Ministry of Agriculture,Water and Rural Development
Department of Water Affairs
Directorate of Resource Management

and

City Engineer (Water Services)
City of Windhoek.

Report to the

IUCN

on

WATER DEMAND MANAGEMENT

COUNTRY STUDY

NAMIBIA

Edited by:

Ben van der Merwe
Environmental Engineering Services

PART I: BACKGROUND

PART II SECTOR PROFILES

PART III   CASE STUDIES

PART IV   OVERVIEW

IUCN WATER DEMAND MANGEMENT COUNTRY STUDY – NAMIBIA

TABLE OF CONTENTS

PART 11: SECTOR PROFILES

PART IV: OVERVIEW

LIST OF ABBREVIATIONS

CBM	**Community Based Management**
DWA	**Department of Water Affairs**
EIRR	**Economic Internal Rate of Return**
ENWC	**Eastern National Water Carrier**
DRFN	**Dessert Research Foundation of Namibia**
DRWS	**Directorate of Rural Water Supply**
GDP	**Gross Domestic Product**
GTZ	**Gesellschaft fur Technische Zusammenarbeit**
IUCN	**International Conservation Union**
LA	**Local Authority**
LSU	**Large Stock Unit**
MAWRD	**Ministry of Agriculture, Water and Rural Development**
MIS	**Management Information System**
MRLGH	**Ministry of Regional and Local Government and Housing**
NDC	**National Development Corporation**
NEPRU	**Namibian Economic Policy Research Unit**
NGO	**Non-Governmental Organisation**
PED	**Price Elasticity of Demand**
SIAPAC	**Social Impact Assessment and Policy Analysis Corporation**
SIDA	**Swedish International Development Cooperation Agency**
SOER	**State Of the Environment Report**
SWI	**Specific Water Intake**
UNDP	**United Nations Development Programme**

NDP1	**First National Development Plan of Namibia Volume 1**
WASP	**Water and Sanitation Sector Policy of Namibia**
WDM	**Water Demand Management**
WPC	**Water Point Committee**
ZERI	**Zero Emissions Research Initiative**

LIST OF TABLES

		Page

Page

LIST OF FIGURES

ACKNOWLEDGEMENTS

The study was jointly undertaken by the Directorate of Resource Management in the Department of Water Affairs (MAWRD) and the former City Engineer (Water Services) Department of the City of Windhoek.

The editor and team leader wish to acknowledge the input of the researchers and authors. They are Ben Groom, Ricky Pieters, Klaudia Schachtschneider and Kathline Neels from the Department of Water Affairs, Hannes Buckle and Reynard Steynberg from the City of Windhoek, Manfred Redecker, an associate researcher, Leon Hugo, Tersius Basson, Willie Knouwds, Joseph Maartens and Andries Hugo from the Division Agricultural Engineering.

A special word of thanks to the members of the steering committee, Ms. B. M. Barnard, Mr. E. Ferreira, Mr. S. Goagoaseb, Mr. H. Habenicht, Mr. P Heyns, Mr. L. Hugo, Mr. H. Kaumbe, Mr. J. Pandeni, Dr. M. Seely, Mr. P. Smit, and Mr. A. P. Wahl.

We wish to thank the national reviewers, Piet Heyns, Director Water Resource Management at the Department of Water Affairs and Dr Mary Seely, Director of the *Desert Research Foundation of Namibia* DRFN, as well as the external reviewers for their constructive criticism. We finally wish to thank IUCN for financial support and particularly Saliem Fakir who co-ordinated the regional study

The editor wishes to extend his gratitude towards Shirley Bethune and Ben Groom for their input and support in finalising the report.

3. MAIN POLICY ISSUES FOR THE WATER SECTOR

Ben Groom

3.1 ECONOMICS

3.1.1 Introduction

WDM can be implemented in many ways with different policy tools being successful in a variety of contexts. These policy tools include **market mechanisms** such as economic pricing, **non-market mechanisms** such as the application of standards, quotas and fines on water use and **direct intervention** such as repairs to leaks, reduction of unaccounted-for-water and promotion of water efficient technologies. None of these methods should be seen in isolation and all form part of an integrated approach towards WDM.

In light of the growing demands in Namibia due to growth and change in the structure of population, environmental constraints and expense of supply augmentation, the emphasis is firmly on WDM to ensure the greatest overall benefits are derived from limited resources. From an economic point of view there are several important considerations to be discussed. These include:

- Economic development and the value of water in different sectors.
- The pricing of water in theory and practice,
- The incorporation of WDM in the planning process.
- The relative costs of WDM compared to supply augmentation.

These points are addressed here and put in the context of Namibia as a developing country.

3.1.2 Economic Development.

Economic development is measured in many ways. One important measure is the income per capita. Other measures include social indicators such as education and health of the population. The performance of the economy, measured by growth in GDP for example, is a key determinant of economic development. Water is often quoted as being the main constraint to the economic development of Namibia. Essentially this means that water is expensive to supply to many areas and the viability and array of potential activities is reduced.

It is apparent that the scarcity of water has both supply and demand side aspects to it. In general water is expensive whilst development opportunities and hence the value of water use is often low.

Value added is a measure of the economic contribution of particular economic activities give an indication of the value of water. It is the contribution to Gross Domestic Product (GDP). Value added per m^3 relates this to water use. **Table 3.1** shows the contribution to GDP by sector and the contribution per m^3 of water. This table will act as a reference point for discussions about value added in the sector profiles.

