water scarce region where water is distributed unevenly in time and space. With increasing population and its legitimate demand for an improved standard of living, entailing expansion of industrial development and agricultural production, the region faces an enormous challenge in how to allocate, use and protect this limited resource. In addition, the region is affected by recurrent droughts and occasional floods which further aggravates the situation. These circumstances demand novel approaches to solve the accessibility and sustainable use of water for the benefit of the population and the environment in the region.

Within 20-25 years from now, it is expected that most of the cities and towns in the region will at least double their population. At the same time the cost of developing new water sources and supplies is increasing rapidly. Conventional water management practices often concentrate on increasing the volume of water without paying adequate attention to demand management, prevention of water pollution and the need for water for life-sustaining ecosystems. It is obvious that there is a need to raise the status of water demand management and a need for new approaches and techniques.

Recognising the importance of water for the development of southern Africa, the Swedish International Development Cooperation Agency (Sida) initiated in 1996 an initiative with the overall objective to support integrated management of shared water resources in southern Africa. The initiative is focusing on support to activities that strengthen awareness and build capacity to attain sustainable management of water resources.

Water Demand Management (WDM) is an essential and important part of the Sida initiative that emphasises more efficient use and conservation of available water resources. This reports sets out to explain the concept and benefits of introducing WDM practices in an urban context. However, there is also a great need to further explore this concept looking into different aspects of WDM such as its application in relation to rural settings, gender issues, ecology, economy, management of shared water resources, etc.

Sida is grateful to Mr Peter Macy for presenting an informative introduction to WDM in an urban context and to the India Musokotwane Environment Resource Centre for Southern Africa for editing the report.

Stockholm in February, 1999

Bengt Johansson
Head Africa Division
Department for Natural Resources and the Environment
Swedish International Development Cooperation Agency

Disclaimer

Because of recent increased interest in water conservation, as it relates to water demand projections, a study on the topic was requested by the Swedish Embassy in Harare. The time and scope limitations to this study prevented intensive data collection and analysis. However, all the data used in this report was provided by what was considered reliable sources that were carefully referenced in the report. Where extrapolations or assumptions were made, these were so noted. In the event that some take the exception to the estimates, the methodology used to determine the savings was usually presented. This allows the reader to perform calculations with different values to reflect more accurate and/or changing data Also apologies are offered to those persons and agencies not reached during this short study. Your input would have been appreciated and of great value to this work. Unfortunately, the time limitations made contact with all appropriate people and organisations impossible. Within the SADC region, no data was collected, nor conservation potential evaluated for the Democratic Republic of Congo (DRC) as it had just joined the SADC near the start of this study Further, where monetary values are used, they are in United States Dollars (US$) unless otherwise specified

This publication has undergone extensive and elaborate review and editing by experts working in government and the university in the SADC region The India Musokotwane Environment Resource Centre for Southern Africa (IMERCSA) edited the manuscript. IMERCSA was further responsible for the design and publication of this report.

Peter Macy
Mutare
February, 1999

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ACRONYMS

Cu m	cubic metres
DASU	Directorate for Urban Water and Sanitation
DC	District Council
DNA	National Directorate of Water
DRC	Democratic Republic of Congo
DWA	Department of Water Affairs (Namibia)
EPAL	Empresa Provincial de Agua de Luanda (Provincial Water Company of Luanda)
FAO	Food and Agriculture Organisation
IMERCSA	India Musokotwane Environment Resource Centre for Southern Africa
IWSD	International Water and Sanitation Decade
l/c/d	Litres per capita (person) per day
N/A	Not Applicable
NDP1	First National Development Plan (Namibia)
NGOs	Non-Governmental Organisations
O&M	Operation and Maintenance
SADC	Southern African Development Community
SARDC	Southern African Research and Documentation Centre
Sida	Swedish International Development Cooperation Agency
UfW	unaccounted-for water
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WASP	Water and Sanitation Policy
WHO	World Health Organisation
WSCU	SADC Water Sector Coordination Unit
WRU	Water Resources Unit
ZAR	South African Rand
ZINWA	Zimbabwe National Water Authority

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EXECUTIVE SUMMARY

The Southern African Development Community (SADC) faces numerous challenges and opportunities. One such challenge is the provision of water for its urban and peri-urban populations. The existing water resources infrastructure is already overstretched and the expected meteoric urban population growth will put even more strain on them.

In the past, the resulting increase in water demand was partially addressed by infrastructure improvements to increase supply, which were paid for by government budgets and donor funding. However, this solution, as the only option, is no longer sustainable.

> Fortunately there is a cost-effective alternative that has been gaining prominence: the more efficient use of water resources. Rather than increasing supply, unreasonable demand can be decreased, relieving the supply/demand strain faced by water utilities and government agencies. Efficient use of water is made possible by implementing the elements of water conservation and drought management.

Water conservation focuses on long-term water savings and drought management focuses on short-term water savings to mitigate acute shortages.

Introduction

This report addresses water conservation and drought management in the SADC's urban areas. SADC includes Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, Swaziland, South Africa, Tanzania, Zambia and Zimbabwe.

The primary objective of the report is to help the reader determine what is the water conservation potential for water utilities within his or her country, province or town. The report also covers the following topics:

- Understanding urban water demand and how to calculate demand
- Sample water demand data in the SADC region
- How water conservation potential can be calculated
- Various water conservation methods
- Water conservation practised by some SADC utilities
- Roadblocks and negative impacts regarding water conservation
- A suggested "step forward" regarding water conservation

Water Conservation and Drought Management

This report is meant to be read by a wide audience involved in water resources management. The audience includes planners, engineers, economists, government ministries, donors, non-governmental organisations and others. The report will be useful to decision-makers in the field of water supply and systems infrastructure development. It provides an understanding of water demand patterns in the SADC region. It demonstrates how to establish the water conservation potential for urban municipalities and offers some examples to serve as a reference for future projects. It will also enable decision-makers to assess future water demand and infrastructure needs. Because to many, water conservation and drought management are new concepts, these two are described below:

Background of water conservation

Early forms of water conservation, practised in SADC countries, included water rationing, metering of usage, reuse, lining of conveyance and storage systems. These practices date back to the earliest installations of public water systems in the region. After the 1930s, particularly in South Africa and Namibia, reuse and recycling of water was introduced. At the time, the need for further conservation was not necessary due to much smaller populations and more abundant natural resources. However, today's situation is very different.

> Water conservation (also known as demand management) is not a novel concept. Thorough implementation, to achieve conservation's full potential is novel. The situation of insufficient implementation will need to change rapidly in the Southern African Development Community.

Water resources management requires the continued balance of supply and demand. Advances in water conservation, as a water resources management tool, emerged in the United States in the mid- to late 1970s. Instead of building new dams and pipelines to increase supply, conservation was introduced to curb demand and delay the need for implementing the next water scheme. This was partly due to severe droughts, economic and political pressures. Conservation was normally found to be more cost-effective than supply augmentation. Innovative, low-flow plumbing equipment, developed and used in the Scandinavian countries and parts of Europe, was copied or incorporated into the water conservation programmes. Long-term water savings of between 20-30 percent, were achieved and short-term savings of 40-60 percent, were documented during droughts. However, these programmes were largely concentrated in the industrialised world. While countries in the SADC region have begun to apply water conservation and the technology is available, the practice is still in its infancy. Those who are and will be practising water conservation are pioneers in this field.

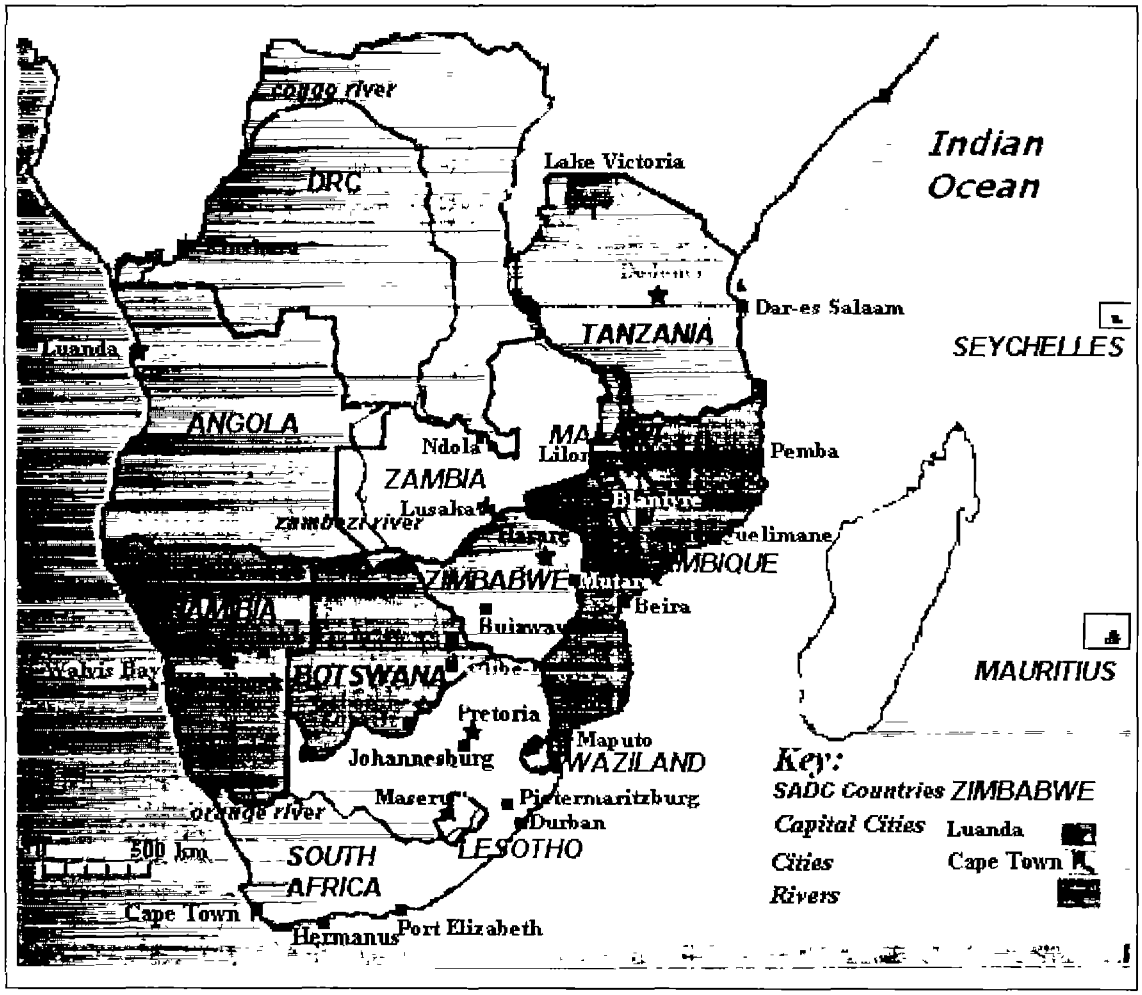
Why water conservation and drought management

> Urban centres in the SADC region are exploding, with populations doubling within 20-30 years.

Future populations will equally exert additional demands on water resources. With the existing populations, many are unserved by accessible and potable water. Millions of dollars could be and probably will be invested towards supply options; but this will not be enough, especially in this era of shrinking development aid and national budgets. The demand, both present and future must be reduced to cope with the supply/demand imbalances. This is where water conservation will play a major role.

Water conservation reduces unreasonable demand, thus helps in coping with ordinary supply/demand imbalances. Drought management significantly reduces short-term demand, thus helps in coping with drastic supply shortfalls. Both of these water management tools are very inexpensive compared to supply augmentation.

Map 1: Selected SADC Towns and Cities



Source. IMERCSA

Water conservation and drought management nomenclature

Water conservation

In the past, water conservation referred to supply options such as (conserving water behind) a dam. This terminology is common in many of the earlier textbooks on water resources management and engineering.

Today, the term water conservation is used inter-changeably with water demand management. It refers to long-term water use efficiency through both wise use and reduction in usage. Results take a while to materialise, but are usually sustainable.

Plans and programmes

Water conservation programmes and drought management plans are the framework or guiding strategy by which conservation and drought management measures are implemented. A plan is comprised by numerous programmes. The distinction between a plan and a programme is very subtle. A plan is described or formulated in a document and the programme is the execution or implementation of the strategies or measures described in that document.

Methods and measures

Typically, there is a distinction between conservation methods and measures. A method is the larger, umbrella term under which falls more specific measures. For example, a campaign to reduce unaccounted-for water would be a conservation method. Supporting this method would be a number of measures such as leak detection and repair, increased metering, meter repair, and reduction in theft.

80/20 Principle

In the SADC region, there are numerous conservation methods (and measures) that can be used to reduce water demand. This report, however, advocates the "80/20 principle" to water conservation. That is, effort should be applied for 20 percent of the possible conservation methods to obtain 80 percent of the results. This assures that there is a prioritisation of efforts and an organised approach aimed at maximising impact while minimising effort and costs.

State of the art

While this report advocates the 80/20 principle towards the selection of water conservation methods, planners should keep an open mind towards whatever might be most effective. The objective is to reduce demand at a reasonable cost without undue inconvenience to the consumers. An example of "state of the art" thinking with water conservation is to change from water-based sanitary disposal to dry-based If health problems can be mitigated, this would be very effective in large urban and peri-urban areas that are not yet "attached" to the conventional sewerage system. Dry-based sanitary disposal would obviate the need for large volumes of water and wastewater treatment. Another idea is "dual piped systems" using reclaimed water: one pipe for exterior irrigation and non-drinking water demands and the second for potable water for interior water uses such as taps and showers or baths.

Wherever water systems are not yet fully developed and populations growing, there exists opportunities for innovative concepts to be implemented. Here is where countries in the SADC region could have a distinct advantage over countries in the developed world that are already committed to their systems even if they are not efficient and are outdated.

Drought management

Urban drought management is almost always applied during droughts, but can also be used during emergency periods such as when a large pipe bursts or a supply source becomes contaminated.

> Drought management are actions, over and above 'water conservation' that are aimed at *short-term aggressive demand reductions and supply augmentation*. Results from drought management are achieved rapidly and fade rapidly after the drought.

When a city or water utility is faced with drought conditions and has to ration water, this is an element of drought management When the same city or utility has to bring in bowsers of water to fill empty tanks during a drought, this is another form of drought management. The actions are severe and have to achieve substantial results in a short period.

If drought management has to be practised annually, then it is no longer a response to a drought but simply poor management. In this case, longer-term solutions are crucial. These include water conservation and perhaps supply alternatives once the water conservation potential has been achieved.

Impacts of water conservation and drought management

Water conservation has been practised, as a water resources management tool for over 20 years because it reduces demand, is cost-effective and environmentally sound. There are some disadvantages, such as reduced revenue. However, these pale in comparison to the benefits which include water savings, wastewater and energy (demand) reductions as well as benefits to the environment. All of these benefits are also associated with favourable financial consequences.

Water savings

Numerous studies have been conducted in developed and developing countries that clearly demonstrate the efficacy of water conservation and drought management. Depending on the mix and type of conservation methods, long-term (annual average) savings can be up to 30 percent. Short-term savings, for example, to mitigate drought impacts, show much higher savings of up to 60 percent of annual average demands.

Wastewater and energy savings

An added advantage of water conservation is that less wastewater has to be treated and less energy (electrical) is used. When a household uses less water in the shower and kitchen or when a factory recycles more of its process water, then it will discharge less to the municipal or on-site treatment systems. Smaller consumption also require less electricity for heating the water in a geyser, pumping or treatment. Often, the wastewater reductions and energy savings generate a larger financial reward than water savings alone. The reason for this is that the unit cost of wastewater disposal and power generation is more expensive than water treatment and distribution.

Environmental implications

Water conservation and drought management can be used to downsize, delay or reduce the need for new pipelines, dams, and treatment works. The construction of these works, alteration of flow patterns and disturbances to breeding/migratory areas normally damages the environment Therefore, water conservation has a positive environmental impact just by minimising the need for these facilities.

Our environment can be considered the greatest benefactor from water conservation and drought management.

The more water is used efficiently, the less is required from natural sources. If more water is left in primary sources such as rivers and lakes, then more is available for aquatic, mammal and bird species as well as riverine plants, microbial and crustaceous species. Other benefits include improved aesthetic quality and value of water sources (raw and receiving) and instilling a sense of responsibility on the part of the consumers.

Financial savings

The financial savings from water conservation are significant. These include utility savings for capital costs (e g., pipelines) and savings for operating cost (e.g., chemicals and pumping). There are also savings to the consumer in reduced bills when the savings are passed on to the consumer, although this is rare. Figure E.1 illustrates cost savings from delayed construction. In this case, construction of additional supply has been delayed by four years. This results in financial savings, from the initial capital investment, due to the time value of money. This also results in savings (from four years without operating costs) for such items as chemicals, pumping or labour.

Cost implications

The design, implementation and maintenance of water conservation measures are not free. For example, leak detection/reduction requires field investigations and usually the purchase of leak detection devices, the capital cost of new fittings or pipes as well as the cost of labour Another example is industrial recycling. The recycling does not necessarily require external treatment of the polluted water because it can be recycled in the industrial process. But, a recycling system must be built in order to use the effluent. The reuse of water requires some form of treatment to improve the quality of the effluent for reuse (for example, where domestic sewage is treated for reuse as irrigation water for a golf course). This may require conveyance modifications, additional pumping and chemical costs.

The advantage that conservation measures have however is that in most cases it is less expensive than water supply options. The cost per volume saved by water conservation is less than the cost per volume gained by water supply. In fact, water conservation is usually significantly less expensive than water supply. Whenever deciding upon either supply or water conservation options, it is important to calculate the benefits and costs of each option to justify the expenditure and gain confidence in these assertions.

Present situation in the SADC region

Most utilities in the SADC region have not seriously embraced the advantages and benefits of water conservation. This situation cannot be allowed to continue.

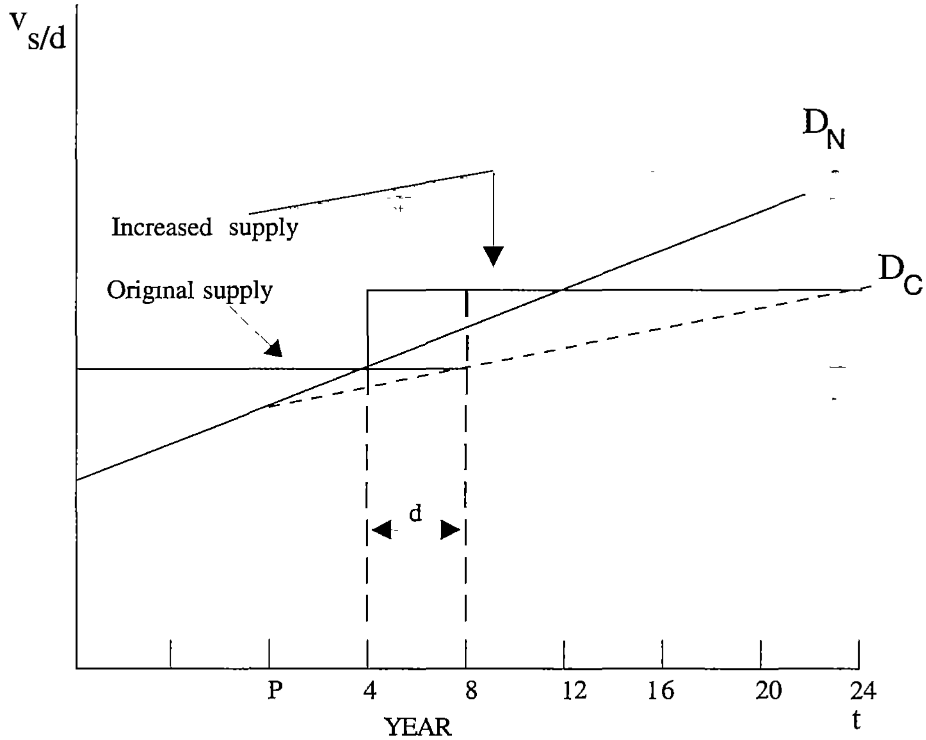
Implementation Obstacles

If water conservation is such a good idea, why isn't it being universally implemented in the SADC region? The answer is not because it is a bad idea, but due to existing obstacles faced by this relatively new concept.

Understanding

Clearly the most serious obstacle in achieving any success with a water conservation strategy is the low level of understanding by the decision-makers and the users about the technical and financial

Figure E.1: Cost Savings from Delayed Construction



Key to Figure E.1

d:	4-year delay in construction due to conservation
D_C:	Conservation demand
D_N:	Normal demand
P:	Present time (Now)
t:	time
Vs/d:	Supply/demand volume

1. Figure E.1 illustrates the delay in constructing new supply reservoir if water is conserved.
2. When supply equals demand, (shown by the line D_N) a new reservoir has to be constructed It is generally wise to construct new reservoirs when drought supplies equal demand, to avoid any possible deficits.
3 The delay is favourable because of the associated savings from the initial capital investment (time value for money) and savings from 4 years without operating costs for the new reservoir, especially so if the construction costs are constant at least in real terms over time.
4. The wider the angle between "normal demand" and conservation demand, the more effective conservation is, and hence the later the need to construct facilities to sustain increased demand.

benefits of conserving water. Without this understanding, decision-makers won't approve and facilitate the use of water conservation. Without this understanding, the stakeholders won't be able to accept and assist with approved and then implemented water conservation methods.

Policy

Until a stronger legislative backbone supports the concept, water conservation successes will be small and mostly in drought prone areas. However, even with the establishment of effective policies, success will be elusive unless there is a commitment to enforcement. Policies or regulations not only have to be established, but supported from the highest levels and with realistic budgets allocated for their enforcement.

Resources

Once the need for water conservation is accepted and policy commitments have been made, the financial resources must be made available and people trained or educated for significant progress to occur. Water conservation measures require initial capital investments, as well as operation and maintenance (O&M) budgets depending on the technology used. This can be compared to the cost of a new dam or pumping station when no conservation is practised. They also require trained and committed staff to run them (similar to a pumping station).

Negative Impacts

Both drought management and water conservation measures have been criticised for the following reasons:

Reduced revenue

When the demand for water decreases, the revenue from the sale of water also decreases. When less water is supplied, there is only a saving on the variable operating costs such as hours of pumping and power costs, but the fixed operating costs which include salaries, for instance, remain the same. This means that both the fixed capital and interest redemption cost must be recovered including the operating costs and therefore, conservation measures provide for an increase in tariffs to be able to cover capital and fixed operating costs.

Unaccounted flow causes a loss in revenue and even if the unaccounted flow is little, it is still a loss. On the part of the water utilities, what is important is to improve billing efficiency while the consumers on their part, must pay for the water supplied and consumed.

Reduced capacity for drought savings

A further argument against water conservation is that it removes the "fat" or the possibility to reduce water demand. Therefore, when a drought occurs, there are no further savings available since the consumers are already saving water as efficiently as possible. Past studies have found this argument to be only marginally correct. Savings during a water conservation programme are achieved through technical adjustments (e.g., replacing water using fixtures or increasing reuse potential). Savings during a drought are more attitudinal due to fear of actually "running dry" or fear of paying too much for water and being fined. The savings can and have been significantly higher (for short periods of time) than technical savings achieved during a water conservation programme. Therefore, even if savings are achieved by virtue of a water conservation programme, additional savings could be achieved from a drought management programme.

Concentrated flows

When the water demand is reduced due to water conservation measures, the production of sewage or wastewater is less. This can cause blockage of the sewage conveyance system. Solutions include constructing interconnecting pipes or interconnection chambers to allow for reuse flows to be "flushed" through the conveyance network. Another method is to request contributors to the sewage conveyance system to simultaneously make a large contribution to the network (e.g., flush at the same time).

Negative publicity

Often water suppliers are reluctant to initiate and advertise water conservation programmes particularly drought management programmes due to the negative publicity. The inference is that the water suppliers are implementing these programmes due to poor water supply management. This could not be further from the truth if water conservation measures and drought management were implemented systematically over time under normal conditions. The water supply managers and their organisations could actually demonstrate a resolve towards efficiency and lowering long-term water rates. They could demonstrate their ability to manage natural disasters (i.e. droughts). They could show that the organisation is well managed and operates in a proactive rather than reactive mode. Most new businesses and industries would gain confidence in moving to a particular city if they felt the water supplier was progressive and proactive in its control of demand and administration of its water supply system. The public must also be educated and be made aware of the advantages of water conservation.

Proposed way forward

Given the limited financial resources of the region, donor funding notwithstanding, it is important by governments and others such as the media to prioritise and to provide support to water suppliers for sustainable initiatives that will bring about major reductions in water demand. Within this context the following action items are suggested to achieve this goal:

- ☐ Requirement that all future water and wastewater infrastructure projects include the analysis of the impact of water conservation and drought management as they relate to the projects.
- ☐ Requirement that all municipalities of over 100,000 consumers have detailed and implemented water conservation programmes with clearly identified targeted water saving goals and a cost/benefit analysis of the different options.
- ☐ Requirement that all municipalities of over 100,000 consumers have detailed and completely approved drought management programmes, which are fully supported by, impacted consumer group representatives and key decision-makers.
- ☐ Water suppliers conduct when appropriate, a supply area study of the following key elements:
    - Unaccounted-for water.
    - Meter coverage.
    - Accounts receivable success.
- ☐ Water suppliers undertake assessments on the achievements made through water conservation and how these can be improved further in the event of increased demand.

A Tale of Three Cities

Of the 11 SADC cities studied, three were selected for detailed study regarding water conservation. These are Bulawayo in Zimbabwe, Hermanus in South Africa, and Windhoek in Namibia.

Water management in Bulawayo

Bulawayo was selected as a good representation of many cities in the SADC region. It is progressive towards commercial/economic growth, but has been stymied by lack of sufficient water resources. In 1991-92, it had to battle with the effects of a crippling drought.

Water situation

The evaluation of past and future water conservation for any city requires an understanding of the customer base (past, present and future) and how it uses water. During the 1991-92 drought, Bulawayo's domestic demand averaged 80 litres per capita per day (lcd) in the high-density areas and 220 lcd in the low-density areas.[1] Water demand is expected to grow by three percent annually.[2]

Water conservation

Bulawayo is a relatively progressive city in the SADC region when it comes to water conservation and this is reflected in a low per capita water demand. During the 1991-92 drought, the penalties for overuse were quite stiff, amounting to Z$10/kl (ZWD 10/$m^3$) for households up to 10 m^3 per month above the rationed amount. Any additional demand was charged at Z$100/$m^3$

However, the city has since reverted to more basic issues of water system maintenance, long-term supply/conservation and bill collection. Maintenance and even some capital projects suffer for lack of success in bill collection. For example, in 1997 residents of Bulawayo were in arrears by Z$20 million for payment of outstanding water bills.[3]

Unaccounted-for Water

Estimates for Bulawayo's unaccounted-for water (UfW) have ranged from 17.5-40 percent of total produced water. One of the reasons for high unaccounted-for water is possibly due to meter registration and meter reading errors. For example, in 1996, about three percent of the bills were based on estimates. Leakage control was the responsibility of one-person patrols, on a bicycle, for the 2,100-km of pipeline. Bulk metres, whether functioning or not, are being read although it appears as if data is not being analysed to spot irregularities. The city is also trying to control pressures through the strategic placement of pressure reducing valves. The city wants to achieve full metering of all its consumers.

Water Rates

Bulawayo has an aggressive increasing block rate structure for domestic consumers and fixed rates for industrial consumers aimed at reducing water demand.

Bulawayo's block rate structure

Range	**Domestic cost/m^3 as of 1/10/97**		**Industrial cost/m^3 as of 1/10/97**	
Monthly Use (m^3)	**Inside City (Z$)**	**Outside City (Z$)**	**Inside City (Z$)**	**Outside City (Z$)**
0-18	2.40	2.64	NA	NA
18-30	5.00	6.00	NA	NA
30+	7.80	9 30	6.25	7.00
Fixed charges	18.00	42.00	65.00	120.00

(When these figures were given, US$1 was equivalent to Z$14)

Bulawayo's tariffs as shown in the Table are in line with the locally produced *Water Conservation Study*, a report that recommended the tariffs to be gradually increased until they reach the long-term marginal cost of water.[4]

Capital facilities are typically sized for the larger water users such as industrial consumers and large water-using commercial and institutional consumers. If they were sized for residential or smaller commercial consumers, they could be much smaller and the resulting water rates lower. The varying costs used in increasing block rate structures, therefore, are considered a fair method of payment. That is, if facilities such as a pumping station are sized to accommodate high peak demand of a soap manufacturer, then the soap manufacturer will be paying rates in the highest block rate The residential user, who does not need this level of service, will be in the lower block and paying the lower block rates. Increasing block rates are not only fair, but also encourage consumers to be more efficient.

In addition, Bulawayo uses what are called *Owners Rates* that include payment for disposal of wastewater and rubbish as well as payment for land use. It is the element of wastewater rates that has an impact on reducing demand since it is tied to the number of toilets for domestic and effluent discharge for industrial consumers.

Demands are further reduced by the continuation of (a form of) the Water Rationing Act instituted during the 1991/92 drought. The Urban Councils Act No. 24 (dated May 8, 1996) is paraphrased below:

- 800 litres/d allowed for individually metered houses and flats and residential building operations on vacant stands (if development is taking place).
- 400 litres/d allowed for bulk metered cottages and residential flats
- 100 percent of average water use (based on June to November 1994 use) allowed for multi purpose buildings with bulk meters.
- 100 percent of average water use (based on June to November 1994 use) allowed for hotels, hospitals, clinics, industrial and commercial consumers, restaurants and Esigodini.
- 100 percent of entitlement allowed for the Mzinyathini Irrigation Scheme.
- No allowances given for swimming pools, weddings and other gatherings.
- No use of hosepipes for industrial/commercial users (unless part of industrial process or from borehole/well).
- Leakage (1st offense) quantities must be paid plus 50 percent in penalty fees.
- Leakage (2nd offense) quantities must be paid plus 75 percent in penalty fees.
- Leakage (3rd offense) quantities must be paid plus 100 percent in penalty fees.
- If customer exceeds allocation on 3 successive occasions, service is cut off.

(The surcharge, for excess use discussed above, is Z$ 15/m³)

Recycling

Currently, the sewerage system and the remainder serve about 90 percent of the city's population by septic tanks. An average of 8 Ml/d (8,000 m3/d) is reclaimed and used to irrigate parks, playing fields, road margins, central reservations and sports fields. The city's goal is to reuse 20 percent of domestic wastewater.[5] One hundred percent recycling of industrial effluent is also possible.[6]

Future conservation

Additional suggested conservation measures include:

- Achieving the savings potential for breweries (clear and traditional beer) and bottling companies to reduce water demand and effluent discharge. The "once-through" flows could be treated and recycled. Specific once-through flows include:

- ☐ Clean up operations
- ☐ Clean up of holding tanks (e.g., malt tanks or syrup tanks)
- ☐ Container washing operations

Initial capital costs to set up treatment, monitoring and reticulation systems for recycling would be high. It is recommended that manufacturers and distributors of recycling equipment/services be contacted for free audits of recycling potential and payback calculations. It might be possible to have the manufacturers and service companies pay the initial capital costs with guarantees for cost-recovery from savings (water/wastewater/energy). This holds true for other high water using industrial consumers such as abattoirs and foundries.

- ☐ If applicable, reform the billing structures to ensure that the direct water users are the direct monthly water payers. They have little to no incentive to conserve if they don't directly pay. Also, all consumers should pay based on an increasing block rate billing structure.
- ☐ Implement a government / institutional exterior demand reduction method to improve irrigation equipment, and educate homeowners and groundskeepers on efficient irrigation techniques. Irrigation during the high evapotranspiration (ET) hours and excessive runoff can be prohibited.
- ☐ Implement a residential and commercial interior-demand-reduction method to repair leaks and replace existing inefficient plumbing fixtures. Previous reports estimate 20,000 m^3/d-savings from low water use fixtures at a cost of ZW$600 per house.[7]
- ☐ If applicable, metering and billing of effluent from industrial consumers who discharge to municipal sewers or waterways without adequate treatment.
- ☐ Development and approval of a thorough/comprehensive (updated) drought management plan.

Reasonable rates of long-term water demand reductions, (e.g. 20-30 percent) can be mandated by the "top down" approach and achieved by Bulawayo or any municipality. Larger, short-term reductions, between 40-60 percent, can be achieved by implementing a drought management programme.

Water management in Hermanus

Hermanus is a small, tourist town on the south-eastern coast of South Africa, near Cape Town. While Hermanus is more of a middle income, vacation suburb than a large metropolis, it has significant and aggressive initiatives in water conservation. Hermanus is also the namesake for South Africa's Hermanus Declaration on water conservation.

Water situation

In 1996, the population was 22,481. There are 70 industrial consumers, 7,357 single family residences and 779 multiple family residences.

Hermanus' water demand patterns[8]

Year	Cubic Metres
1991-92	2,413,000
1992-93	2,451,000
1993-94	2,896,000
1994-95	2,886,000
1995-96	3,010,000
1996-97	2,424,000

Water conservation is focused on interior and exterior domestic uses followed by control of municipal UfW.

Water conservation

The Greater Hermanus Water Conservation Programme started in October 1996 with the goal of reducing water demand by 30 percent in three years. In the first year, savings of 19.5 percent were achieved. The savings were enough to provide water to an additional 1,395 homes (based on a household use of 35 m3/month). These savings and the ability to find water for new dwellings were necessary due to the growth in Hermanus for high-density residential complexes and retirement villages.

Some of the water conservation activities include:

- Block rate tariffs
- Water invasive alien vegetation clearing project
- School water audits
- Water loss management
- Water wise gardening
- Public information
- Adoption of national water regulations as municipal by-laws
- Security meters and pre-paid meters

Block rate tariffs

The rate structure was devised such that those who drive the marginal cost of water pay the marginal price.

Hermanus' increasing block rate structure

Use in Kilolitres	Cost in Rand/ kilolitre
0-5	0.3
6-10	0.7
11-15	1.7
16-20	1.8
21-25	2.4
26-30	3.0
31-40	4.0
41-60	5.0
61-80	6.0
81-100	7.5
101+	10.0

(When these figures were given, US$1 was about 5 Rand)

Water invasive alien vegetation clearing project

In 1996, unemployed residents were hired to clear the dam catchment area of exotic (invasive) vegetation. The catchment was 70-100 percent infested with the exotics, including Jackson, Hakea, Blue gum, Black Wattle, Cluster Pine, Rooikrans and Myrtle.

School water audits

This measure piggybacked the national water conservation campaign's educational arm to involve pupils in conducting water audits of their schools and homes. The audit helped determine how much water is being used, where the water is used and the implementation of water savings ideas.

Water loss management

This is a multi-pronged method including the metering of all water (even so far as hydrants and standpipes in undeveloped housing areas). Master water meters are installed at each of the supply reservoirs. Monthly water balances and audit for each service zone is conducted to identify the area with the highest UfW. Other measures include checking for minimum night flows, meter under-registration, unmetered connections and for recording pipe bursts and scouring.

Water-wise gardening

The garden was a target for water conservation since it consumes 26 percent of all water supplied. The public education campaign included mailing out a brochure on water-wise gardening to consumers, and a low-water use plant competition for local nurseries. There were also two low-water use demonstration gardens (showing low water use and high water use plants for comparative purposes).

Security meters and pre-paid meters

This pilot project entailed the installation of pre-payment meters in some homes. This gave the customer the opportunity to not only pre-pay for water but to pre-pay for other municipal services as well. The meter is also fitted with a panic button for various problems that the customer may face such as a break-in or fire.

Greater Hermanus' 32 percent reduction in water use has enormous implications. For example, were greater Cape Town to achieve this (and there is no reason why it should not do so), it would save 80,000 million cubic metres of water a year. This would enable it to postpone the building of its next dam by seven years, saving R780 million in interest. Such water savings for Gauteng would run into billions of Rand. South Africa's Minister of Water Affairs and Forestry, Prof. Kader Asmal, has called this programme, "—potentially the most important water management initiative ever undertaken in South Africa".[9]

Water management in Windhoek

The table below provides startling data that total water demand has actually started to decrease as a result of Windhoek's waters conservation efforts. This is not only uncommon in the SADC region, but in the world as well.

Windhoek's water demand pattern (m^3/yr)

Year	Population	Residential	Industrial	Commercial	Total use	Production
1995	181,696	10,057,093	1,537,389	4,419,996	16,014,478	17,913,286
1996	191,508	7,828,783	1,413,571	4,094,164	13,336,518	15,172,375

The 1995 water demand per person of 241.5 litres per day and of 196 litres per day in 1996 shows what is possible when water conservation is given full support.[10] The UfW for 1995 of 10.6 percent and 12.1 percent for 1996 is also relatively very low compared to other developing countries. This success is even more outstanding in light of the population growth rate of 5.1 percent annually.