Table 3.1: Value Added per Cubic Metre of Water Consumed by Sector 1996

Economic Sector	Value addec 1996 (millions of N	Water use 19 (Mm³)	Value added pe cubic metre of water 1996 (N$)
Agriculture	**1,029**	**142,9**	**7,20**
Commercial	650	92,9	7,00
Subsistence	379	50,0	7,60
Mining	**1,654**	**25,2**	**65,60**
Diamond mining	1,169	13,6	86,00
Other mining	485	11,6	41,80
Manufacturing	**1,552**	**5,3**	**292,80**
Fish processing	354	0,5	708,00
Other manufacturing	1,198	4,8	249,60
Services	**3,215**	**5,5**	**574,50**
Hotels and restaurants	226	1,2	188,30
Transportation	252	0,8	315,00
Other services	2737	3,5	782,00
Whole economy (GDP)	**11,796**	**231,2**[1]	**51,00**

*Source: G M Lange, Natural Resource Accounting Program, DEA.

The more efficient use of water through WDM strategies will enable greater economic contributions to occur from the same limited water resources available. Policies such as economic pricing will help allocate water to higher value uses, as low value uses become unprofitable. This will contribute to economic growth and development provided that there are complementary macroeconomic policies in place which promote activities[2] based on sound economics. For example there are certain development strategies that could impact adversely on water usage. One of the goals set out in the first National Development Plan 1995 (NDP1) and the Water and Sanitation Policy of 1993 (WASP) was food self-sufficiency in basic grains. The motivations for this policy are manifold but include the desire to be free from external markets for foodstuffs, promotion of rural development/employment and higher incomes and the achievement of food security

The contribution of agriculture to GDP, as shown in **Table 3.1,** is only 8.7% while water use is approximately 60% of the total water production for the country. Employment levels are higher for higher value crops such as grapes, while water requirements for basic food supply may "crowd out" higher value uses, and dependence will be created on the perennial rivers, imported fertilisers etc. Higher value crops will increase incomes for farmers more than low value crops such as basic grains. Economic growth is more likely to be achieved in planning more valuable uses for water and encouraging trade. Increasing incomes is the most effective way to achieve food

[1] This total is different to the estimate given by Day 1997. Water production in 1996 was at least 30% lower as result of the drought.
[2] I.e. no unnecessary protection or subsidisation for particular low value uses of water where water is scarce, understanding that there may be a need to protect infant industries from foreign competition.

security for the Namibian population instead of food self-sufficiency in basic grains[3]. Due to high evaporation in Namibia more water is needed for the same production in comparison with better areas for agriculture (irrigation) in other countries.

The value added per m^3 can also give us an idea of each sectors' ability to pay for full cost recovery of water. **Table 3.1** does not include environmental costs since these costs are rarely included in any national accounts. As such the true economic effect of water use in each economic sector is not reflected in these figures.

It is evident that both the sustainable yield of water resources and the potential demands for water in Namibia should be known if we are to achieve the target of sustainable economic development. Furthermore, allocation mechanisms such as economic pricing need to be in place to guide consumers, including industry, in their water consumption decisions.

All of these factors are important when considering a sensible Water Demand Management strategy that endeavours to aid the development of the country. A sensible strategy from an economic point of view would ensure that water is not used inefficiently on the one hand, and not unnecessarily restricted on the other.

3.1.3 Water Pricing Principles.

3.1.3.1 Price Elasticity of Demand

The price of water is an important determinant of who uses it and how they use it. Demand for water in economic terms indicates a price/quantity relationship; i.e. "demand" describes the relationship between the price of water and the quantity purchased. It has been found that this relationship is inverse such that as price increases the quantity of water demanded decreases. The "price elasticity of demand" tells us something about this relationship. **Table 3.2** shows estimates of the Price elasticity of demand for water in several countries. It can be seen that in all cases the relationship is negative, indicating increasing prices reduces demand. When water is under-priced, economic pricing is a useful tool for to lower water demand

Table 3.2. Price Elasticity of Demand Estimates in Urban Centres.

Town	Price Elasticity of Demand
Perth, Australia	-0.11
Victoria B.C, Canada	-0.40
Helsinki, Finland	-0.11
Malmo, Sweden	-0.15
Eastern States, USA	-0.57 (summer)
Tucson, USA.	-0.45

[3] Individuals may increase their market power through national economic development, and hence achieve greater food security.

There is a dearth of information on price elasticity among urban consumers in Southern Africa. The shortage of historic information hampers the analysis to determine price elasticity of water. Forster and Mirrilees (1993) made the following comment on price elasticity:

"However, when introducing penalties to curb household water consumption during droughts, some municipalities found that in order to have any discernible effect, severe penalties were necessary. It has since been speculated that most First World consumers may only start considering permanent water saving measures at about the R2,50/m^3 level, well in excess of the current R1,20 to R1,60 paid by most urban consumers. If correct, this would mean that in terms of the appropriate valuation of water, existing supplies to developed communities are probably under priced."

During the change in water tariff system from a basic charge to a flat rate in 1991, the same phenomenon was experienced in Windhoek. The tariff was changed from a basic charge plus a low unit tariff per m^3 to a minimum charge that includes a certain volume of water and a relatively high unit charge. The change in tariff system lowered the account for lower income consumers up to 25 %. For consumers who used more than 50 m^3/month the cost of water increased with more than 25 %. In spite of the major increase on some customers' accounts, there was no change in water consumption pattern.