There is a reason behind Windhoek's success in water conservation. In the next 10-15 years, Windhoek will probably need to tap its nearest perennial water source, the Okavango River: about 800 km away.[11] Reports vary widely and have stated that if the supply/demand situation in Windhoek did not change, the city would run short of water any time between 1998 and 2009.[12,13]

Water conservation

Windhoek is already acting to mitigate the potential water shortage problem with the implementation of water conservation principles. An integrated policy on Water Demand Management was approved by the city council in 1994. The daily per capita residential (only) demand was reduced from 210 litres in 1991 to 124 litres in 1996.

Windhoek's conservation efforts date back to the early 1950s when it planned the construction of a 4,500 m3/d physico-chemical wastewater reclamation plant, which was commissioned in 1969. By the end of 1999, Windhoek would be able to reuse all its wastewater to water parks, sports fields or cemeteries through a two-pipe system and the reclamation to a potable standard. On the domestic side, about 13 percent of wastewater is treated for reuse.[14] But, about 60 percent of all water used in up-market Windhoek is for gardens. Its infiltration into lawns and gardens makes it unavailable for reuse. Water for gardening represents a large sector for savings.

An important conservation programme involves appropriate and conjunctive tariffs. When tariffs are sufficiently high, they tend to keep exterior irrigation demands reasonable. Water tariffs were recently raised by 30 percent and any water demand exceeding 60 m^3/month per household or enterprise was billed at 5.30 ZAR/m^3. However, it has been reported that the steep increases in price of water had little effect on water demands during the 1991-92 drought because residents wanted to maintain their green gardens.[15]

Windhoek's increasing block rate structure (effective July 1, 1997)

Use in (m^3) per month	Tariff (N$/$m^3$)
0-8	2.20
8-15	3.10
15-36	3.80
36-45	5.00
45+	6.50

(When these figures were given, US$1 was about 5 N$)

The existing tariffs for businesses and industries with water meters larger than 25 mm will be amended to N$4.00/$m^3$. Industrial consumers pay a wastewater tariff based on percentage of their water demand and pollution load. Also, the tariffs for standpipes will be increased from N$1.85 to N$2.00/m^3 (i.e. N$5.40/family/month). The Water Demand Management programme is financed by a 0.5 percent levy.

The city is also trying to reduce UfW. Infrastructure maintenance is expected to improve after commercialisation of the bulk water supply section of the Namibian Department of Water Affairs (DWA).

As of 1997 the specific water conservation activities being implemented in Windhoek include:

- Water audits
- Meter replacements
- Metering of all connections
- Public awareness and education
- Block rate tariffs
- No irrigation of gardens between 10:00 and 16:00 (mandatory)
- Use of swimming pools covers (mandatory)
- Use of low-flush toilets (mandatory for building plans approved after January 1997)
- Use of low-rate showers less than 10 litres/minute
- Reuse of purified effluent for irrigation and reclamation to a potable standard
- Water conservation guidelines for wet industries
- Direct recharge of groundwater
- On-site reuse of "gray water" (e.g. sink and bath water)
- Encouragement of efficient irrigation measures by training of gardeners
- Encouragement of mulching (soil conditioning) to reduce garden water use
- Target per capita demand to 100 lcd and demand growth to less than three percent in five years.

Future conservation

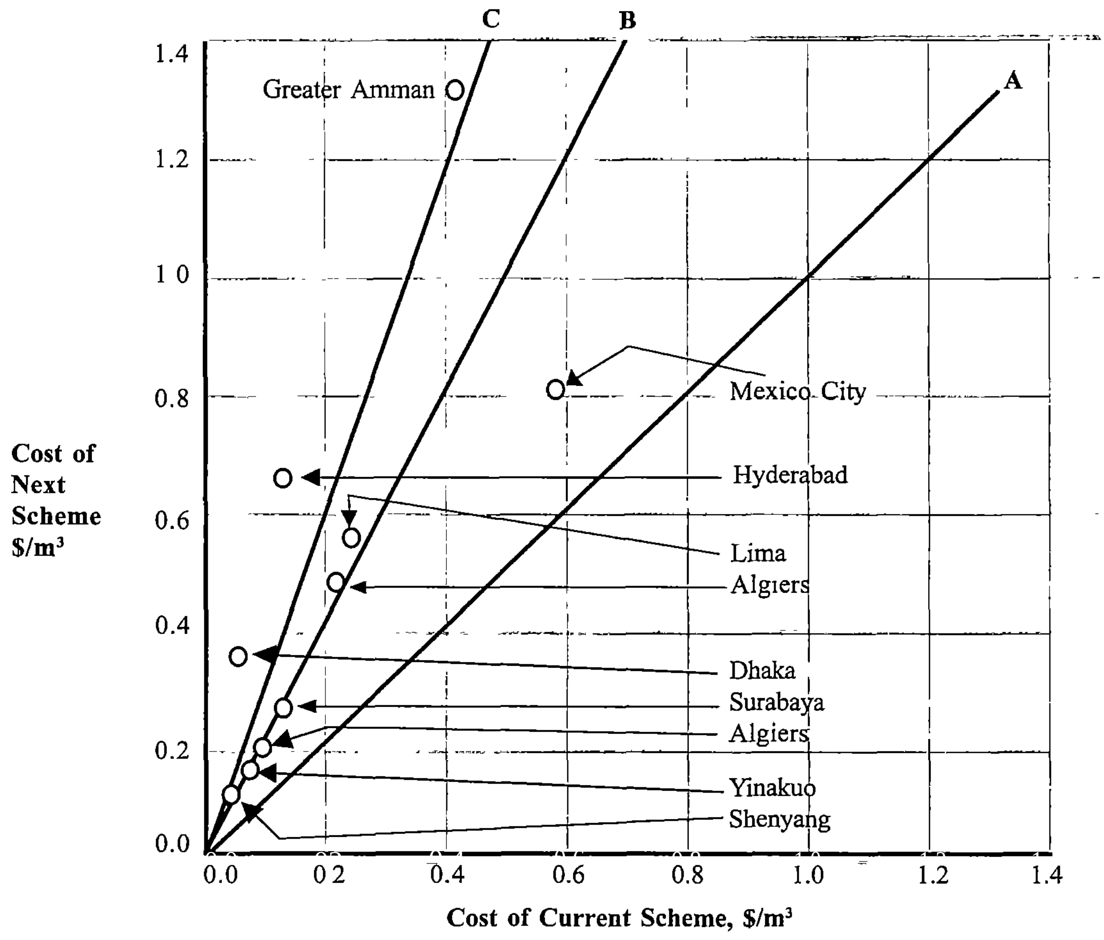
If plans for the extension of the Goreangab Water Reclamation Works go ahead and a strict water policy on conservation is implemented, then the production sources would be able to supply water until the year 2000/10 (based on a 95 percent reliability from the main supply sources).

Clearly, the target group to reduce demand is the residential users (including new consumers). Windhoek should add drought mitigation to its conservation programme and update the drought management plan. The recently achieved water demand reductions can be continued and perhaps mandated within the Policy Issues" section of the Windhoek water conservation plan Larger, short-term reductions, between 40-60 percent can be achieved through the implementation of a drought management programme.

INTRODUCTION

The World Bank estimates that 80 percent of future economic growth in the developing world will occur in urban areas[16]. With the Southern African Development Community (SADC) region's urban population projected to grow by six percent annually[17], water supplies are and will continue to be severely stressed in the region. For example, the annual urban population growth rate in Mozambique, Botswana and Tanzania between 1990-95 was 7.77, 7.14 and 6.51 percent respectively[18]. This far exceeds the urban growth rate of 4.4 percent for the whole of Africa. Assuming the population growth rate in the SADC region remained constant, new water supplies will not only be required but demand will also have to be controlled to avert shortfalls. Reliance on the supply side of the equation is becoming increasingly more expensive. The cost to develop a new water source (or water scheme) is often two to three times the cost of current sources.

Figure I.1:Cost of Water Supply (as at 1988 prices)



A: Cost ratio Next to Current x 1; B: Cost ration Next to Current x 2; C: Cost Ratio Next to Current x 3.

The illustration on Cost of Water Supply from the World Bank Policy Paper on Water Resources Management reveals that reliance on the supply side of the equation is becoming increasingly more expensive. Learning from the sample of municipalities from developing countries, the cost of the "next" water source (or scheme) is often 2 to 3 times the cost of current sources (or schemes). The cost and price of water sold will naturally escalate. This is as it should be since the least costly sources are usually exploited first and have been paid for with "old money" [19]

This study focuses on the demand side of the water supply/demand equation. That is, the water conservation/demand management potential for the urban centres in the SADC region. Its objective is to provide an initial look into the potential of water conservation in the region.

The study's main objectives were to:

- Determine urban (i.e. towns, and cities) water demand and use patterns in the SADC region.
- Suggest ways of urban water conservation, and factors influencing their implementation.
- Assess the potential for drought management with regard to urban water conservation strategies.

In preparing this study, officers in relevant water ministries, municipalities, the donor community and NGOs in 12 of the 14 SADC member states were contacted (see acknowledgements) to facilitate their involvement in data gathering. In addition personal contacts were made with experts in the field and relevant literature which included both published and unpublished material such as books, manuscripts, conference papers, articles and journals were consulted.

Field visits were also made to cities in Mozambique, South Africa and Zimbabwe to gather relevant data on urban water demand and supply.

Two approaches were employed to estimate water conservation potential: the *bottom-up approach*, which involved many calculations and estimates; and the *top-down approach*, which involved the mandating of required water demand reductions.

The main water demand categories used in this study were domestic, industrial, commercial, institutional and other uses. The other-uses category in this case, included water loss such as unaccounted for water (UfW), utility usage and evaporation as well as transmission loses.

The larger concepts of integrated water resources management and associated environmental issues are not discussed in detail. Similarly, high population growth rates and lack of attention to the balance between environmental realities and the necessity for agricultural development are not discussed but are factors affecting urban water scarcity. Without appropriate attention to deforestation, desertification, soil erosion, overpopulation, overgrazing and poor planning and management of both the agricultural and urban sectors, there will be even less water available in the watersheds serving consumers. These issues and the solutions, however important, do not form part of this report.

CHAPTER 1

Urban Water Demand in the SADC Region

Water demand and use categories

Demand forecasting is a critical element during project preparation as it determines the timing, the size, the phasing, and the cost of a water supply project, as well as the financial and economic benefits.[20]

The most important element in determining water conservation potential is the collection of accurate water consumption data Poor knowledge of water consumption has led to inaccurate water demand projections, usually overestimated, and too costly infrastructure investments where much of the capacity remains unused for a number of years.

Two major projects, the 1971 Second Bogota Water Supply project in Colombia and the 1978 Greater Sao Paulo Sewage Collection and Treatment project in Brazil'[21], provide examples of issues that could arise due to inaccurate water demand projections.

In Bogota, population, number of connections, and per capita demand projection levels were all overestimated, resulting in the volume of actual demand falling well below installed capacity. The water company was placed in serious financial difficulties.

In Sao Paulo, technological changes and price fluctuations reflected by demand for water were not taken into consideration. One major deficiency during the preparation of the Sao Paulo project was to assume that industries would always choose to discharge their effluent into the municipal waste treatment plant, regardless of price charged. The industries resorted to water conservation and discharge reductions, after the establishment of industrial effluent discharge fees as would have been expected The result, as in Bogota, was an oversized system that has been functioning well below its capacity for many years.[22]

Determination of urban water conservation potential requires knowledge of the water budget: how much water is, and will be used in different use categories. Urban water demand and use categories usually considered, are presented in Box 1.1.

Usually, commercial categories are combined with institutional due to similarities in their water demand and use patterns. Water demand is, therefore, assessed on an annual basis, according to the stated groups. Knowledge about these categories helps in calculating savings or effectively targeting conservation programmes. Where applicable, data on peak period consumption are obtained to facilitate accurate planning. Such data help in estimating storage and pumping capacities needed to satisfy consumer requirements, particularly during peak demand periods.

During dry periods, water demands tend to increase and such variations need to be properly accounted for during planning stages. Therefore, one of the reasons why detailed water consumption data are important is that such knowledge helps the water planner target key areas when trying to reduce water demand

Box 1.1: Urban water demand and use categories

Domestic/residential	normally single and multiple family (flat and apartment) consumers
Commercial:	store owners, restaurants, and hotel consumers.
Institutional:	government and public facilities consumers such as hospitals, office buildings, retirement homes, churches, and parks.
Industrial	water users including bottlers, refineries, tanneries, abattoirs, foundries, soap manufacturers and textile manufacturers,
Other demand:	demand and use patterns falling outside those specified above

The ideal situation is to have readily available, all the data for water consumption and use. Such data are, however, in most cases (including the scenario presented during this study), hard to acquire. This implies that a number of estimations have to be made.

Calculation of water demand

Specific water demand data can be obtained through bottom up calculations; that is, through the use of water and wastewater meter readings, unit data, field analysis or any other acceptable means. Unit calculations require data such as demand per person and the total population served. Field analysis requires approaches such as the 'bucket and stop watch' flow tests, micro-metering or other methods to test demand assumptions in the field.

To estimate domestic or residential water demand, some important factors include.[23] family size and income, ownership and age of the house; physical factors such as temperature and precipitation; and water conservation approaches such as water price and conservation programmes in place. Family size and temperature usually lead to an increase in water demand, while ownership and age of the house, precipitation, increased water price and conservation programmes in place all lead to a decrease in water demand.

For a reasonably accurate bottom-up computation of water demand, the minimum unit demand variables shown in Table 1.1 should be considered.[24]

Table 1.1: Unit water demand categories

Category	Current/Future Units	Unit Water Demand
Domestic/ Residential	Single family units Single family household size Single family lawn size Multiple family units Multiple family household size Multiple family lawn size	 Single family internal per capita water use Typical external water per square metre Multiple family internal per capita water use Typical external water per square metre
Commercial	Type of commercial establishments Building area of establishments Landscaped area establishments	 Typical internal water use per square metre Typical external water use per square metre
Industrial	Type of industrial establishments Units of production (e.g., tones of steel)	 Typical water use per unit of production
Other	Kilometres of pipe/canal Pipe/canal dimensions	Typical leakage rate per type, diameter and age of pipeline/canal

CHAPTER 2

Methods to Estimate Water Conservation Potential

Due to rising population and industrial development, water demand in the SADC region is equally bound to increase. Effective water conservation and drought management provides opportunities towards meeting present and future water demands in the region. However, this might be hard to determine because water conservation is still a young science in the SADC. Planners will want to see what has been done elsewhere and adjust those scenarios to the local conditions.

There are two general methods used for calculating or describing the savings potential from conservation applied in the southern Africa region. These are the bottom-up and the top-down approaches.

The Bottom-up approach

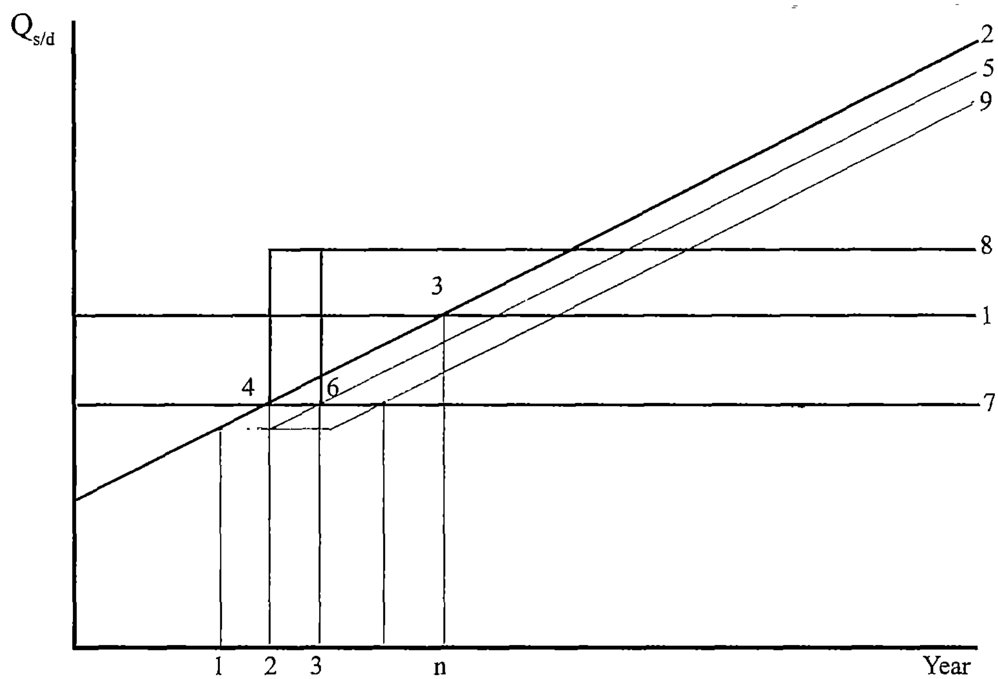
The first and most common method is the bottom-up water conservation approach, which can be calculated as follows:

Sw	=	(EUD-CUD) x FU x DUS x DU x AM x IM x FM
Where: Sw	=	Water savings;
EUD	=	Existing (pre-conservation) unit demand;
CUD	=	Conservation unit demand;
FU	=	Frequency of use of water-using device or equipment;
DUS	=	Dwelling unit size;
DU	=	Dwelling units;
AM	=	Applicable market;
IM	=	Initial market penetration;
FM	=	Future or final market penetration.

The future or final market penetration refers to the percentage of the population remaining to be impacted by the conservation method. The product of AM, IM and FM is the sustainable or resultant market penetration. The reduced value of the product (AM x IM x FM) indicates that a measure may not pertain to all consumers (AM), the water utility may only be able to attract a percentage of the applicable consumers (IM) and the conservation measure's savings may not last indefinitely (FM).

The problem with the bottom-up approach is that this level of detail (the components of the equation) is difficult to determine and must be estimated. Another consideration is the reliability of the elements in the calculation, given the uncertainties of the future. After the estimates are suggested, they should be checked for realism. In real situations, the calculated demand reductions don't occur automatically and tend to deteriorate with time due to poor maintenance or even removal of water-saving devices. This uncertainty is no different from that faced when calculating the benefits on the supply side (such as a dam). Construction and filling take time and then, with years of siltation, the basin loses some of its original capacity.

Figure 2.1: Impacts of Conservation



Key to Figure 2.1:

1: Normal year supply.
2: Normal year demand, which increases with population increase.
3: The year when normal supply meets normal demand.
4: The year when drought year supply meets normal demand and thus when construction should take place to assure future supply meets demand.
5: Required demand adjustment in year 2 to avert a drought year supply shortfall.
6: Year when construction can be delayed due to demand adjustments (No.5).
7: Drought year supply.
8: Augmented supply.
9: Required drought management demand adjustment to stave off a supply/demand shortfall in year 3.

Box 2.1 Simplified Procedures in Using the Bottom-up approach: Sample Calculation

Assume that it is desired to calculate the savings from replacing toilets in homes of large urban cities (using data from normal rainfall periods). The calculation therefore follows:

(15 lpf - 6 lpf) x (3 flushes per person/day) x (365 days/yr) x (5 persons/home) x (20,000 existing homes) x (0.8 applicability to existing homes) x (0.2 existing market penetration) x (0.8 long term market penetration) = 126 million litres saved per year for this one measure for this one customer classification and for this one hydrological situation. In this case,

Perhaps the 126 million litres saved is enough to forgo a water supply project. But what then if the traditional supply project is not constructed and this conservation saving of 126 million l/yr is not realised? The results would be severe if not catastrophic. Bottom up calculations require that uncertainties be removed which include but are not limited to:

(1) Determining the real initial flush volume; How much have the existing toilets been modified?
(2) What is the new flush volume? Will it increase with possible future modifications?
(3) How many times does a person flush per day? Will this change with lower flush rates and increased blockages?
(4) How many persons are in a typical (existing) home?
(5) How many homes are there? What is their occupancy rate?
(6) What is the applicable market?
(7) How many people will initially change out their toilet or toilet flush mechanism? There is very little data on this for the SADC region so rough, extrapolations will have to be made from other areas. How does the market penetration change in a drought year as opposed to a year with normal or above average rainfall?
(8) What is the long-term sustainability of this measure? Will the new toilet be replaced or modified?

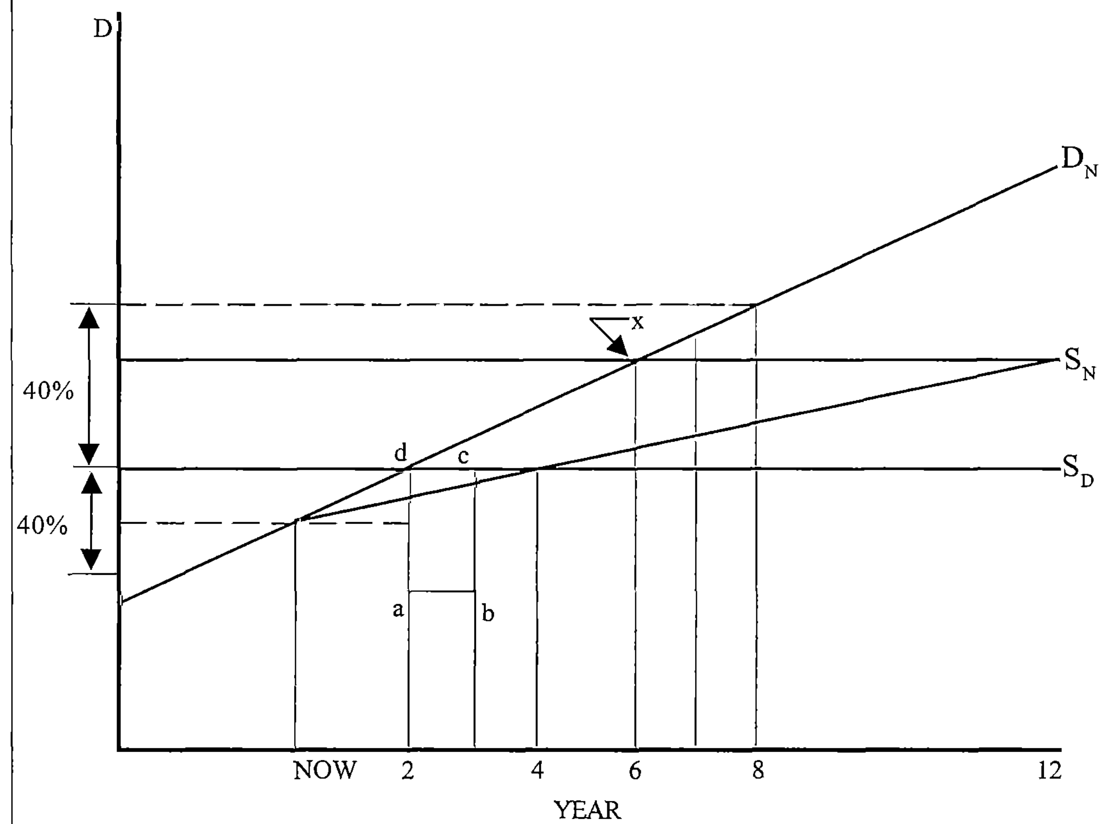
NB: lpf stands for litres per flush.

This is just one measure for one customer category for one type of water demand situation. The water conservation planner would typically conduct this analysis for the domestic (single and multiple family consumers), industrial, commercial, and institutional and other water users. This would include present and future users, and for normal and drought periods. This further increases the impact of the uncertainties. With these uncertainties, it is no wonder engineers and planners are reluctant to consider or calculate water conservation when determining water demands used to size future capital facilities. The difficulties faced by the bottom up approach demonstrate why it is uncommon to consider water conservation when calculating demand among the professional community of water engineers and planners. Conservation, however, has been proven to work cost-effectively, as it substantially reduces demand. To get over this obstacle, if insisting on using the bottom up approach, requires that one conduct small-scale pilot projects to collect accurate and up-to-date data without having to invest large sums of money.

The Top-down approach

Another method, considered to be more reliable in estimating conservation potential, is the Top-down approach. It states what the demand reduction must be, for example, 40 percent. This has commonly been used in drought situations because the local water utility knows the volume of its available water supply. It therefore, can easily state what demand curtailment is necessary so as not to run out of water.

Figure 2.2: Water supply and demand curve



Key to Figure 2.2

D. Supply and Demand Volume D_C: Conservation Demand
D_N: Normal Demand S_D: Drought -year Supply S_N: Normal-year Supply
abcd: Expected maximum Savings from a well executed drought management programme that is 40 percent of normal demand but can be sustained for only one year.

Notes:

The figure illustrates the delay in constructing new additional supply reservoirs (dams, lakes etc) if water is conserved.

When Original supply equals demand, (shown by point x in the graph) new reservoirs have to be constructed since demand will always increase with time, due to factors such as increase in population and industrialisation. The wider the angle between "normal demand" and conservation demand, the more effective conservation is, and hence, the later the need to construct plants to sustain increased demand.

The utility informs its consumers about a specific demand reduction required to ensure the available supply lasts until the next rains. Whatever it takes, this demand reduction is required and in most cases achieved To achieve a fixed and absolute reduction, this approach can be used when stating water conservation potential as well. An example demand reduction of say 20 percent could be set as an objective. Regardless of all the uncertainties, a commitment is needed by the water consumers to assure the 20 percent is achieved. If the 20 percent is not reached, additional efforts would have to be applied to achieve the 20 percent so as not to upset the supply/demand balance.

In a developing country this approach will throw up 'red flags' since it intimates maintenance, monitoring and adjustments to the conservation programme to assure that the percentage savings do not become something less.

Fortunately, SADC countries have shown greater success at demand modifications than developed countries. This is borne out perhaps more by necessity than planning. For example, the consumers in the City of Bulawayo, in Zimbabwe, realised savings of 62 percent during the 1991-92 drought

No method is perfect, but the Top-down approach is actually more reliable because it eliminates all the uncertainties described in the Bottom-up approach. Therefore, the former has gained greater acceptance by engineers and planners. It should be understood that mandated demand reductions are normally far larger for drought management than water conservation. The reason for this is that drought management is for a short period and consumers can usually accept larger cutbacks for a short period. Also the level of cooperation in the face of a severe threat is better and understanding by consumers increases during a drought.

Whatever calculation method is used, implementation will involve costs and water utilities in developing countries will struggle to operate and maintain cash reserves to assist consumers with water conservation. Revenues will at first decrease. The burden to recover costs when revenue decreases due to water conservation, is passed through to the consumers which results in little incentive for the consumer to save water. Implementing conservation however, should not be avoided because of the significant long-term cost difference between reducing demand and increasing supply. In a global climate of decreased budgets and donor funding, it is easier and less expensive to modify water demand than to augment supply.

Box 2.2: Detailed Procedures in Using the Top-Down Approach

Step 1: Required reduction in demand

Establish an initial figure of how much demand is to be reduced. This is usually dependent upon the existing (and expected) supply/demand situation both during drought and normal periods This initial demand reduction is only an estimate dependent upon a cost/benefit analysis. For example, it is unlikely that an 80 percent demand reduction would prove to be cost-effective. A graphical explanation of how this is determined is shown in Figure 2.2 which illustrates that:

- The expected maximum savings (abcd) from a well-executed drought management programme is 40 percent of normal demand, but can be sustained for only one year. This is because intense savings like 40 percent are difficult for consumers to maintain beyond short-term emergencies such as a drought.
- Drought-year supply meets demand two years from "NOW". Either an increase in supply would be required or effective drought mitigation and associated demand (abcd) realised.
- Normal-year supply meets demand six years from "NOW". If no drought management plans were in place, then supply augmentation would be obligatory.
- Drought-year supply meets conservation demand four years from "NOW". This effectively postpones the need for an increase in supply or any drought mitigation measures.
- Normal-year supply meets conservation demand 12 in years from "NOW". If no drought management plans were in place then supply augmentation could be delayed by six years.
- The combination of a drought management plan and water conservation has postponed the new supply source by six years.

Step 2: Cost/benefit analysis

The second step involves estimating the cost of the long-term demand modification (for the same reason that engineers and planners estimate the cost of dams and other infrastructure improvements). The cost of long-term demand modification helps determine its viability and acceptance and is required for normal budgeting. The method of estimating the cost of water conservation includes one element of the calculations used in the Bottom-up approach. It adds the necessary dollars to pay for the measures needed to change demand. These can include rebates or incentives to the customer to reduce water consumption, improve on inefficient plumbing fixtures, costs of water, electricity or sewage. Cost/Benefit analysis requires calculations for benefits accrued from reduced water, electricity usage and reduced effluent discharge fees.

Step 3: Selection of demand modification/supply augmentation

Having performed the cost/benefit calculation, one will have an idea of how much the water conservation will cost; say $0.20/m^3 saved (Namibia's 1992 Emergency Drought Relief Programme cost 50 ZAR/m^3). This would be compared to other supply augmentation schemes. Most studies have shown that this would cost less than supply augmentation schemes. While the demand reduction must still be considered fixed (using the top-down approach), the actual (calculated) cost of water must be qualified.

CHAPTER 3

Water Conservation Methods

In order to achieve a certain level of water savings, it is important to determine, first of all, what conservation methods are most practical for achieving the desired savings. There are numerous ways that can be used to reduce water demand in the SADC region. Some of the methods used in reducing water demand can be imported from practical experiences in other parts of the world. However, the most effective method is the one that applies the best in each individual case in this region and is easily adaptable and accepted.

While there are many conservation methods available, a strategy that needs mentioning is the '80/20 principle'. The principle states that efforts should be applied for 20 percent of the possible conservation methods to obtain 80 percent of the results. Five main methods are suggested for achieving savings in the SADC region:

- Reduced unaccounted-for water
- Reduced industrial demand.
- Reduced domestic demand.
- Reduced commercial/institutional demand.
- Reduced drought-period demand.

Reduced unauthorised unaccounted-for water method

Unauthorised unaccounted-for water (UfW) is a serious problem facing urban water systems. Samples of water losses from Mauritius[25], Ghana[26], Ethiopia[27], Sudan[28], Egypt[29] and Trinidad and Tobago[30] show loses ranging between 25-57 percent. Observations in the 1980s from four cities in the SADC region and three from outside the African continent, indicate that UfW has tended to worsen not improve[31]:

F. Zvomuya

Water losses through leakages in the distribution systems are one of the major problems faced by water supply institutions in the SADC region

Table 3.1: Unaccounted-for Water in selected cities as a percentage of total supply[31]

Location	1980	1984
Pretoria, **South Africa**	10.5	21.8
Johannesburg, **South Africa**	10.0	12.8
Cape Town, **South Africa**	11.9	8.3
Bulawayo, **Zimbabwe**	13.5	NA
Montevideo, **Uruguay**	40.0	32.2
Oslo, **Norway**	38.1	46.8
Paris, **France**	20.6	19.2

The method of reducing unauthorised unaccounted-for water involves specific measures. These include leak detection and repair, block rate billing and reduction of water theft. For example, some utilities may own and operate sonic leak detection equipment and repair their own leaks. Others may want to reduce UfW through sub-contracting or giving concessions for services such as leak detection or metering and tariff setting. In Argentina, for example, in 1993 Buenos Aires gave a concession to Lyonnaise des Eaux to handle various aspects of their operations. After two years, supply increased by 28 percent, and there were no more water shortages; billing amounts increased by 50 percent after three years to reach a payment ratio of 95 percent even with 27 percent rate discounts for consumers[33]. A comprehensive conservation method to reduce UfW is given in Table 3.2.

Table 3.2: Areas to be addressed by the UfW reduction method[34]

Area	Issues	Actions
Commercial Systems	Inefficient billing system Poor connection or/and disconnection procedures High level of accounts receivable Low income consumers not billed Illegal/unregistered connections Water pricing policies	Data base of users Design/implementation of better commercial systems Improved users/ demand data Disconnect policies Control of high volume users
Metering	Unmetered connections Faulty meters Under registration of meters Lack of confidence on billings/ number of consumers	Meter installation Meter replacement/repair Bulk metering
Leakage	Leakage in reservoirs & mains Poor quality pipe & installation Lack of information on pipe network Lack of maintenance	Systematic maintenance, detection, monitoring & maintenance of old pipes Information programs to public & other Standardisation of installation, material & control Pipe data base Replacement connection policy Adequate pressure regulation
Operational Control	Deficient operational control	Monitoring indicators Water distribution system automation Designing operations control units

Leak detection measure

Old reticulation systems, unsuitable pressure, inadequate operation and maintenance budgets, lack of resolve and motivation and lack of detection equipment lead to frequent and costly leaks. It is estimated that worldwide distribution system efficiency ranges from only 40-60 percent[35], implying that up to a maximum of 60 percent savings could be achieved. Using Lagos in Nigeria as a specific example, the losses from the system were about 50 percent of the total amount of water supplied[36]

A study conducted for 19 locations around Johannesburg, South Africa[37] illustrates large losses typical of some of the SADC cities. This is presented in Table 3.3

Table 3.3: Leakage amounts from Johannesburg's suburbs[38]

Loss description	Loss amount	Of what amount
Absolute	29.5 %	Total supply
Relative	41.9 %	Consumer demand
Specific	0.7 m^3/hr	Per Km of reticulation system

Johannesburg's suburbs account for 81 percent of leaks, which are from 2 to over 10 cubic metres per hour. These are found predominantly in the water mains and, to a lesser extent, in the service or house connections. A summary of the losses from this study is presented in Table 3.4.

Table 3.4: Analysis of leak flow rates

Leak Rate	<1	1-2	2-5	5-10	>10	Total
Losses (m^3/hr)	18.3	33.8	97.2	48.9	76.0	274.2
Percentage	6.7	12.3	35.5	17.8	27.7	100.0
No. of Leaks	38.0	26.0	32.0	8.0	3.0	107.0
Percentage	35.5	24.3	29.9	7 5	2.8	100.0
Leak Location Mains	5.0	5.0	14.0	7.0	3.0	34.0
Service	9.0	9.0	13.0	1.0	NA	32.0
Valves	14 0	11.0	3.0	NA	NA	28.0
Hydrants	10.0	1.0	2.0	NA	NA	13.0

Any utility manager would be concerned with a leakage and a revenue loss of more than 29.5 percent (refer to Table 3.3). This problem is typical, if not understated, by the Johannesburg example. Using the 80/20 principle of applying 20 percent of the effort to achieve 80 percent of the results, some water engineers have determined that an acceptable loss of supply from system leakage is 8-10 percent (0.025-0.20 m^3/hr/km).[39,40] This low rate of leakage is almost never reached in the SADC region. There is, therefore, significant room for improvement in most reticulation systems in the SADC.

Leak detection and repair can, apart from the local water supplies, be accomplished by a private contractor, or through management contract schemes that bridge the first two approaches (public or private). This measure should target the larger, more cost-effective leaks in raw water delivery systems, water mains and public standpipes. It will also target leaks on the consumers' side.

There is hope for leak detection and repair for municipalities in developing countries. For example, in Conakry, Guinea, 50 percent of the water pumped in 1988 was UfW and only 10 percent of the bills were collected. Today only 25 percent of the water is lost and 85 percent of bills are paid.[41] The UfW in Jamaica was estimated to be 73 percent.[42] In the first year alone, the UfW was reduced to 65 percent. This was accomplished with 100 percent metering of commercial consumers (and a smaller percentage of domestic consumers), purchase of leak detection equipment, training and monitoring. In Cotê d'Ivoire the SODECCI has achieved 95 percent bill collection and an UfW rate of between 12 to 15 percent.[43] Canal lining is another solution since it reduces seepage losses. In dry climates lining can reduce losses by 5 to 10 percent since seepage and evaporation losses can be about 30 to 50 percent.

Block rate billing measure

Achievable savings for this measure are 20 to 40 percent of total water produced In the early 1980s, an analysis of the tariff policies of 31 African countries showed that 28 of them (90 percent) had a one-tariff policy for urban and rural areas. For the urban areas, only 18 percent of the countries had policies aimed at full-cost recovery, 75 percent had tariffs partially covering costs and seven percent did not impose any tariffs at all. Absence of cost-recovery measures meant that 82 percent of the countries' urban water systems relied on the central government to subsidise their operation and maintenance costs[44]. Often the poor do not benefit from systems with low tariffs; they will lack water connections and may be forced to buy water from vendors at prices 10 times higher per unit than those paid by users with connections.

Full-cost pricing and 100 percent metering are absolutely essential to good management and water conservation for municipalities in SADC. This entails the purchase and repair of meters for large industrial and institutional consumers, bulk metering (when individual metering is not feasible) of urban and peri-urban zones or individual metering of single and multiple family residences. In some cases, for example in Côte d'Ivoire[45], mixed payment systems are being tried where the state utility company is selling water to about 40 percent of the residents of a particular town. The remaining 60 percent buy water from standpipes run by committees that in turn buy water from the state utility company. This measure also involves changing the water rate structure so that unit costs increase with greater water use (increasing block rate structure) and there may also be a punitive tariff for the big water wasters.