It is estimated that the "threshold price" where customers will start to use less water is approximately N$ 5.00/m^3 for 1998 for medium and high income groups in Windhoek. In the Namibian context water in Windhoek is regarded as expensive in comparison with other towns in the country.

According to Lebel et al (1993) the price of water for industrial use has an influence on water consumption, and it is accepted that price increases over recent decades have led to decreased industrial use in developed countries.

The price sensitivity of industries may be related to industrial effluent charges and long term expected increases in the water price. In Namibia even wet industries spend less than 1 % of their expenditure on water and wastewater treatment. It is doubtful whether they will be price sensitive before water and waste treatment costs represent a higher cost factor for industry. In Windhoek successful results were only obtained through discussions and commitments by some industries to save water.

In Phoenix, Arizona the total water consumption declined by 30 % during the summer months for the period 1975 to 1994 (Water & Environment, July 1995). In Tucson, Arizona, a saving of 22% was realised over the period of 15 years starting in the mid 1970s (Batthia et al 1993). It should be noted that tariff policies played an important part in realising the savings.

According to Gleick et al (1995) in California it will be possible to reduce indoor water consumption by 44% by the year 2020 with a 100 % compliance of the National Energy Policy Act (USA). The outdoor use can be reduced by 50 % by more efficient use of outdoor water and re-use of purified effluent.

Price elasticity estimates in California by Mitchell and Hanemann (1994) were summarised by Gleick (1995) and are indicated in **Table 3.3**

Table 3.3 Price Elasticity Estimates for Residential Water Use in California

Single-family Residential Customers	**Range of Elasticities**
Winter season	-0.10 to -0.30
Summer season	-0.2- to -0.50
Multi-family Residential Customers	**Range of Elasticities**
Winter season	0.00 to -0.15
Summer season	-0.05 to -0.20

Source: Mitchell and Hanemann 1994

A study by Bradley (1994) in Sri Lanka on changes in consumption since 1991 shows a high price elasticity of -0,75 for the domestic sector. In industry and the commercial sector the price elasticity was -0,35 while for the government institutions sector price increases appeared to have no effect at all.

Bathia et al (1993) summarised the effects of residential and industrial price increases and changes in pollution regulations as follows:

"In developing countries, there is a myth that prices do not play a significant role because the water bill is a small percentage of total household expenditure. In fact, there are few studies of household water demand in developing countries that support this belief. In general, since water tariffs have been traditionally low, the incentives for efficient use in households have been low. It is difficult to estimate elasticity of demand where there is no metering of consumption and price changes have not been significant. However, where sharp increases in prices have been made and consumers have had to pay higher prices for additional quantities (increasing block rates), consumers have reduced consumption.

In a number of developed countries - Israel, Canada, the United States, Australia, and Great Britain - researchers have found that household water demand drops by 3% - 7% when prices rise by 10 %. Thus, water prices play an important role in reducing consumption. The cases of Tucson and California in the United States show that when sharp increases in prices are made and consumers have to pay higher prices for additional quantities (increasing block rates), consumers reduce their consumption.

To the extent that tariffs have been low and people have not developed the habit of conserving water, the potential for savings is considerable if the right tariff policies are put in place. If water for domestic uses were priced at the marginal cost of providing it (including the opportunity cost of water), consumers could be expected to respond by eliminating and reducing some uses.

There is compelling evidence that improved policies can have major impacts. In a number of cases in developed countries, pricing and tariff policies combined with regulations have produced savings of 20% - 30% and more.

Conservation in the industrial sector is possible if an appropriate policy environment is created. Evidence suggests that regulatory measures and economic incentives, mainly water tariffs, have caused significant reductions in water demand in industrial units. There are examples where administrative and legislative measures (licenses, quotas on water use and effluent discharge, and the introduction of water saving technologies) have reduced industrial water consumption 40% - 70%. Many different economic incentives can promote efficient use of water: water tariffs; tax or subsidy policies for equipment; interest rate subsidies or soft loans for water saving and/or effluent treatment equipment; and effluent charges."

From the literature and experience in other countries it is clear that an integrated approach on WDM in combination with an effective water pricing policy can influence the long-term water consumption. In Windhoek savings of more than 30 % were realised in the residential water consumption. Through an integrated approach and commitment of all the players it is estimated that similar or even higher savings can be achieved in the commercial, industrial and especially the public sector.

3.1.3.2. Price of Water.

When the full resource costs to the economy involved in the supply of water is not recovered, it is subsidized by the supplier. The full resource costs of supply contain the following components:

- the capital costs
- operation and maintenance cost
- environmental costs
- opportunity costs.

- Financial Costs

The financial costs of water supply include capital, operations and maintenance costs. It is important from the point of view of financial sustainability for private water supply agencies such as Namwater to recover these costs. From a developmental point of view, governments may increase funding to other worthy causes if water supply is run on a cost recovery basis.

- Environmental Costs.

The environmental costs of water supply can be significant. For example along the Orange River an increase in Black fly as a result of the regulation of the water flow has meant that livestock losses have increased. The incorporation of these costs in the tariff for water will reduce water usage and environmental damage to efficient levels.

- Opportunity Costs.

The opportunity costs of water use are the effects of current use of water on other potential users of water who may be deprived. These may include industries, residential consumers or environmental costs. One can see from **Table 3.1** that using a m^3 of water in agriculture rather than the manufacturing sector, for example, has an opportunity cost of N$292.80 – N$7.20 = N$285.60/$m^3$. Including opportunity costs in the price would ensure water was allocated to higher value uses.