Water rate modifications need to be addressed carefully as they are often politically sensitive to enact and economically difficult for the poorer water users. Finally, explicit billing for wastewater treatment costs based on volume of effluent and sewage strength is also essential. Water rates should be calculated so that the user fully pays for the level of service provided. This would mean, for example, that an industrial consumer using more water would pay a high amount. A low-income consumer with expectations of an intermittent water supply of low volume would pay little. When such a structure is designed and implemented, then invariably higher and more reliable volumes provided would have to cost more. The impact on demand is called price elasticity. There is an inverse relationship between the cost and the demand. The higher the cost the lower is the consumption.

Previous studies show that residential or domestic price elasticity's range from -0.11 to 0.7 with an average value of -0.45. That is a 10 percent increase in water price will be accompanied by a 4.5 percent reduction in (residential) demand.[46] The elasticity for industrial demand is purported to be between 0.43 and -1.32 with an average value of -0.77. For commercial demand the elasticity is between -0.17 and -1.33 and for motels and hotels, specifically it averages -0.24. The following tables provide price elasticity studies/results from other regions of the world.

Table 3.5: Price Elasticity for Industrial Water User Groups[32]

Investigator	Price Elasticity	Comment
Williams & Suh (1986)	-0.721, -0.43, -0.72 to 0.98	For average price, marginal price and bill price, USA
Ziegler (1984)	-0.98	For average price in paper and chemical plants, USA
Leone et al (1974)	-0.96, -0.77, -0.88	For chemical, petroleum and steel industries respectively, USA
Rees (1969)	-0.958	For chemical industries, UK
Ridge (1972)	-0.30 and -0.60	For brewing and fluid milk industries, USA
Gupta & Goldar (1991)	-1.32	For cotton, textile, paper, dairy, ball bearing and distilleries, India
Metaplanners (1992)	-0.45	For steel and related industries, India

Table 3.5a: Elasticity - effluent in food processing industries[48]

Increase In	Reduction in Water Use, %	Reduction in BOD, %
BOD surcharges	0 44	0.51
Water & Normal Sewer Charges	0.63	0.75

Metering and higher prices in Sao Paulo, Brazil had the following effects on three sample industrial consumers.

Table 3.5b: Sao Paulo, Brazil: Industrial demand reductions[49]

Classification	Effluent Reduction, %
Pharmaceutical	49
Food Processing	42
Dairy	62

Correct pricing mechanisms are made possible only by full metering so that costs are associated with actual volume used. Previous studies suggest that water savings resulting from metering alone are in the range of 13 to 45 percent [50] The effect of full metering has been illustrated by some Asian cities. Unmetered Asian cities have total demand levels ranging between 600 to 630 lcd, compared to metered cities with a demand ranging from 200 to 400 lcd. A similar pattern exists in Latin American cities. For example, in Argentina the net demand in virtually unmetered cities is around 400 lcd while demand in the metered city of Santiago, Chile is 240 lcd.

Achievable savings for this measure are 25 percent for domestic consumers, 40 percent for industrial consumers and 30 percent for commercial/institutional consumers.

Reduction of water theft measure

Reducing water theft is possible but difficult to enforce. Industrial, commercial and residential water users might steal water. Industrial and commercial users can usually be made to stop stealing water if found. Residential consumers are far more difficult and can actually be dangerous when one "cracks down" such theft. Monitoring teams, public education campaigns and reporting by other concerned consumers and citizens can reduce water theft

Achievable savings for this measure would be about 20 percent for domestic consumers, five percent for industrial consumers and 10 percent for commercial or institutional consumers.

Total achievable savings for the method, from successful implementation, are estimated to be 20 to 40 percent of total water produced.

Reduced industrial demand method

This method includes specific measures such as reuse, legislation, assistance and process modifications.

Reuse measure

Reuse or recycling of water has great potential in the increasingly industrialised developing countries such as in Mexico where, for example, 80 percent of the dry season irrigation in Mexico City now comes from wastewater reuse[51]. In Beijing, reuse of industrial water rose from 46 percent in 1978 to 72 percent in 1984 while industrial output increased by 80 percent. Another example is the reuse of municipal effluent by Aguas Industriales de Vallejo in Mexico City. It treats municipal wastewater to provide secondary-level treated effluent for industrial firms for cooling and processing purposes and to the government agencies for irrigation and washing purposes.

Except for food processing, about 80 percent of water used by industries is for cooling and cleaning[52]. Legislation provides the enabling legal environment to assure that future (and hopefully present) industrial consumers are maximising their reuse potential. The financial institutions can consider providing assistance whether in the form of loans or simply contacts that encourage the industrial clients to implement money saving reuse measures.

Achievable savings for this measure range from 30 to 60 percent of interior industrial usage, but vary greatly with the type of industrial consumer.

Process modifications measure

Process modifications include items such as dry or mechanical conveyance instead of water conveyance. The solutions are wide and varied depending on the particular industry and equipment or processes being used. One process modification common to all industries is simple repair and maintenance of any water-using process so that it is as efficient as possible.

Achievable savings for this measure are 10-20 percent of interior industrial water demand. Total achievable savings, from successful implementation of this method, are estimated to be 20-60 percent of interior industrial demand for the larger urban municipalities of the SADC region.

Reduced domestic demand method

The method includes the following measures: plumbing fixture requirements, repair and replacement, and efficient lawn and home garden irrigation.

Plumbing Fixture Requirements/Repairs/Replacement measure
In the growing urban environment, leaking plumbing and fixtures are a significant contributor to total water consumption including recycled water used for industry or for irrigation of lawns. For example, an average leaky faucet in an apartment building can waste up to 630 litres per day while a leaking toilet can waste between 370-630 litres per day. In the case of a leaking pipe, a 1.5 mm hole can waste almost 1,500 litres per day under normal pressure.

Legislation can mandate the type of low-water use fixtures that can be placed in all new construction. For existing fixtures, repair and replacement programmes can be successful tools of water conservation. This measure targets single family and multiple family dwellings (e.g., flats). A rough calculation for urban interior water conservation (for reticulated domestic consumers) is shown in Table 3 6. With a vigorous campaign, overall in-house water demand could be reduced by as much as 50 percent through use of suitable water saving fixtures.[53]

Table 3.6: Estimate on domestic interior water conservation (l/c/d)

Fixture	Existing Flows[(b)]	Conserving [(a)] Flows	Saving Per Person
Leaks	31.0	30.3	0.7
Toilet	60.0	23.0	37.0
Bath	28.6	26.5	2.1
Shower	144.0	31.0	113.0
Bath Sink	105.0	32.2	72.8
Miscellaneous	31.0		
TOTALS	**408.6**	**165.0**	**243.6**

Note (a):
Leaks : Leakage estimated is quite low because it is assumed that old fixtures are replaced with new low-flow fixtures that do not leak. This is a means of not double counting savings.

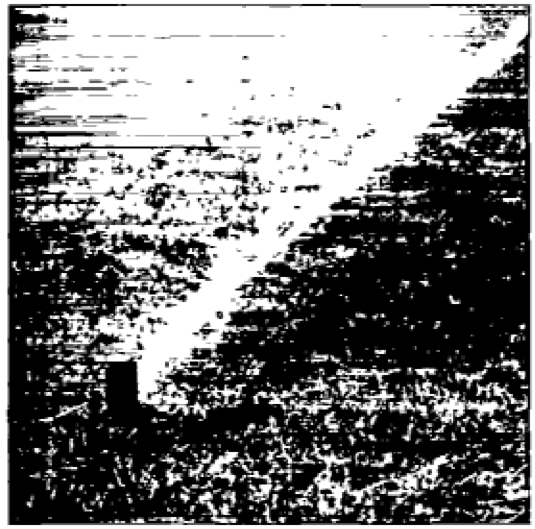
Toilet - estimated 4 flushes per person per day x 15 l/flush
Bath - estimated 2/7 baths per person per day x 100 l/bath
Shower - estimated 4.8 minutes per shower per person p/d x 30 l/min
Sink - estimate 3.5 minutes per person per day x 30 l/min

Note (b): The high conserving leakage accounts for the new toilet and reported associated leaks. Values taken from Water Conservation, William O. Maddaus.

Savings for this measure would be about 60 percent of interior domestic demand with full market penetration. Assuming only a 40 percent sustainable market penetration, the achievable savings would be 25 percent of interior domestic demand.

Lawn and home garden irrigation measure
Lawn and home gardens consume between 30-50 percent of all domestic water demand in urban areas. A measure is needed, therefore, that targets all non-interior domestic water demand, and is focused on lawn and garden irrigation.

Use of purified water for lawn irrigation defeats the purpose of conservation



Lawn irrigation in Harare.

The measure requires audits to find faulty or broken outdoor taps and irrigation systems or devices. It requires education, awareness or even legislation to help reduce the amount of water used, as opposed to water required, for maintaining exterior growth.

Efficiency levels for spray irrigation are about 30 percent compared to places like Israel where it's up to 80 percent, even when evapotranspiration is as high as 60 percent.

Savings for this measure could be as high as 50 percent of exterior domestic water demand with full market penetration.

Assuming only a 30 percent sustainable market penetration, the achievable savings for this method would be 15 percent of exterior domestic water demand or about five percent of total domestic water demand.

Reduced commercial/institutional demand method

This method includes measures such as, fixture repairs and replacement, efficient irrigation and cooling.

Plumbing, fixture repairs and replacement measure

Water wastage in the commercial and institutional sectors can be significant due to old fixtures that leak and consume water or are over designed. Leakages can also be common in situations where systems operate when buildings are unattended such as in faulty flush toilets. However, reducing demand on freshwater and only using it for human consumption can compensate for this. Some hotels in Thailand, for example, reduced their freshwater requirements by 45-50 percent by recycling treated wastewater and using it to clean floors, flush toilets, keep grounds, and water trees.

Achievable savings for this measure are 40 percent of interior commercial/institutional demand assuming a relatively high market penetration. This high market penetration is reasonable if there exists price incentives to reduce demand, such as through increasing block rate tariffs.

Efficient Cooling measure

Cooling and energy generation in large urban centres in sub-Saharan Africa can demand large volumes of water. The high demand institutions include hospitals, government buildings, diplomatic missions, schools, and thermal power stations. Savings are realised by increased circulation of cooling water, installation of energy management systems and raising thermostatic settings, including proper maintenance.

Achievable savings for this measure are 10 percent of interior commercial and institutional demand.

This measure targets all non-interior commercial/institutional demand, but is focused at lawn and garden irrigation. The measure requires audits to find faulty or broken outdoor irrigation systems and devices. It also requires education or even legislation to reduce the amount of water used (as opposed to required) for maintaining exterior growth.

Savings for this measure should be as high as 50 percent of exterior commercial/ institutional demand with full market penetration. Assuming only a 50 percent sustainable market penetration the achievable savings would be 25 percent of the exterior commercial/institutional demand.

Total Achievable savings from successful implementation of this method, are estimated to be 10 to 40 percent of commercial interior demand and 20 to 25 percent for commercial exterior demand.

Reduced drought period demand method

The methods listed as typical water conservation methods could be used to reduce demand during protracted drought periods. It is always easier to have water conservation measures accepted, funded and implemented during a drought. However, immediate responses and savings are required and standard water conservation measures take time to implement and achieve results. Therefore, a separate demand management strategy with a focus on savings and public education should be prepared and used.[54]

The savings that can be achieved by a short-term drought management programme are about 30-60 percent, although savings of up to 65 percent have been realised during extreme drought situations or severe emergencies. However, maximum reductions of say up to 60 percent from the domestic consumers, 20 percent from the industrial consumers, 30 percent from commercial consumers, and maximum overall reductions of 30 percent are reasonable in SADC. These are maxima, and a phased drought programme would call for a percentage of these levels depending on the severity of the drought.

Achievable savings for municipalities in SADC

Table 3.7 summarises what is achievable for municipalities in the SADC region. This suggestion is general and individual situations will vary based on present and future demand patterns, existing conservation initiatives and other variables. However, it serves as a guide or starting point for general potential in water conservation within the region.

Note that the savings are not necessarily cumulative if one implements all the methods simultaneously The reason is that the methods actually overlap.

Table 3.7: Expected water conservation methods savings

Conservation Measures	Domestic	Industrial	Commercial/ Institutitonal	Other
Reduce Unauthorised UfW				20-40%
Leak Detection/Repair	NA	NA	NA	20-40%
Increasing Block Rate Metering	25%	40%	30%	
Reduction in Water Theft	20%	5%	10%	
Reduce Industrial Demand		20-60% (int)		
Reuse Legislation/Assistance	NA	30-60% (int)	NA	NA
Process Modifications	NA	10-20% (int)	NA	NA
Reduce Domestic Demand	20-25%(int)			
Fixture Repair & Replacement	10-20%(ext)			
Efficient Irrigation	25% (int)	NA	NA	NA
	15% (ext)	NA	NA	NA
Reduce Commercial and Institutional Demand			10-40% (int)	
			20-25% (ext)	
Fixture Repair & Replacement	NA	NA	40% (int)	NA
Cooling Efficiencies	NA	NA	10% (int)	NA
Efficient Irrigation	NA	NA	25% (ext)	NA
Reduce Drought Period Demand	60%	20%	30%	30%

Note: int stands for interior
ext stands for exterior

For example, stiff tariffs might result in 40 percent industrial savings. The implementation of a concurrent industrial reuse measure that would, on its own, save 30 percent would not mean that total industrial savings are 70 percent (40 + 30). The combined savings would be a fraction of the two.

It is important to note that the Top down approach calls for fixed reductions and not estimates. So, if the actual savings from the above measures are more or less, then small adjustments can be made. While this report does not discuss savings from reduced effluent discharges and energy use, those using the data should not neglect these important financial and environmental benefits when conducting thorough cost/benefit analyses. Interior water savings, for example, equate to effluent discharge reductions and often to significant energy savings.

The methods described above should be linked with a public education campaign. The public must be informed about the prevailing situation and the need for conservation. They should be informed as to what they can do to save water. There is no point in telling them to save while not telling them how or why or when to save. Public education is also required to gain their support for whatever conservation method is implemented.

CHAPTER 4

Examples from the SADC Region on Urban Water Conservation Strategies

This chapter provides insight into the actual water conservation activities in the SADC region using a sampling of countries and municipalities. It also includes suggestions for what might be added to their particular water conservation programmes. A note of caution with regards to the suggested conservation methods is that these were based on the limited information that this "desk top study" was able to ascertain. Specifics and details of the programs should be left to those most knowledgeable of the situation in the particular cities. The chapter reviews water conservation activities in 7 SADC countries of Angola, Botswana, Malawi, Mozambique, Namibia, South Africa and Zimbabwe

Background

Throughout the SADC region, urban centres, particularly the major cities, are experiencing phenomenal growth in population which in a majority of cases is not matched with available infrastructure. Such a disparity is often blamed for the limited access to safe water and the illegal water connections, which make it difficult to account for all the water supplied.

While tariffs for water deter reckless use of the resource, their administration sometimes fails to encourage consumers to conserve water. For example, bulk meter readings (although easier to manage) do not instill a sense of responsibility in consumers. Legislation governing use of water is also available, although poorly enforced. On a positive note, water recycling, as a management strategy, is common to many southern Africa's cities. Much of the recycled water is used for industrial cooling; irrigation of parks, sports fields and road margins; and construction

ANGOLA

If the situation in Luanda can be extrapolated to the other urban centres in Angola, then significant reductions can be made in this country. Luanda's annual growth rate of 7.6 percent represents a rapidly increasing pressure on the already insufficient water system. Water conservation focus ought to be in Luanda in which 54 percent of Angola's urban population lives.

Some water conservation already exists in the city by virtue of the informal sector selling water to 70 percent of the urban population. The assumption is that the selling price provides the incentive to keep usage to a minimum. However, additional cost-effective measures can be applied. Besides adherence to the existing national policy, consumers and water suppliers should be encouraged to observe the following:

- Legislating 100 percent (individual or bulk) metering for new services and eventual 100 percent metering of existing services, within a fixed time period (say 2-years). This would include requiring a significant accounts receivable success ratio (say >70 percent).
- A (say 5-year) goal to sustain under 25 percent UfW.

The up-front costs will be significant, but the future revenue gains will more than compensate. Realistically, initial assistance would have to come from available development funds allocated to renewal of the urban water sector or creative management contracts similar to those being established in Mozambique.

Luanda

There already exists some water conservation in the city by virtue of the informal sector selling water to 70 percent of the urban population. It is assumed that the selling price provides the incentive to keep usage to a minimum. However, additional cost-effective measures can be applied. Besides adherence to the suggested national policy, the following is offered:

- Implement a residential and commercial interior-demand-reduction method aimed at repairing leaks and replacing inefficient plumbing fixtures.
- Legislation should mandate water-conserving fixtures for all new residential and commercial construction after a given time (e.g., 2 years) to allow the suppliers to "catch up" with the legislation.
- Implementing a (low density, high income) residential and commercial/institutional exterior water demand reduction programme aimed at improving irrigation equipment and educating homeowners and groundskeepers on efficient irrigation techniques. Irrigation during the high evapotranspiration (ET) hours and excessive runoff should be prohibited.
- The above three measures, combined with the national measures might result in a reduced revenue stream. Rate modifications would then have to be enacted to assure the financial viability of the municipality and full-cost recovery.

The "barefoot plumbers" concept, used in South Africa, would be quite effective and inexpensive in repairing leaks in the domestic and commercial sector. Any methods to replace fixtures will be expensive and therefore, a determination of who will pay for the new fixtures must be made It might become a mix of customer and municipality payment, but it is more likely that the municipality will have to shoulder this cost and recuperate the investment through improved efficiency. The exterior demand-reduction-conservation method can use a staff of (higher) trained "barefoot plumbers".

BOTSWANA

Botswana has already initiated various elements of water conservation including the encouragement of reuse and water conserving tariff structures. The increasing block rate tariff structure is shown in Table 4.1. Table 4.2 shows the government councils' block rates.

Table 4.1: Domestic/commercial Block Rate Structure for some urban areas in Botswana[55] (Thebe/m^3)

Water Use m^3/month	Gaborone and Lobatse	Jwaneng	Francistown	Selibe-Phikwe	Sua
0-10	95	95	95	95	95
11-15	280	193	224	154	220
16-25	358	253	325	193	319
25+	493	292	358	242	352
Raw water	157	NA	84	special	NA

1US$ - 320 Thebe

In urban centres, the first 10 m^3 per month of water costs $0.30 on average, and meets the family's basic needs[56]. The charge rises to $1.25 above 15 m^3 per month and up to $1.62 when demand is above 25 m^3 per month. Issues currently being debated include charges for standpipes since subsidies for standpipe supplies constitute a significant government burden[57].

Conservation happens rather naturally in Botswana due to water scarcity, drought, high increasing block rate structure, and near universal metering in the urban centres. Due to the high water rates, water demand would be kept relatively low in most of the residential, commercial and (light) industrial sector. The stated national policy is to achieve 100 percent industrial reuse by 2010[58].

Currently, the city follows national guidelines and plans to recycle about 60 percent of its urban flow by 2020[59]. The potential for additional conservation in Botswana lies in increased efficiencies in the sanitation infrastructure for the high-density areas. This also applies to consumers who are slow to implement conservation measures during periods of water shortage and those that pay their bills late. Suggested water conservation measures for Botswana include legislation for interior domestic plumbing fixtures for new construction. Reform of the government billing structure, where applicable, is also necessary to ensure that the direct water users (e.g., a government ministry) are direct monthly water payers.

Table 4.2: Government Councils' Block Rates (Thebe/ m^3)

Water Use (m^3/month)	Gaborone/ Lobatse	Jwaneng	Francistown	Selibe-Phikwe	Sua
0-10	105	95	105	95	95
11-15	307	193	246	220	154
16-25	394	253	357	319	193
25+	541	292	394	352	242
Standpipe Bulk : (Council)	474	253	308	NA	205
Treated:	NA	NA	NA	NA	NA
(DWA/District Council) Untreated Bulk: (DWA/DC)	172	NA	NA	NA	120

Note that included in these fees is a minimum charge of P9.00

With Gaborone using over three times as much water as any other large city in Botswana, the focus of water conservation here is important. With Gaborone using over 3 times as much water as any other large city in Botswana, the focus of water conservation should be applied. Gaborone follows national guidelines and plans to recycle about 60 percent of its urban flow by the year 2020.[60] In addition to national legislation and the suggestions above, the following should be considered for the city:

- ☐ Implementing a (low density high-income) residential and government/institutional exterior demand reduction method aimed at improving irrigation equipment and educating home-owners and groundskeepers on efficient irrigation techniques. Irrigation during the high evapotranspiration hours and excessive runoff can be prohibited.
- ☐ Increasing meter coverage to include all high density areas with standpipes.

- If applicable, metering and billing of effluent from industrial consumers.

MALAWI

Malawi's population density puts enormous pressure on the urban centres and their water supply. However, the percentage of Malawi's population that resides in urban centres at 12 percent, is comparatively low. Even so, an urban population of 1.3 million in 1995 is significant.

Lilongwe

Lilongwe's population expanded threefold in the last 10 years, putting enormous pressure on water supply. The influx of people is bound to increase illegal connections, causing low pressures. The illegal connections will increase the UfW rate, decrease the metered coverage and the expected revenue receivable success rate. While Lilongwe is only moderately industrialised, it is home to government and foreign institutions and residences that are high consumers of water.

The city experiences unattended faulty taps and stand pipes due to inadequate plumbing services; undetected pipe leakages because of non-existent leak detection equipment; and inadequate leak detection equipment of the Lilongwe Water Board. In addition, there is water wastage during the night and weekends because offices retain automatic flushing systems. Families of staff waste water on campuses because bulk meters don't provide incentives to save. There are also inaccurate meter readings because bulk meters fail to register trickle flows[61] .

The Third Lilongwe Water Supply Project, sub-programme - Reduction of Institutional Consumption Programme aims to:

(1) Provide campus staff houses with individual meters and premises with combination meters.

(2) Procure leak detection equipment and provide training in their use.

(3) Adopt appropriate water conservation methods.

(4) Offer adequate commercial plumbing services.

Several additional measures are suggested by this project. These include sourcing funding for a water theft and wastage group within the water board; implementing a residential, commercial and institutional interior demand reduction method aimed at repairing leaks and replacing inefficient plumbing fixtures. A pilot reuse project will be implemented for municipal reuse and where possible, change bulk meters for individual (dwelling/customer) meters.

Blantyre

For Blantyre, the country's commercial capital, the following conservation measures should be added to address the low-density, higher income usage of exterior water as well as the industrialised community:

(1) Implement a (low-density, high-income) residential and commercial exterior-demand-reduction method to improve irrigation equipment and educate homeowners and groundskeepers on efficient irrigation techniques. Excessive runoff and irrigation during the high evapotranspiration hours can be prohibited.

(2) If applicable, meter and bill effluent from industrial consumers who discharge to municipal sewers or waterways without adequate treatment.

(3) Implement a pilot industrial water conservation measure aimed at high water using industries to establish precedent setting, low-water use procedures for these industries.

Several other suggested measures can be made for the country's water conservation strategies.

These would include:

(4) Legislating 100 percent (individual or bulk) metering for new services and eventual 100 percent metering, within a fixed time (about two years), of existing services. This must include requiring a significant accounts receivable success ratio (>90 percent).

(5) A goal to sustain under 20 percent UfW in a fixed time period (e.g., three years).

(6) Legislating mandatory water conserving fixtures for all new residential and commercial construction after about two years to allow the suppliers to "catch up" with the legislation.

(7) Evaluating and possibly modifying the tariff structures so that they not only provide full-cost recovery, but also discourage water wastage.

MOZAMBIQUE

The Directorate for Urban Water and Sanitation (DASU) within the National Directorate of Water (DNA) is responsible for the overall coordination of urban water demand. The individual urban water companies (e.g., Águas de Maputo) are also given local responsibilities.

Water conservation potential in Mozambique is quite significant due to the deterioration of the water infrastructure. For example, UfW is estimated to average 60 percent[62]. Existing water conservation programmes generally focus on anti-water waste laws, identifying and repairing leaking pipes[63], identifying and eliminating water theft, and improved metering and bill collection.

At the national level, it has been difficult to emphasize much more since the pre-1992 period was focused on the civil war and post-1992 has seen the focus on water sector reform. Water conservation can be included in all aspects of the commercial and public water sector as this reform starts to take shape. For example, the National Water Policy goals actually do emphasize full metering and reducing UfW to at least 20 percent.

Maputo

The capital city, Maputo, has a leak detection crew and a water theft identification crew, while the cities of Tete and Beira have carried out leak detection. This has resulted in repairs, legislating contracts and replacement of the most deteriorated sections of the distribution system.

In the absence of a national programme towards water conservation, the private sector has provided assistance. For example, there are localised private vendors of water who help to 'force' conservation just by demanding a high price for the commodity.[64] Also, some of the unregulated public standpipes have water committees, which manage water demand and maintenance.

An urban water supply regulatory authority is being established to govern the use of contracts with private and possibly state-owned water suppliers. Part of the reform of the water sector in Mozambique will lead to the establishment of management contracts for five large cities, Maputo, Beira, Quelimane, Nampula and Pemba. While these management contracts, given to private concerns, will not involve the devolution of assets, they will ensure that the operation of the urban supplies will be similar to a private water supplier. The private suppliers' incentive to cut waste depends on a strong and well-informed regulation or threat of substitution by another supplier (otherwise the private supplier has a monopoly). This should help increase water demand efficiency in Mozambique

NAMIBIA

In 1992, over one-third of Namibia's population lived in urban areas. Namibia's municipalities have set the standard for water conservation. Much of this was borne out of necessity due to the dry climate and susceptibility to drought. Conservation measures implemented during the droughts of 1981-82 and 1991-92 reduced water demand by about 30 percent. However, due to the dry climate of Namibia and growing population, increased effort will have to be made, particularly at the legislative level. The country's water resources are still governed by the Water Act No 54 of 1956. New legislation to reflect the changing climate of water resources management is vital. Perhaps a preliminary proposal or White Paper could initiate this process. The Water and Sanitation Policy (WASP) document helps guide water development in Namibia but has only been approved by Cabinet (in 1993) and not yet by parliament. An emphasis on the cost recovery aspects of the WASP document could help significantly[65]. Since water had not been given prominence in the first National Development Plan (NDP1), a revision of NDP1 and a new NDP2 could significantly help Namibia manage its water resources.

Public education can help increase the understanding of the variability of water inputs in Namibia and the need to plan ahead for, short, medium and long-term water needs. Increased education can pave the way for conservation measures such as reuse. Namibia recycles 10-25 percent of its effluent, offering an obvious opportunity for savings[66].

Another area of savings is through tariffs. These tariffs are higher than before, but may not be high enough if they don't reflect full-cost pricing. For example, tariffs should reflect the costs of the next source whether it is from the Okavango or desalination plants. The current block tariffs scheme is highlighted in Table 4.3.

Table 4.3: Block tariffs for some urban areas in Namibia ($/m^3)[67]

Quantity (m^3)	Gobabis	Walvis Bay	Windhoek
0-10	0.52	0.35	0.51
10-60	0.59	0.41	0.73
60-120	0.72	0.59	1.02
120+	1.01	1.06	1.46

Recommended additional national conservation measures for the country include:

- Legislation for all interior domestic plumbing fixtures focused on new construction but also for eventual change out of existing fixtures;
- If applicable, reform government billing structure to ensure that the direct water consumers, such as government ministries are the direct monthly water payers;
- A newly designed and focused national water education campaign;
- A rate study with the objective of determining the full cost pricing for the larger urban centres based on costs for future water resources.

In 1992, a decision was made for Windhoek to implement water conservation so as to mitigate the potential water shortage. A policy on Water Demand Management was approved by the city council in 1994. The residential daily per capita demand was reduced from 210 litres in 1991 to 124 litres in 1996. Windhoek's conservation efforts date back to the early 1950s when they endeavored to build a 4,500 m^3/d wastewater reclamation plant. It was eventually commissioned in 1969[68]. By the end of 1999, Windhoek will be able to reuse all its wastewater for irrigation purposes. For domestic use, about 13 percent of wastewater is recycled[69]. But, about 60 percent of all water used in upmarket Windhoek is for gardens and therefore unavailable for reuse. This represents a large area for savings.

The city is also trying to reduce UfW. Infrastructure maintenance is expected to improve after commercialisation of the bulk water supply section of the Namibian Department of Water Affairs (DWA). Specific water conservation activities being implemented in Windhoek include water audits, meter replacements, metering of all connections, public awareness and education, and block rate tariffs. Irrigation of gardens between 10:00 hours and 16:00 hours has been banned. Use of swimming pool covers is mandatory and so is use of low-flush toilets for building plans approved after January 1, 1997.

Other conservation measures include use of low-rate showers of less than 10 litres/minute, reuse of purified effluent for irrigation and reclamation to a potable standard. They also include water conservation guidelines for wet industries, direct recharge of groundwater, on-site reuse of "gray water" (e.g. sink and bath water), encouragement of efficient irrigation measures by training gardeners, encouragement of mulching to reduce garden water use. In addition, targeting per capita demand to 100 l/c/d and demand growth to less than three percent in five years are also important measures.

If plans for the extension of the Goreangab Water Reclamation Works go ahead and a strict water policy on conservation is implemented, then the production sources will be able to supply water for some time, based on a 95 percent reliability from the main supply sources. It appears as if Windhoek need not try to do more than maximise the savings from existing conservation measures. However, there is always potential for additional savings. Clearly, the target group to reduce demand is the residential users (including new consumers). Additional measures to conservation appear in Box 4.1.

One other element to add to the conservation programme involves drought. It is suggested that the city embellish and have approved an updated drought management plan which is ready for execution if need be.

Reasonable rates of long-term water demand reductions (e.g. 20 to 30 percent) can be mandated by the 'top-down' approach and achieved by Windhoek. Larger, short-term reductions, on the order of 40 to 60 percent can be achieved through the implementation of a drought management programme.

SOUTH AFRICA

South Africa has the highest percentage of its population in urban areas and the highest urban per capita demand in the SADC region. One in every four people in South Africa lacks access to safe water and, therefore, it also has the greatest ability to see water savings from the implementation of water conservation programmes.[70] Fortunately South Africa has, for a long time embarked on many creative and successful water conservation measures.

The country's initiative towards reuse was implemented as early as the late 1930s[71]. It included an experimental 4,500 m^3/d plant in Daspoort, Pretoria, and plants in Cape Flats and Cape Town. After additional sand filtration and chlorination, secondary purified wastewater effluent has, since 1938, been used as cooling water at municipal power stations in South Africa[72]. Since two-thirds of all (non-mining) industrial water is for cooling, reuse has been an important resource[73].

Recently, a number of projects, including trial fitting of house plumbing with conservation devices by 'barefoot plumbers' were launched by the National Water Conservation Campaign. Unskilled workers were trained in basic plumbing skills to install low-flow shower roses and dual-flush toilets. They were also trained to fix leaks, check the accuracy of water meters and provide education on how to save water and energy. In Kruger National Park, visitors were charged for the volume of

Box 4.1: Namibia's Water Conservation Programme

Policy Issues

- ☐ Accept principle of total reuse of water *
- ☐ Apply permanent block tariffs *
  - Lower residential demand to 100 lcd over next five years
  - Curb water demand growth to under three percent annually
  - Remove elasticity in demand
  - Full cost pricing for new supplies with demands above 250 lcd
- ☐ Use smaller plots in new townships and allow two houses per plot
- ☐ Only allow parks and sports fields if irrigated with effluent *
- ☐ National policy on urbanisation
- ☐ National policy on wet industries
- ☐ Levy on water price for demand management *

Legislation

- ☐ Update National legislation to ban baths in new hotels
- ☐ Update municipal water supply and drainage regulations *
  - Low flush toilets
  - Low flow showerheads
  - Swimming pool covers
  - Water waste
  - Water pollution control (e.g., Goreangab Dam)
  - Control groundwater abstraction of private boreholes
  - Ban garden watering between 1000 to 1600 hours

Technical Issues

- ☐ Alternative garden watering systems
- ☐ Use of mulch to alleviate evaporation from gardens
- ☐ Lower UfW
- ☐ Two-pipe system for watering gardens with effluent
- ☐ Use of gray water on residential plots for gardens
- ☐ Investigate recharge of Windhoek aquifer during periods of excess water

Public Measures

- ☐ Liaise with all consumer groups *
- ☐ Concentrate on school children
- ☐ Liaise with diplomatic missions *
- ☐ Investigate water demand and liaise with large water users *
- ☐ Liaise with nurseries on indigenous plants and low water use gardens
- ☐ Train gardeners to use water effectively.

* *Measures with an asterisk are those suggested by the author for particular attention to follow the 80/20 principle.*

water and electricity they used. To help the visitors keep this cost low, the units were fitted with low-flow shower roses, dual flush toilets, buckets in the shower and geysers set at 55°C compared to 65°C. The average reduction in water demand was a remarkable 73 percent. Suggested National measures for South Africa include:

- National legislation for universal metering (individual and bulk) for municipalities, of a certain size, within a stated period of time.
- National legislation for maximum UfW and minimum reuse for specific high water using industries.
- National legislation for maximum flow rates for common plumbing fixtures installed in new construction after a certain year.

Cape Town

The following measures, if not already seriously in practice, should be considered in Cape Town and all large cities.

- Implementing a low density residential and government/institutional exterior-demand-reduction method aimed at improving irrigation equipment and educating homeowners and groundskeepers on efficient irrigation techniques. Irrigation during the high evapotranspiration hours and excessive runoff should be prohibited.
- Implementing a residential, commercial and institutional interior demand reduction method aimed at repairing leaks and replacing inefficient plumbing fixtures.
- Update municipal water supply and plumbing regulations
  - (a) Low flush toilets
  - (b) Low flow shower heads
  - (c) Water waste
  - (d) Ban garden watering between 1000 to 1600 hours
- Increasing meter coverage to include all high-density areas including standpipes. Where possible, change bulk meters for individual (dwelling/customer) meters.
- Implement a pilot industrial water conservation measures (e.g., reuse) aimed at high water using industries in order to establish precedent setting, low-water use procedures for these industries.
- If applicable, metering and billing of effluent from industrial consumers.
- Implementing a pilot reuse project for municipal reuse. Only allow parks and sports fields to be irrigated with effluent. Improve storage and transportation systems to reduce leakages and losses due to evaporation.

Hermanus

The steps taken for the urban area of Hermanus give a classical example in water conservation. The Greater Hermanus Water Conservation Programme was started in October 1996 to reduce water demand by 30 percent in three years. In the first year alone, savings of 19.5 percent were achieved. According to the town engineer, the savings were sufficient to provide water to an additional 1,395 homes (based on a household use of 35 m^3/month).

Box 4.2: Some water conservation measures in the Hermanus

Water invasive alien vegetation clearing project
In 1996, unemployed residents were hired to clear the dam catchment area of vegetation that was 70-100 percent infested with the exotics. The exotics consisted of Jackson, Hakea, Blue gum, Black Wattle, Cluster Pine, Rooikrans and Myrtle.

School water audits
This measure was promoting the Nation Water Conservation Campaign's educational activities to involve pupils in conducting water audits of their schools and homes. The audit helped determine how much water was being used, where the water was used and the implementation of water savings ideas.

Water loss management
This is a multi-pronged approach that includes the metering of all water supply systems. Master water meters were installed at each of the supply reservoirs Monthly water balance and audit for each service zone is conducted to identify the area with the highest UfW. Other measures include checking for minimum night flows, meter under-registration, unmetered connections and for recording pipe bursts and scouring.

Water wise gardening
Since 26 percent of all water goes to the garden, it was a likely target for water conservation. The public education campaign included sending out a brochure on water-wise gardening to consumers, and a low-water use plant competition for local nurseries. There were also two low-water use demonstration gardens (showing low and high water use plants for comparison).

Security meters and pre-paid meters
This pilot project entailed the installation of pre-payment meters in some homes. This would give the customer the opportunity to not only pre-pay for water but to pre-pay for other municipal services as well. The meter is also fitted with a panic button for various problems that the customer may face such as a break-in or fire.

These savings, and the ability to find water for new dwellings was necessary due to the growth in Hermanus of high-density residential complexes and retirement villages[74]. Some of the municipality's water conservation activities include block rate tariffs, water invasive alien vegetation clearing project, school water audits, water loss management, water-wise gardening, public information, adoption of national water regulations as municipal By-laws and security meters and pre-paid meters.

ZIMBABWE

Zimbabwe has had to be quite active in the area of conserving water, particularly in drought management. Much of Zimbabwe's general water policy was and is controlled by the existing Water Act. The Department of Water Resources on behalf of the Ministry of Lands and Water Resources administers the Water Act No. 41 of 1976. The Act provides for the planning of the optimum development and utilisation of water resources of Zimbabwe. The water sector in Zimbabwe is dynamic and currently undergoing changes. For example, among other things, the new Water Act of Zimbabwe will speed up the process by which the minister can declare a Public Water Shortage Area[75].