3.1.3.3 Equity Considerations and Increasing Block Tariffs.

It is often felt that the pricing of water based on economic principles may achieve efficiency at the expense of equity. Since water demands and willingness to pay for water are influenced heavily by incomes, basing the price of water on demand and supply principles may leave some people unable to afford water. In many developing countries this has been addressed by the use of increasing block tariffs i.e. progressively higher tariffs for progressively higher consumption. Currently Windhoek operates an increasing block tariff system.

It is certainly true that this type of system allows cross subsidisation to occur between higher income and low income users, since it is generally high-income users with gardens and swimming pools that pay the more punitive tariffs for high consumption. Those who use relatively small amounts of water are able to pay less than the cost recovery price for water. There are limitations to the effectiveness of this tariff system with respect to achieving equity-related goals[4]:

[4] D. Whittington and J.J Boland 1998.

- The initial “block” is uniformly set for all family types. It is in general true that poorer households are larger than rich households i.e. have more people. As such this initial cheap block will benefit small households more than large households since a given water consumption per capita will be cheaper per capita.

- This problem could extend to private connections that are being used by water vendors. The connection may be supplying many households with basic water requirements whilst paying higher charges associated with luxury water use.

- Income redistribution is regressive within the first block. I.e. where the cross-subsidy is embodied in the first block, it is necessary to consume the entire block in order to receive the entire subsidy. As households reduce the water consumption the subsidy is reduced.

- In general the maximum possible subsidy is small.

Clearly equitable and affordable water supply is an issue when using pricing as a WDM tool. Block tariffs have been widely used in developing countries to address this issue with scant regard for some of the detailed implications of such methods. It is clear that the design of the tariff system is critical in achieving the required effects of equity and economic efficiency whilst still achieving cost recovery.

With the existing water tariffs in Windhoek approximately 55% of the residential consumers get subsidised water. The existing tariff accommodates extended families as well. As consumption increase the unit rate of water also increases that make it possible to subsidise the poorer part of the community.

The application of an efficient water tariff policy system is the most important instrument for the successful implementation of a WDM policy. All the evidence suggests that water is constantly overused in parts of Namibia because it is consistently under priced.

3.1.4 Past Pricing Policy

In Namibia total subsidies to bulk, urban and rural water supply amounted to N$70 million in 1996. This equated to 0.6 % of GDP. This is very much a world-wide phenomenon with total subsidies to water supply estimated to be US$54 billion in 1996. This is less than the total official aid from “developed” to lesser-developed countries. The Government accepted a policy to lower the subsidy paid to the water sector.

The drain on public finance due to these policies is evident and it is clear that such practices are both economically and institutionally unsustainable. This can be seen in the currently rising tax burden, increasing debt/expenditure ratio both of which would be aided by cost recovery[5]. Without significant contributions from water users to the water supply sector it will become increasingly difficult to maintain and augment a functional water supply system in the face of the predicted rise in demand and rising costs of supply.

[5] Debt expenditure ratio is the local and external debt as a percentage of total government expenditure.

Subsidised water is often directed towards sectors where the economic benefit is low since the water is not implicitly valued. The fact that water has historically been supplied at low cost has lead to a general feeling that water *should* be supplied at low cost. The implementation of water pricing has been met with resistance in some regions, manifesting itself in non-payment of water bills and illegal connections. Subsidised water has shaped the pattern of development in Namibia towards water intensive activities such as irrigation, and within these activities inefficient practises such as flood irrigation. Incentives to use water more efficiently/productively have been low.

Similarly, national policy has been shaped by the perception of water as a means to promote development. For example the WASP and NDP1 both state that food self-sufficiency as a national target. Such a policy would require subsidisation of water and capital inputs and a water allocation decision in favour of irrigated agriculture (Div Planning, Department of Agriculture 1997). Self-sufficiency in basic grains is a policy that is now absent from the National Agricultural Plan.

3.1.5 Present Policies

In Namibia today there is a general movement towards achieving cost recovery for water supply. Since there is no accepted government regulation specifically for pricing of water, the different water supply sectors have their own approaches to this cost recovery.

3.1.5.1 Bulk Water.

Namwater, the new commercial bulk water supplier has a government approved policy of raising prices of bulk water to full cost recovery level by 2000: “full cost” is operation, maintenance and relevant capital redemption (full financial costs). This entails a 20 % increase each year for 5 years until this goal is reached. In some cases this strategy would not result in full cost recovery. These users would be subject to a maximum of a 35 % increase in any year. This will enable the water authorities to slowly recover their costs and cause consumers to internalise the full costs of the water they consume. These tariff increases are nominal increases and as a result should be taken in the context of 10 % annual inflation. The revenue effects of tariff increases are not addressed by the tariff policy i.e. it is currently assumed that demand is not price elastic and therefore revenue will not fall as price increases. The water demand in most urban areas declined over the past three to four years.

Namwater has over 200 water supply points under its control. Many of these supply points are local governments and municipalities who in turn are responsible for the reticulation of water to individual consumers. Although it is important for Namwater to charge the full cost for water from the point of view of financial sustainability and economic incentives, it is equally important that the end users are charged according to the same principles for WDM to be effective.

3.1.5.2 Urban Water.

The following guidelines were given on tariffs in the Water and Sanitation Sector Policy document (WASP, 1993) in respect of urban water supply tariffs and cost recovery:

A low price for a defined minimum lifeline volume of water

Progressively increasing rates for increased consumption.

Rates for mining, industrial and commercial enterprises cover, as far as possible, the full financial cost.