Meaningful opportunities exist for Zimbabwe to achieve higher water use efficiencies. For example, some reports estimated that Zimbabwe might be recycling as much as 10-25 percent of its effluent[76]. One of the reasons for this low amount of recycling is that only Gweru, Harare and Mutare measure the quantity and quality of industrial effluent and set user charges accordingly. Also, reclaimed wastewater is available only in Bulawayo where charges (May 1992) for the reclaimed wastewater were about half of those for potable water. The reuse potential of Zimbabwe could be increased significantly. Further progress can be made to understand and reduce the level of UfW, increase metered coverage, and help all customer classes to be more efficient.

Drought Management

In the past, coordination of drought mitigation has been carried out by the Ministry of Labour, Public Service and Social Welfare and includes the preparation of Emergency Water Plans specific to the conditions and needs of the particular year[77]. It has been stated that drought responses in the past were not as rapid as perhaps they could have been but Zimbabwe is taking actions to improve this. During drought periods, two instruments, in addition to the Water Act, come into play. The National coordinating Unit (NCU) works with the National Action committee (NAC). The NCU gathers and analyses data to assess the drought situation. The NAC ensures that donors will direct funding and actions towards the prioritized drought areas according to an action plan. The Plan's objectives are for immediate and short-term measures to alleviate the drought situation.

Water conservation efforts are being spearheaded by the Water Resources Management Strategy (WRMS). The main elements of the WRMS include but are not limited to:

- Establishing principles for equitable, cost-effective and sustainable allocation of water between users.
- Comprehensive pricing guidelines.
- Guidelines in demand management and efficient use of water; and present and future water demands;
- Resource management guidelines and appropriate responses to different levels of water scarcity.

There are also calls to establish the Zimbabwe National Water Authority (ZINWA) whose objectives, would be to develop a drought mitigation strategy. The commitment to conserve water is growing not only with the establishment of new organisations but also in legislation.

There is also a call to establish the Zimbabwe National Water Authority (ZINWA). The Authority will, among other things, develop a drought strategy to mitigate the effects of droughts.

The commitment to water conservation is growing, not only with the establishments of new organizations and legislation. Within the existing Department of Water Resources, the *Long Term Development of the Large Dams Particularly for Urban Water Supplies: Horizon 2020* supports realistic demand estimates and raw water requirements by reminding themselves to:

"...Take account of demand management with its more efficient use of water due to increasing use of various conservation measures (including recycling in the case of larger cities and towns) and also to take account of the future much higher cost of water, then the net of increase of new raw water (actual less recycled) is assumed to be:

(i) For urban centres with over 500,000 people, 3.0 percent up to the year 2000 and then 2.5 percent thereafter

(ii) For urban centres with between 50,000 and 5,000,000 people, 4.0 percent up to the year 2000 and then 3.5 percent thereafter

(iii) For urban centres of less than 50,000 people, where conservation measures may not be so effective, 5.0 percent per year..."

Water Pricing

Water is currently under priced in Zimbabwe. The main pricing mechanism is the national "blend" price whereby the historical cost of the several Government- constructed dams and associated works was averaged to calculate this price. Table 4.4 summarises the current principal charging mechanisms and rates.

Table 4.4: Water resources pricing principles

Consumers	Supplier	Basis	Charge (Z$)
	Own supply from rivers, groundwater sources or privately constructed dams	No charge	No charge
Industrial	Department of Water Resources and Urban Councils	Flat rate + per m³	500 flat rate + 1.25/ m³
Urban	Department of Water		
	Resources	Flat rate + per m³	2.81/m³
Consumers	Urban Councils	Flat rate + per m³	approx. 2.00/m³

The problem with the current system is the use of national blend prices. This measure barely adheres to the "user pays" principle. The system also involves extensive cross-subsidisation, with some consumers paying more than the costs, while others pay much less. As part of the current reforms in the water sector in Zimbabwe, the government has opted for the "user pays" principle as a pricing mechanism to be implemented in the future.

Reuse

Even in the relatively developed and progressive country of Zimbabwe there exist meaningful opportunities to achieve higher water use efficiencies. For example, some reports estimated that Zimbabwe might be recycling as much as 10-25 percent of its effluent.[78] Others have suggested that the number is actually much lower. One of the reasons for this low amount of recycling is the fact that only Gweru, Harare and Mutare measure the quantity and quality of industrial effluent and set user charges accordingly. Also, at the moment, reclaimed wastewater is available only in Bulawayo where charges (May 1992) for the reclaimed wastewater were about half of those for potable water. The reuse potential of Zimbabwe could be increased significantly.[79]

UfW

Further progress can be made to understand and reduce the level of UfW, increase metered coverage, and help all customer classes (domestic, industrial, and commercial/institutional) to be more efficient

Additional Conservation

Suggested further conservation measures include:

- National legislation for universal metering (individual and bulk) for municipalities, of a certain size, within a stated period of time.
- National legislation for reform of water pricing strategies that lead to application of the "user pays" principle.

- National legislation for maximum UfW and minimum reuse for specific high water using industries.
- Requirement that municipalities of 100,000 or more consumers have operational, locally specific drought management plans. The plans are to be reviewed and accepted by all key decision-makers and organizations to the local entity and ready for implementation if need be.
- National legislation for maximum flow rates for common plumbing fixtures installed in new construction after a certain year.

Harare

Per capita water demand in Harare is not alarmingly high. This is the result of droughts, the tariff structure and perhaps, the impact of water sources external to the municipality such as private boreholes. During the 1991-92 drought, the City of Harare set up a Water Conservation Task Force to help mitigate the effects of the drought. The task force focused on public education. There was a ban on the use of hosepipes for irrigation and filling of pools. This was later reintroduced in 1995-96.

Unaccounted-for Water

A pilot UfW project, done for the City Centre in 1994-95, was a great success. More leak detection equipment, however, is recommended. Water theft is dealt with as soon as it is discovered. Demands are assessed and a punitive scale applied. Water bylaws are in place to discourage tampering with individual meters.

Meters

Every end user of water in the City is metered. Meters are replaced once they get stuck or malfunction. Tests for correctness are regularly carried out. Readings are carried out once every month for end users and once every week for bulk meters.

Water Rates

Harare residents currently pay about Z$ 1.75/m^3 for their water. Specifically a household in Harare pays $0.08 per m^3 for the first 13 m^3 and $0.16 per m^3 for 14-39 m^3, $0.31 for 40-69 m^3. Above 300 m^3 all pay $0.38 per m^3. Industries pay $0.31 per m^3 for the first 300 m^3.

Reuse

Harare now recycles about 10 percent of its wastewater and this may increase to 20 percent. The volume of effluent that is to be recycled will go from about 10,000 m^3/year to 42,000 m^3/year. These figures could be significantly higher.

Suggestions for future conservation measures specific to Harare include:

- Implementing a (low density, high income) residential, commercial and government/institutional exterior demand reduction method aimed at improving irrigation equipment and educating homeowners and groundskeepers on efficient irrigation techniques. Irrigation during the high evapotranspiration hours and excessive runoff can be prohibited.
- Implementing a residential and commercial interior-demand-reduction method aimed at repairing leaks/replacing existing inefficient plumbing.
- If applicable, reform of the government billing structure to assure that the direct water users (e.g., a particular government ministry) are the direct monthly water payers.

Bulawayo

Zimbabwe's second largest city, Bulawayo, is a relatively progressive city in the SADC region in terms of water conservation that is reflected in a low per capita water demand. During the 1991-92 drought, the city was mostly successful in restricting domestic demand to 360 litres per day[80] and industrial demand to 50-70 percent of that in the previous year. The penalties for overuse were quite stiff and amounted to Z$10 per cubic metre for residential demand up to 10 m^3 per month above the rationed amount. Any additional demand was charged at Z$100 per cubic metre. (When these figures were given US$1.00 was the equivalent of 14 Zimbabwe dollars).

Estimates for Bulawayo's unaccounted for water have ranged from 17.5-40 percent of total produced water. This is not out of line with other countries in the SADC region. One, but certainly not the only, reason for high unaccounted for water is likely to lie with the meter registration and meter reading errors. For example, in 1996 about three percent of the bills were estimated and not based on actual readings. The city recognises UfW as a problem and is currently soliciting donor funding to address this issue. Also, the city has contracted for the servicing and repair of bulk water meters. Currently, one person patrols the entire 2,100km of pipeline on a bicycle to report on possible leaks.

Water rationing

Demands are further reduced by the continuation of (a form of) the Water Rationing Act instituted during the 1991-92 drought. The Urban Councils Act No. 24, of May 8 1996, provides:

- 800 litres/d allowed for individually metered houses and flats and residential building operations on vacant stands (if development is taking place).
- 400 litres/d allowed for bulk-metered cottages and residential flats.
- 100 percent of average water use (based on June to November 1994 use) allowed for multi-purpose buildings with bulk meters.
- 100 percent of average water use (based on June to November 1994 use) allowed for hotels, hospitals, clinics, industrial and commercial consumers, restaurants and Esigodini.
- 100 percent of entitlement allowed for the Mzinyathini Irrigation Scheme.
- No allowances given for swimming pools, weddings and other gatherings.
- No use of hosepipes for industrial/commercial users (unless part of industrial process or from borehole/well).
- Leakage (first offence) quantities must be paid plus 50 percent in penalty fees.
- Leakage (second offense) quantities must be paid plus 75 percent in fees.
- Leakage (third offense) quantities must be paid plus 100 percent in penalty fees.
- If customer exceeds allocation on three successive occasions, service is cut off.

In this case the surcharge, for excess use, is Z$15 per cubic metre.

Recycling

Currently, about 90 percent of the city's population is served by the sewerage system and the remainder by septic tanks. An average of 8 Ml/d (8,000 m^3/d) is reclaimed and used for irrigation of parks, playing fields, road margins, central reservations and sports fields. The city of Bulawayo has a goal to reuse 20 percent of domestic wastewater[81], while up to 100 percent recycling of industrial effluent is possible[82].

Mutare

Zimbabwe's other major city, Mutare, also suffered the 1991-92 drought. This required significant reductions in water use. Consumers were limited to 300 litres/family/day. The city also strongly encouraged its industrial consumers to reduce demand. The impact was dramatic both from the increased efficiencies through reuse as well as from use of boreholes.

The dramatic water savings did have one serious negative effect, however. There were sluggish sewage flows, which were so limited that the conveyance pipes actually started clogging. The fire brigade was called in to flush the pipes. Another problem was the attempt to limit supply to three times per week. The problem with this method was that pressure surges ruptured pipes and interfered with meter registration. This method was eventually discontinued.

Although the city of Mutare is currently constructing a new water supply system capable of supplying 0.7 m^3/s to the city, it will, for example, continue to bill industrial consumers for effluent discharges calculated as a fraction of freshwater intake. It also plans to complete 100 percent metering. This involves metering the remaining 15-20 percent of residential users; further reduce UfW estimated at 20 percent; and provide adequate water supplies on the most economic basis.

CHAPTER 5

Proposed Way Forward

Proposed Action Plan

Any action plan must be realistic. Given the limited financial resources of the region, donor funding notwithstanding, it is important to prioritise and to provide support for sustainable initiatives that will bring about major reductions in water demand. Within this context, if the goal of least-cost water resources planning and operation is accepted, then the following action items are suggested to achieve this goal:

- Requirement that all future water (and wastewater) infrastructure projects include, among other criteria, the analysis of the impact of water conservation and drought management as they relate to the proposed projects.
- Requirement that all municipalities of over 100,000 consumers have detailed and implemented water conservation programmes with clearly identified targeted water saving goals and a cost/benefit analysis of the different options.
- Requirement that all municipalities of over 100,000 consumers have detailed drought management programmes that are completely approved by all impacted customer group representatives, by key decision-makers and potential executors of the programme.
- Conduct a three-year regional study of the following key elements: UfW, meter coverage, accounts receivable success.

  Only by having accurate information on the above four items can the appropriate individuals and institutions make improvements. It is a requirement to conduct a study to understand the problems with unaccounted-for water, metering and accounts receivable in the SADC region The first year of the study would concentrate on accurately identifying the percentages for the four items in all the large cities of the SADC region. The following two years would be devoted to documenting how UfW, metering coverage and accounts receivables are being improved, and to document this in a final report. Bi-monthly newsletters can be distributed to all SADC members so that progress (or lack thereof) can be monitored and encouraged through peer pressure.

- Conduct a short study to determine the "economies of scale" that can be achieved in water conservation and drought management by grouping efforts among all SADC members. Issues to cover are:
  - Regional manufacturing facilities for low-flow plumbing fixtures.
  - Collective bidding for leak detection equipment/training and for meters.
  - Collective bidding for industrial/commercial treatment and reuse equipment and services.
  - Collective bidding for management and consulting services.
  - Importation duty wavers.
  - Regional training seminars.
  - Multi-lingual difficulties.
  - Collective transport.
- Establish a regional water conservation and drought management resource Centre funded through and supported by the SADC Water Sector Coordinating Unit in Lesotho.

Appendix I

Glossary

Commercial Consumers - commercial consumers sell a service or product They include stores, restaurants, hotels, private clubs, office complexes, etc. Normally their numbers are small, but demand per connection may be high.

Domestic/residential Consumers - refers to a utility or municipal classification of customer. Usually domestic/residential consumers are homeowners of single and multiple family homes. While their consumption is low, the numbers of dwellings are large, impacting on demand.

Drought management - the term is used to refer to actions, over and above existing "water conservation" actions that are aimed at short-term, aggressive, demand reductions and supply augmentation during periods of drought. It is possible, however, to turn drought management actions into water conservation measures. An example would be the imposition of watering hours during a drought.

Grey water - wastewater or effluent of higher quality is often called gray water because of its characteristic gray colour. Although gray water cannot be used for potable purposes, it can often be used for toilet flushing, irrigation or other areas that don't require potable water.

Industrial Consumers - industrial consumers are the largest water users per account. These are industries, factories and manufacturing establishments. Examples include bottlers, steel manufacturers, etc.

Municipal/other Category - this category pertains to the water municipality/utility/authority itself. Their water demand can be for pipe flushing, backwashing, etc.

Public/institutional Consumers - refers mostly to government and diplomatic consumers. Examples include government office complexes, public parks, hospitals, fire fighting, etc.

Raw water - Water that has not been treated. Water found in rivers, lakes and other sources in its natural form, which may or may not be abstracted for a purpose and treated.

Recycling - normally refers to multiple uses of water within the same facility or operation. For example, cooling water is run "once-through" before being discharged. Alternatively, it could be recycled (with treatment) so that it is continually used in the cooling process. This reduces what is discharged and what is required as fresh "make-up" water. Quite often the term *recycling* is used interchangeably with reuse.

Reuse/reclamation - reuse refers to using the same water multiple times usually after some form of treatment. Normally, reuse water is for other purposes than the originating purpose. For example, water is provided for domestic interior demands, treated and then applied to outdoor irrigation that requires a lesser quality water. Quite often the term *reuse* is used interchangeably with recycling.

Wastewater/effluent - water, which is no longer potable, is often called wastewater or effluent. It is discharged to municipal sewers, on-site treatment systems or receiving bodies such as rivers. Wastewater and effluent are of varying quality depending on upstream uses of the water.

Water conservation - the term water conservation is used inter-changeably with water demand management. So that it is clear what is meant by water conservation, it refers to long-term water use efficiency through both wise use and the reduction in usage. For the purposes of this report, water conservation does not refer to the impoundment of water or traditional supply issues. Further, water conservation does not apply to draconian policies or practices (in the urban setting) such as limiting supply to the World Health Organisation (WHO) minimal standards of 40 litres per capita per day. In the urban setting, this quantity would indicate poor management and not water conservation. It would also likely result in ancillary sanitary and health problems.

Water demand - water demand, water use and water consumption are often applied interchangeably when discussing water resources. Each term has its strengths and weaknesses and can often become confusing. To add to this confusion is the fact that economists, engineers and planners often use the three terms but with different meanings. This study uses the term "water demand" to refer to the amount of water actually used or consumed. It does not refer to what is demanded or requested but what is actually used by the particular category.

Appendix II

Country Data on Urban Water Demand

Water demand data presented in this section were obtained from telephone communications, site visits and reports. Data were gathered for 12 out of the 14 SADC countries: Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. Where applicable, the gathered water demand included data from large cities. The combined urban and rural water requirements for the countries under study are presented in Table II.1[83].

Table II.1: Water demand for selected SADC countries, 1995 (million m³/year)

Country	Domestic/ Industrial	Stock	Mining & Energy	Irrigation	Nature	Total
Angola	1,720	272	15	750	-	2,757
Botswana	175	44	65	47	6	150
Lesotho	84	19	5	160	-	268
Malawi	730	23	5	1,820	-	2,578
Mauritius	155	-	125	460	-	740+
Mozambique	135	65	10	3,000	-	3,210
Namibia	200	70	15	248	5	538
South Africa	10,397	368	1,937	12,764	4,702	30,168
Swaziland	25	13	2	331	140	511
Tanzania	1,690	70	10	10,450	-	12,220
Zambia	532	60	20	1,580	-	2,192
Zimbabwe	697	30	30	4,980	-	5,737

Source: SADC/IUCN/SARDC. Water in Southern Africa Harare/Maseru, 1986 p.81

ANGOLA

In 1995, an estimated 31.9 percent or 3.5 million of the 11 million people in Angola lived in urban areas.[84] Annual urban water demand for 1995 was estimated at 1.72 billion cubic metres (cu m).[85]

The protracted civil war has destroyed most of the socio-economic infrastructure, especially water supply systems in heavily populated cities such as Huambo and Kuito. Most people then migrated to safer cities, overloading the already poorly maintained and strained water supply systems.