Direct and immediate recovery of costs for the supply of water to plots that can be considered as plot related investments (i.e. local distribution).

The price of water charged in Namibia does not reflect the scarcity of water. This may be related to the fact that bulk supply to urban areas is still subsidised with respect to capital charges.

There is no distinct cost recovery policy for Local Authorities, although some authorities are financially independent and therefore have an incentive to recover their costs. Volumetric tariffs are common place in the urban centres of Namibia. Currently in Windhoek, Swakopmund, Tsumeb, Walvis Bay and Henties Bay rising block tariffs have been implemented such that those urban users who consume larger quantities of water must pay a higher tariff for each unit of water. This system has a baseline level of water consumption for which the lowest tariff applies. This enables a fairer distribution of water in general. The tariffs for bulk water supply are reviewed annually, while those of towns and municipalities eventually follow suit.

However, even today in the capital Windhoek the bulk water tariff is subsidised, the full financial cost tariff being N$3,17[6] per m^3 and the price charged to the municipality being N$2,40. The cost recovery price is apparently calculated taking depreciation of appreciated capital investment cost into account. This is the case at most of the bulk supply points at present.

The use of WDM on a day to day basis in Windhoek could mean that the vulnerability to drought has been reduced by the reduction in water consumption. The drop of consumption from 20Mm3 in 1994 to just over 16Mm3 in 1997 illustrates this point. Pricing, combined with various non-market mechanisms and direct interventions; e.g. advertising campaigns, media involvement in awareness campaigns in schools and community development programs, decrees etc. have kept water demand in Windhoek at 1990 levels despite a 43 % increase in the population over the same period.

Direct interventions have occurred in Windhoek, including aquifer recharge, recycling of water and installation of dual pipe systems. These factors have contributed to the reduced production levels from water provided from conventional sources like surface reservoirs and groundwater. These methods of water supply are cheap compared to conventional supply augmentation and are viable in all larger urban centres. See **Table 3.4 and 3.5.**

3.1.5.3 Rural Water

[6] The price is under review and the cost recovery price may be lower

In rural water supply movements are being made towards the recovery of capital, operations and maintenance costs by 2007. In WASP 1993 tariffs charged at the "economic rate" are advocated. This refers to full financial cost recovery. There are provisions made for irrigation and rural water supply where, due to consideration of affordability and the wider socio-economic benefits, particular uses may be subject to a "special subsidy". The wider social benefits of water use, health, employment etc, are addressed by this policy.

Rural water supply accounts for 57% of all water consumed in Namibia. Cost recovery is being approached through decentralised community based management, rather than charging tariffs for water. In this sense water demand will be managed by the communities. This is described in greater detail in Section 4.2. However, the cost of water supply varies from one rural area to another, meaning that full cost recovery may more difficult to achieve in some areas. The question of willingness to pay is very important for the success of this strategy.

In summary, the present approach to water management in Namibia is beginning to embrace the principles described at the Dublin conference of 1992 which encourage treating water as an economic good. The different sectors are approaching this in different ways with urban and bulk sectors being more pre-disposed to cost recovery through tariffs than the rural sector.

3.1.6 Planning for the Future.

The assured yield of water resources in Namibia is estimated to be close to 500Mm^3/a excluding the perennial border rivers (Day, 1997)[7]. Water production in Namibia is currently approximately 300Mm^3/a. The growth rate of water demand in Namibia, driven by the combined factors of population growth and changes in the structure of the population, has been estimated as being somewhere between 3 and 6% per annum depending on the assumptions used[8].

This implies that the demand for water will double in the next 10-20 years at which time the entire assured yield of the water resources (excluding border rivers) will be accounted for by demand[9]. More recently the potential effects of climate change and the *El Nino* phenomenon have raised questions about the level of the assured yield in the future[10].

It must be borne in mind that Namibia's current water supply potential is located in many different areas. This means that demand centres may not coincide with supply sources. The development of extra units of the available water is likely to become more expensive and as such the viability of development will depend upon the strength of demand.

---

[7] The assured yield is the yield that can be guaranteed at a particular level of probability. In Namibia this is normally evaluated at 95%.

[8] See Central Areas Water Master Plan, Interim phase 1995, and Okavango Pipeline Feasibility Study 1997.

[9] This assumes a price constrained demand growth, i.e. the current pricing prevails and the population consumes in the same way for the next 10- 20 years.

[10] It is thought that rainfall will become more variable as a result of climate change in Namibia.

In the future supply augmentation will have to be addressed. Potential sources include desalination at the coast, further development of groundwater and further extraction of water from border rivers. Only desalination and groundwater imply self sufficiency in water supply since extraction from border rivers will depend on international co-operation. Each potential source is fraught with its own particular problems, be they cost, political, or environmental constraints.

The planning of water supply schemes has been historically focussed on urban centres while most commercial farmers supplied their own water mainly from groundwater sources. In the more recent past, general economic policy has focussed on uneconomic principles for rural development as a means for increasing rural incomes such as self-sufficiency in basic grains.

In the past water supply schemes were built with little regard for the economic costs and benefits that arose and often in the absence of an analysis of potential WDM. As a result Namibia has large infrastructure, Hardap and Naute dams for example, which is used almost entirely for irrigation, whilst other investments have been made largely for urban use, e.g. Three Dam system (Omatako, Swakopport and Von Bach). Rural areas have not had equivalent water infrastructure development.

In 1996 an investigation was done to extend the Eastern National Water Carrier linking Grootfontein to Rundu, and hence the Okavango River with Windhoek. This would have acted as an emergency supply for Windhoek in the event of severe drought as was experienced at that time. An integrated policy on WDM was approved in July 1994 by the City Council of Windhoek and implementation started towards the end of 1994. In 1995 the water production was already 15% lower than the unrestricted demand scenario. There was a major possibility that the reservoirs supplying water to the Central area will run totally dry with severe consequences for the economy of the country should new development in the country be stopped. Good inflow was experienced during the beginning of 1997 and the emergency scheme was postponed indefinitely.

WDM has certain advantages over supply augmentation as a means of maintaining the increasing demands for services provided by water, since the environmental costs associated with infrastructure and additional abstraction can be postponed and downsized if needed in future. The water made available by WDM as a result of direct interventions such as leakage reduction for example, has a very low opportunity cost[11] whilst movements towards economic pricing remove economic inefficiencies in water use by making people aware of the resource costs of water supply. Investment in WDM therefore will often be a cheaper way to provide services from water, will imply self-sufficiency and will avoid or at least postpone the costs, both internal and external, of traditional supply augmentation.

[11] I.e. it has no tangible use as a leakage to the system, whereas new sources of water often do serve a valuable function already, e.g. perennial rivers sustain economic activity along the banks in the form of fishing, agriculture and wildlife resources. These could all be affected by extraction.

3.1.7 Water Demand Management versus Supply Augmentation: The Comparative Costs.

The water demand management programs of the Municipality of Windhoek are financed by a levy on the income from water. At present this levy represents less than 1% of the total income from water, and is the equivalent of 4.2cents/m^3. Estimates of the amount of water that are saved as a result of WDM are given in **Table 3.4.**

Table 3.4 Predicted Water Demand in Windhoek, With and Without WDM.

Water Consumpti	1995	2000	2005	2010	2015
No WDM (Mm^3/a)	**21.1**	**26.7**	**34.6**	**44.4**	**57.1**
WDM (Mm^3/a)	**17.9**	**20.7**	**24.1**	**27.9**	**32.3**
Savings (Mm^3/a)	**3.2**	**6**	**10.5**	**16.5**	**24.8**

Given that the savings shown for 1995, 3.2Mm^3, have been achieved at a cost of 4.2c/m^3 for total consumption, the total cost of these savings is N$750 000 calculated at 1997/98 cost structures. The unit cost of this saving is approximately 24c/m^3. Indeed if the prediction shown in Table 3.3 is correct the Average Incremental Cost[12] of this strategy is 11c/m^3 [13]. This compares extremely favorably to other supply options and the estimated Namwater cost recovery tariff for Windhoek of N$3.17/m^3. **Table 3.5** shows the costs of alternative supply options.

Table 3.5 Unit Cost of Supply Augmentation Options for Windhoek[14].

Potential Water Supply Options	Unit Cost, N$/m^3 at Windhoek
Existing Supply	3.17
Okavango	6.25
Kunene (option 1)	7.85
Kunene (option 2)	10.36
Desalination	19.65
Tsumeb Aquifers	6.40

This shows that the cost of incremental water supply to Windhoek is extremely high compared to the WDM option that has been practised by the Municipality. The WDM funded from this levy includes information campaigns, administration of block tariffs, the pipe monitoring program; i.e. both market mechanisms and direct interventions. However, WDM can only "supply" more water in as much as there are inefficiencies to

[12] This takes the discounted stream of costs and water units and creates a unit cost for the time period shown

[13] This excludes the investments in the recycling plant at Goreangab, but excludes any cost savings that are made from the reduced level of consumption. It also excludes the reduction in the unit cost of water as a result of the delays in the need for supply augmentation. The unit cost is calculated assuming that the cost of WDM is 4.2c/m^3 for total consumption in each year. A 10% discount rate was used reflecting the opportunity cost of capital. It has been stated that the reduction in water consumption could be an underestimate.

[14] Based on the emergency supply scenario of the Rundu to Grootfontein Link of the ENWC feasibility study. Calculated by Ben Groom DWA.

be reduced, behavioural changes to be affected and efficient technologies to be introduced. Ultimately the growth in population and possibly relative incomes will be inexorable drivers of water demand growth. This means that supply augmentation may still be necessary at some stage. The biggest long-term benefit of WDM is the lowering of the annual growth rate in water demand. This will influence the size and investment as well as the scheduling of future augmentation schemes.

Further opportunities for augmenting the water available for consumption, but not impinging upon the water resources themselves include recycling and reclamation of water. Furthermore innovations such as evaporation reduction through artificial groundwater recharge are also possibilities. The nuances of this type of water supply are described in the Windhoek case study.

3.1.8 Policy Challenges.

Given the cost of supply augmentation compared to Water Demand Management and unconventional water sources, levels of unaccounted-for-water in Namibia's urban centres, and the level of subsidisation that still exists, it is clear that there is considerable **scope** for the implementation of WDM in its various forms. The scope is less clear in rural areas.

3.1.8.1 Pricing.

More efficient use of water will be the upshot of improved policy, however the issue of water scarcity may not be wholly reflected by financial cost recovery tariffs excluding environmental and opportunity costs. I.e. there may still be high consumers at the cost recovery price.

Similarly, the effect on supply institutions' revenue as a result of price increases is an important issue for the implementation of WDM. The effect of price on revenue can be derived through knowledge of the price elasticity of demand (PED). **Table 3.2** shows that there is evidence to believe that demand is price inelastic, i.e. revenue will increase as a result of price increases. However, given the level of tariff subsidisation in the past, it is possible that the initial effects of price increases could reduce revenues. Furthermore for consumers to respond to the Namwater price increases requires the tariffs to be passed on by the Local Authorities, and bills to be paid.