About 60 percent of the urban population have access to safe water supplies. Of the 60 percent, 45 percent get their water from mobile supply tanks, 31 percent from public standpipes, and 8.3 percent from home taps.[86]

The Angolan capital, Luanda, is home to about 54 percent of the total urban population. As such, it faces many of the demands associated with large urban populations in regard to water supply. In

1995, its population stood at 1 89 million, recording an extraordinary 7.6 percent annual growth.[87] Its 1997 urban population stood at 2.5 million.[88]

Empresa Provincial de Agua de Luanda (EPAL) runs the city's water supply. The authority largely depends on government funding through the Direcçao National de Aguas (DNA). The government's water tariffs are low compared to prices of other (mobile) water suppliers. The percentage of the government's budget for water and sanitation is about one percent of the total national annual budget.[89] Coupled with low recovery costs, EPAL cannot make the necessary investments

About 70 percent of Luanda's population is supplied by tankers, low-level tanks and standpipes while the remaining 30 percent is served by reticulation networks.[90] According to a recent study, between 5,000-10,000 informal water retailers exist in Luanda with tank capacities varying between 5-10 cu m.[91]

BOTSWANA

In 1995, an estimated 29.1 percent or 552,900 of the 1.9 million people in Botswana lived in urban areas. In 1975, households were allowed to obtain private connections for which they paid a flat rate of about US$0.30 per month. These rates were increased in 1990 to better reflect the service and supply costs.[91]

The 1995 average urban water demand for Botswana was about 175 million cu m, resulting in a relatively high corresponding daily per capita water demand of about 252 litres. Urban water demand is estimated to reach 336 million cu metres by the year 2020. Water demands for specific cities, are presented in Table II.2[93]

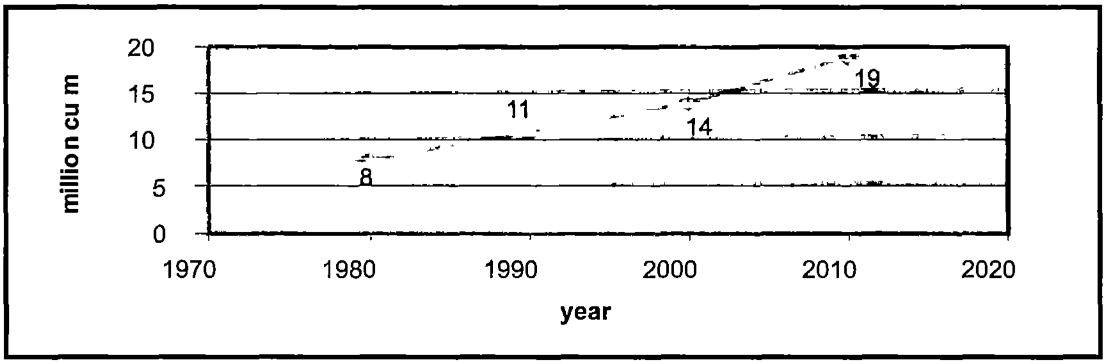
Table II.2: Botswana's 1996 water demand estimates by city (million cu metres/year)

City	Population	Domestic or Residential	Institutional or Industrial	Commercial	Total
Gaborone	170,000	6,243	5,287	2 ,25	14,252
Francistown	89,000	1,664	1,374	1,227	4,265
Selebi-Phikwe	44,000	1,745	561	2,032	4,338
Lobatse	26,000	607	439	1,061	2,107
Jwaneng	11,000	891	43	408	1,342

LESOTHO

In 1995, an estimated 15 percent or 315,000 of the 2.1 million people in Lesotho lived in urban areas. The annual urban water demand for 1995 stood at 84 million cu m, representing an average daily per capita demand of 109 litres.[94] The rather low per capita use may be due to the fact that some urban dwellers are not connected to reticulation systems or that those connected infrequently use them. This is because there are alternative water sources from peri-urban vendors who sell water from their community standpipes at lower rates (0.5 Maloti/cu m). However, domestic water demand is expected to rise, fitting well into the trend established since 1980 as shown in Figure II.1

Figure II.1: Trend in Lesotho's Domestic Water Supply (million cu m/year)



MALAWI

In 1995, an estimated 13.5 percent or 1,498,500 of the 11.1 million people in Malawi lived in the urban areas. Five water boards handle urban and peri-urban water supply in Malawi: Lilongwe, Blantyre, Southern, Central and Northern Region. The 1995 annual urban water demand for the whole country was about 730 million cu m, reflecting a corresponding per capita daily water demand of 180 litres.

In 1996, the population of Lilongwe was about 429,017, consuming up to 37.6 million cu m per annum. By 1997, Lilongwe's population had risen to about 459,048 people, consuming up to 38.4 million cu m/year. Consumption is projected to rise to about 55.3 million cu m/year by the year 2001.[95] The city of Blantyre has a total of 29,000 metered connections and the water demand and use categories are presented in Table II 3

Table II.3: Water demand and use in Blantyre 1997 (million cu m/year)[96]

Category	Demand
High density traditional	2,695
High density permanent	1,432
Low density	6,545
Government/Public	4,500
Schools/Colleges	1,023
Industry/Commerce	4,295

MAURITIUS

An estimated 40.6 percent of the 1.1 million people in Mauritius lived in urban areas in 1995.[97] The Water Resources Unit (WRU), falling under the Ministry of Energy and Water Resources, is responsible for water development issues. These include demand assessment, management, monitoring and conservation. WRU liaises with the Central Water Authority. While the 1995 urban water demand figures for Mauritius were unavailable, the projected municipal water demand stands at 220 million cu m for the year 2000, increasing to about 400 million cu m in 2020.[98]

MOZAMBIQUE

In 1995, an estimated 34.2 percent of the 17.9 million people in Mozambique lived in urban areas.[99] The 1995 annual urban water demand for the whole country was about 135 million cu m, representing the corresponding per capita daily water demand at 20 litres. Of this volume, unaccounted for water was estimated at 60 percent[100].

Table II.4: Mozambique's 1992 water demand estimate by city (million cu metres/year)

City	Population	Domestic	Non-domestic	Losses	Total
Maputo*	590,324	15,527	10,500	16,920	42,950
Beira	83,594	2850	1,330	3,136	7,317
Quelimane	19,986	342	293	254	889
Nampula	54,234	895	1,139	1,220	3,255
Lichinga	5811	104	86	4848	238
Chimoio	11364	292	267	25	584

* *Figures obtained from Mozambique's Ministry of Water, 'Provincial Towns Water Sector Study - Estudo Das 12 Cidades' by DHV Consultec.*

Additional water demand data for specific cities were gathered from field visits, interviews and the 'Twelve Cities' report by the National Directorate of Water (DNA). The data is presented in Table II.4. The water demand and use groups were drawn up as: domestic, to include houses and yard connections; non-domestic, to include institutional, industrial, commercial and public taps; and losses, to include unaccounted for water.

NAMIBIA

In the case of Namibia, about 37.5 percent of the 1.5 million people in the country lived in urban areas in 1995. Specific water demand data could only be obtained for Windhoek. The data[101] are shown in Table II.5.

Table II.5: Windhoek's water demand (million cu metres/year)

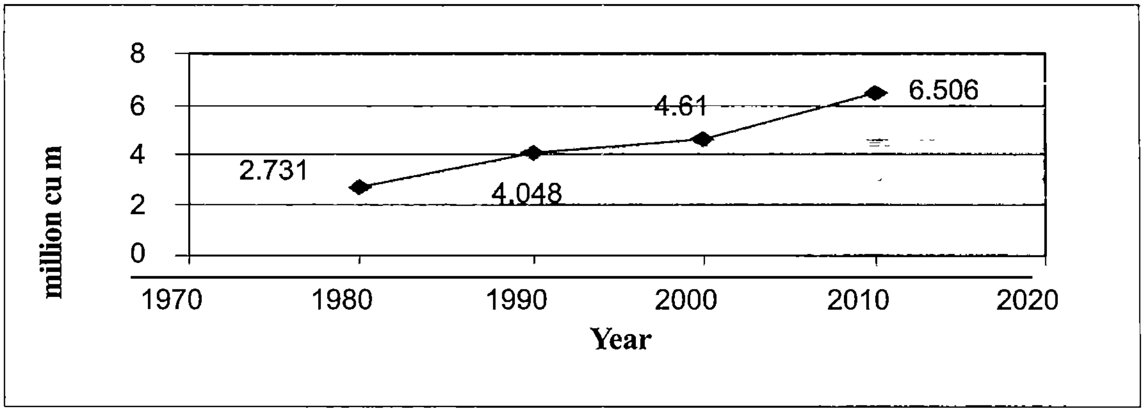
Year	Population	Residential	Industrial	Commercial	Total demand	Total supply
1995	181,696	10,057	1,537	4,420	16,014	17,913
1996	191,508	7,829	1,414	4,094	13,337	15,172

On average, Windhoek's daily per capita water demand was about 242 and 196 litres in 1995 and 1996 respectively. Unaccounted for water was about 11 and 12 percent for the two years, respectively.[102] The decreasing per capita daily consumption is remarkable, especially in light of the increasing population (average annual growth rate estimated at 5.1 percent in 1996). Single family units were 25,405 and multiple family units were 2,605. In addition, there were about 80 industrial and 40,000 residential consumers drawing water from public standpipes. Had Windhoek's water demand patterns not changed, the city was going to run dry by 1998. In fact, by the year 2003, the city would require drawing water from some of its perennial sources, the nearest being the Okavango River (about 800 Kilometres away).[103] However, depending on the potential to develop future groundwater sources, the date may be delayed to the year 2009.[104]

SOUTH AFRICA

In 1995, about 48 percent of the 41.5 million people in South Africa lived in urban areas.[105] The 1995 annual urban water demand for the country was about 10,397 billion cu m, reflecting a corresponding high per capita daily water demand of 686 litres. The trend in South Africa's urban water demand is shown in Figure II.2.[106]

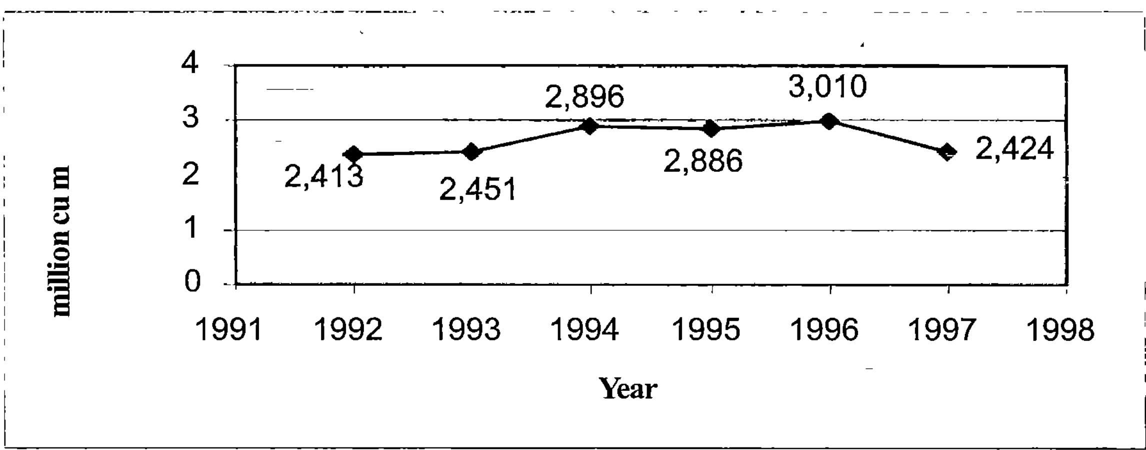
Figure II.2: Trends in South Africa's urban water demand



Water demand for South Africa's tourist town of Hermanus requires some special consideration This resort town is known for its strong conservation measures and is the namesake for South Africa's Hermanus Declaration on Water Conservation. Hermanus' population was estimated at 22,481 in 1996. Within the town, there are 70 industrial consumers, 7,357 single family units and 779 multiple family units Water conservation trends for the town reflect its water demand patterns shown in Figure II.3.

A point to note is that the town used almost the same amount of water during 1992 and 1997. This of course is against a trend of increasing tourist numbers to the town.

Figure II.3: Hermanus water demand patterns



Water demand for the cities of Pretoria and Johannesburg[107] for 1996 was estimated at 1,342 billion cu m. Details of water demand and projections for 1990, 2000 and 2010 for Cape Town, Durban, Pinetown, Pietermaritzburg and Port Elizabeth are presented in Table II.6.[108]

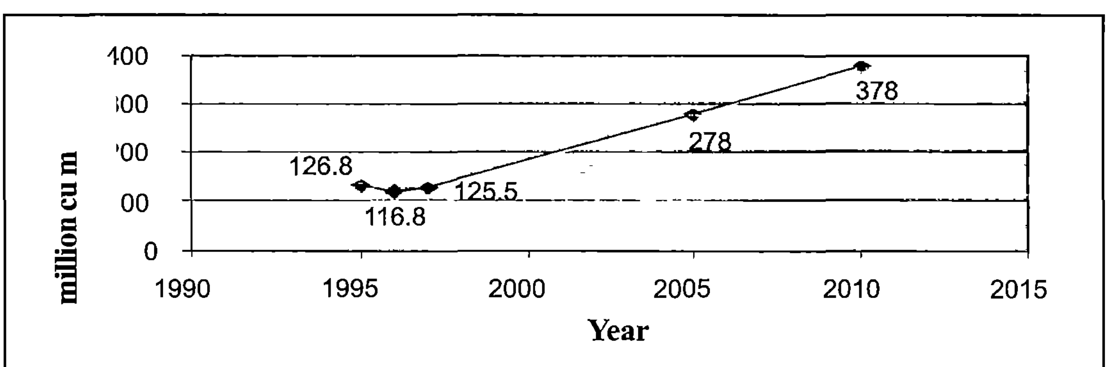
Table II.6: Water demand and projections for selected South African cities (million m³/year)

Cape Town					
Year	**Population**	**Domestic**	**Industrial**	**Municipal/ Commercial**	**Total**
1990	2,220,000	152	41	63	256
2000	2,700,000	216	61	90	367
2010	3,100,000	275	80	114	469
Durban-Pinetown-Pietermaritzburb					
Year	**Population**	**Urban**	**Industrial**	**Nature**	**Total**
1990	2,400,000	134	170	18	322
2000	3,200,000	179	228	18	425
2010	4,100,000	261	279	18	558
Port Elizabeth					
Year	**Population**	**Domestic**	**Industrial**	**Unmetered**	**Total**
1990	980,000	49	25	8	82
2000	1,220,000	73	37	12	122
2010	1,510,000	106	53	18	177

SWAZILAND

About 31.2 percent of the 1.2 million people in Swaziland lived in urban areas in 1995. The Urban Water Services Corporation is the provider of water. The 1995 annual urban water demand for the country was estimated at 25 million cu m, with a corresponding per capita daily water demand at 57 litres. Unaccounted for water was estimated at 60 percent.[109] However, domestic water demand is expected to rise,[110] fitting well into the trend established since 1980 (Figure II.4).

Figure II.4: Swaziland's trend in domestic demand



Another source[111] shows that the country's urban domestic water demand was 5.77 million cu m in 1994. It was projected to rise to about 16.35 million cu m by the year 2016. Similarly, industrial water demand was 5.71 million cu m in 1994 and was projected to rise to about 13.94 million in 2016.

TANZANIA

In 1995, about 24.4 percent of the 32.5 million people in Tanzania lived in urban areas. The 1995 annual urban water demand for the whole country was estimated at 1.69 billion cu m, representing a per capita daily water demand of 142 litres. No further water demand data was collected during the study.

ZAMBIA

About 43.1 percent or 4,094,500 of Zambia's 9.5 million people lived in urban areas in 1995. The 1995 annual urban water demand for the country was about 532 million cu m, reflecting a corresponding per capita daily water demand of 145 litres. The 1990 water demand and population data[112] for selected Zambian cities are shown in Table II.7.

Table II.7: 1990 urban water demand for selected Zambian cities (million cu metres/year)

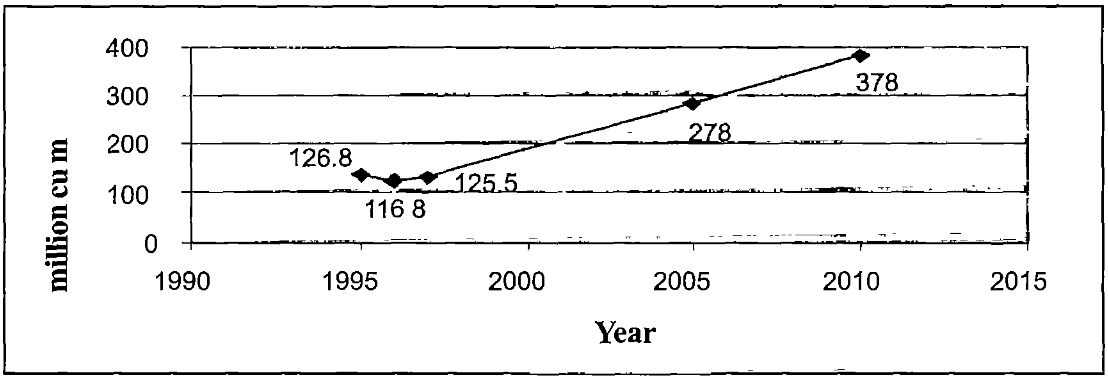
City	Population	Demand
Kitwe	400,000	3,596
Ndola	608,038	9,000
Luanshya	147,000	1,040
Chipata	16,340	270
Chingola	116,000	833
Mufulira	200,000	5,006

Detailed data sets for Lusaka were scarce. However, information based on the Central Statistics Office and Water Sector Development Group Database show that the capital's 1990 population was 816,861 people, consuming about 8,800 cu m of water per hour.[113]

ZIMBABWE

In 1995, an estimated 32.1 percent of the 11.3 million people in Zimbabwe lived in urban areas.[114] Urban water supplies are a responsibility of either city councils or municipalities. The 1995 annual urban water demand for the country was about 697 million cu m, reflecting a corresponding per capita daily water demand of 169 litres. Another source estimates that the 2020 daily urban per capita water demand will be 220 litres[115]. The trend in Harare-Chitungwiza urban water demand is shown in Figure II.5 [116] Another (1996) calculation[117] that combined the Harare-Chitungwiza water demand with the small town of Norton estimated the demand at 155 million cubic metres. Water demand data for Bulawayo and Mutare were also compiled. Bulawayo is basically located in the drier parts of Zimbabwe where water is scarce. In fact, during the 1991-92 drought, the Bulawayo city council had to implement strong water rationing measures, some of which are still in place. Data for 1992 show that the city's daily per capita demand was 80 and 220 litres for the high and low density residential areas respectively.[118]

Figure II.5: Trend in Harare-Chitungwiza water demand



The 1995 breakdown for Bulawayo water requirements are as follows:

35.9 million cu m for domestic uses; and 11.2 million cubic metres for industrial and 11.2 million cubic metres for commercial. This brings the 1995 total to about 58.3 million cu m [119]

The city of Mutare's population was estimated at 144,000 people in 1995[120] and the figure rose to about 175,000 in 1996 with a corresponding demand of 12 million cu m. The Department of Water Resources estimates an annual growth rate of about 3.5 percent after 1999.[121]

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