3.1.8.2 Equity

Using pricing as WDM tool brings to light the issue of willingness to pay and ability to pay. Ensuring that at least the basic minimum level of water consumption occurs is the challenge associated with pricing policy. There is economic justification for reducing the price of initial units of water consumption on the basis of the health benefits. However, where ability to pay is in question, subsidising water may not be the correct approach.

3.1.8.3 Planning

The policy challenge for future planning of water supply and consumption, centres on establishing the most economical supply of water and the most beneficial uses for water.

It can be seen that WDM strategies are competitive in terms of cost when compared to supply augmentation options and avoid many of the external costs. Furthermore, sensible pricing for water will play an allocative role for water ensuring a more efficient distribution and relieving the Government of its allocation role.

3.1.8.4 Sustainability

The ultimate aim of water resource management is to maintain the integrity of water supply and the sources from which supply is derived in the long-term. Most definitions of sustainability make reference to maintaining environmental services, of which water is one, for future generations. Sustainability is hence an equity concept that needs to be achieved in the most efficient way.

3.1.9 Conclusions

Policy challenges for integrated water resource management and WDM can be summarised as follows:

- To ensure the efficient allocation and usage of water resources in the face of:
  - Growing water demands.
  - Water scarcity constraining economic activity.
  - The desire for sustainable development.

- To implement the tools of WDM in such a way as to be financially sustainable for the water supply institutions and equitable for water consumers.
- To incorporate WDM in the planning process for countrywide water supply planning.
- To ensure that environmental issues and sustainability are included in the framework for WDM policy. Pertinent environmental issues include:
  - Groundwater linkages to the environment.
  - Downstream effects of abstraction from perennial rivers.
  - Downstream effects of dams on ephemeral rivers.

3.2 SOCIAL ASPECTS.

Ben Groom, Ben van der Merwe and Cathline Neels

3.2.1 Introduction.

The social objectives for the water supply sector have been documented in the First National Development Plan of Namibia, 1995/1996-1999/2000. These objectives are to:

- Provide safe water to the whole population.
- Give priority in provision of water to rural areas.
- Provide water at affordable prices.
- Conserve water and avoid wasteful use of water and environmental damage.
- Ensure water contributes to improved public health.
- Provide water within the community's reach and avoid the burden of water collection.
- Ensure that water promotes and supports community based social and economic development, particularly in rural areas.

It is further stated that the water sector should be financially sustainable depending upon the ability of the sector to become self-sufficient. This in turn requires a degree of cost recovery. The social targets above and the role of cost recovery hold different implications for rural and urban sectors. Furthermore there are more specific targets for these two sectors in the Water Supply and Sanitation Sector Policy 1993 (WASP).

According to the World Bank, world-wide: -

">> More than a billion people do not have access to clean >> drinking water now. >> The reason, critics say, is that many developing countries, along >> with international aid >> agencies, have not provided community-level drinking water and >> sanitation systems" (NYT, 8/12/98, source: World Bank 1994)

In Namibia it was estimated in 1990 that only 50% of the rural population had access to a reliable source of safe drinking water (NDP1). The figure for the urban areas was 95%. In general the urban water supply has good coverage although with urbanization occurring at a rate of more than 5% per annum this may not be true for long. Rural and urban objectives are treated separately here. According to the investigation as part of the SIAPEC investigation the rural figure improved to 62% in 1996. This figure is based on safe water supply within 2.5 km from a household.

The role of Gender in the management of water resources and its implications for WDM strategies are addressed also. Women and men play different roles with respect to water and as such these roles should be highlighted and incorporated in the policy analysis.

3.2.2 Rural Objectives.

Priority is given to supplying water to rural areas in NDP1. The social objectives for rural water supply as documented in NDP1 1994 are:

- 80% of the rural population to have access to safe, reliable water supplies of water by the year 2010. Access is at present defined as within 2.5 km of the home.
- 95% of the rural population to have representation on water committees at the district level by 2000.

These targets were regarded as transient targets that may be refined at a later date. For example the objectives have been refined more recently, the Directorate of Rural Water Supply (DRWS) hopes achieve the above targets by the year 2007.

It has been estimated that DRWS has made movements in the right direction for the attainment of these objectives. **Table 3.6** shows the current percentages of people within the stipulated "access" distance.

Table 3.6 Distance from, and Reliance on, Improved Water Sources in Rural Areas*.

	Distance from Improved Water Source.			
	<1 km	<2.5 km	> 2.5 km	Unimproved
As % of Population	53.7	61.9	11.7	26.2.
	Improved		**Unimproved**	
	Dry Season	Wet Season	Dry Season	Wet Season
Reliance as % of Population	73.7	53.0	26.2	47.0

*Source: SIAPAC Community Consultation and Survey Program, Summary Report.

In 1996, when the study was undertaken, nearly 62% of the rural population were within the 2.5km of improved water supply, the goal as defined in NDP 1. This compares with the 50% access to safe and reliable water stated in NDP 1[15]. A further 18% of the population need to be brought within 2.5km of water supply by 2007 for the NDP 1 goal to be achieved. Should the target distance be reduced to 1km, a further 26.3% of the rural population need to be brought within this distance. This should be seen in light of 2% annual growth of the rural population, which in absolute numbers is greater than absolute urban growth[16].

It was also found that the per capita daily consumption in the rural areas was on average only 8.8litres. This is below the recommended level for health of 15litres. Cattle consume the majority of water in rural areas, on average almost 7 times more. The focus of water demand management therefore needs to be on more efficient cattle watering, management, maintenance and the reduction of wastage rather the reduction of human per capita consumption.

Overgrazing in the vicinity of water points is a major problem in rural areas. Balancing of the carrying capacity of available grazing with livestock numbers will lower the pressure on available water sources.

[15] It is unclear if access to safe and reliable water defined in NDP 1 and being within 2.5 km of improved water sources are the same.

[16] This is based on estimates by Henning 1996 of 5.4% urban population growth and a rural urban split of 70:30.

Policy Options.

The policy to increase access to water supply is clearly defined by NDP 1 and the WASP, however there is a question over how best to achieve this policy. The target may be achieved in several ways:

- The movement of people towards water sources
- The establishment of new water points
- The rehabilitation of old boreholes[17].

In all three cases the scope for water demand management to achieve the targets through education and appropriate technology for example is obvious:

- The movement of people towards water resources, be it rural urban migration or intra-rural migration, will put extra demands on existing water sources. WDM measures such more efficient use of water and information will reduce the pressure on those water sources.

- If designs are optimized and operations are changed to maximum efficiency for existing and new water points a more efficient water use will result. These measures may include:

- Technological changes: low pressure systems, appropriately sized pumps, appropriate type of pumps, provision for efficient troughs for livestock watering etc.
- Education of water users on efficient water use practices.
- Community based management (CBM).

- Dysfunctional boreholes arise for several reasons:

- The borehole dries up.
- The pump system is not working or has been removed.
- The borehole casing breaks, or is removed.
- Water Point Committee breaks down.

Proper management and operation for maximum efficiency will aid in resolving some of these problems. More efficient use of water as a result of implementing the principles outlined above, will extend the life of a borehole by:

- Reducing the amount of water required for given services leading to sustainable use of the water source.
- Reducing the pumping costs for groundwater by reducing the pumping head. In the broader context reduction of water consumption can make the use of renewable sources like wind and solar power practical. Lower volumes of water

[17] At present the Department of Water Affairs has a database of 42,500 boreholes, of which 32,000 have depth data. It is unclear the extent to which these boreholes, and others not registered on this database, are being used, nor the reasons why certain boreholes are dysfunctional (SOER 1998).

and lower pumping heads will reduce the recurrent costs for fuel in the short-term and maintenance in the longer term[18].

- Establishing enabling conditions for sustainable institutions.

Reducing the costs to communities is of vital importance to the rural communities as the proposed CBM of water resources is put in place. The question of the willingness and ability of the rural communities to self-finance their water supply has been addressed in two separate studies. Nationally almost 80% of the rural population stated that they would be willing to manage their own water supply. Similarly almost 80% stated that they would be willing to contribute to the cost of managing the water supply (SIAPAC). The ability to pay has been analyzed assuming a given % of income as the willingness to pay.

The SIAPAC study revealed that the should the poorest quartile be willing to pay 5% of their income towards the cost of water this would often represent more than their "surplus" or disposable income after all other expenditures. In Hardap, Omaheke, Omusati, Oshana, Okavango and Caprivi, this 5% was greater than the surplus. This would imply that although it would appear that at a 5% level many households could afford to cover the costs of water supply, some substitution away from other goods would be required.

Nevertheless many households would be unable to contribute sufficiently to sustain the water supply. Despite over 70% of the rural population stating that a local solution to the problem of inability to pay would be desirable, and in some regions cross-subsidization between members of the community, setting up the institutions required to put local solutions in place remains an issue. Full cost recovery can present a major problem in respect to equity to water supply in rural areas.

3.2.3 Urban Objectives.

Despite a higher quality of water service in urban areas, there is often a disparity of service levels between income groups. The water supply policy for urban areas has also been stipulated in both NDP 1 and WASP, is made up of the following objectives:

- A municipal situation for all non-farming areas where people reside on a permanent basis.
- Tariff Policy should aim to:
- Define a lifeline level of water consumption at a lower price.
- Increasing rates for increased consumption.
- Immediate cost recovery of to provide water services to plots.

Beyond this is the Local Authority Act 1992, gives guidelines as to the responsibilities of Local Authorities, making provision for the proclamation of individual regulations in Municipalities.

[18] This assumes that costs are not excessively affected by the other people's consumption. I.e. the aquifer is separate from the influence of others

The objectives of the tariff policy are fully in line with the principles of WDM. Both cost recovery and equity considerations are stated as aims for the tariff policy. Similarly access to water, where access in the urban areas can be considered to be an economic concept, is addressed by the notion of a lifeline tariff for initial consumption.

The constraints on water supply augmentation put the issue of WDM at the forefront. There is a need for improving the management of water within the urban centres. **Table 3.7** shows the level of unaccounted-for-water in the urban centres of Namibia. It transpires that a total volume of 1.9 Mm^3 could be saved per annum if the unaccounted-for-water of all the local authorities can be lowered to a maximum of 15% per annum. The value of water lost amounts to N$4.56 million per annum calculated at the average bulk water price of N$2.40/ m^3 charged by NamWater.

Table 3.7 Total Water Production, Estimated Population and per Capita Consumption

Local Authority Area.	Unaccounted for water %	Residential per Capita Water Consumption (l/c/d)
Oshakati	35.0+	90
Otjiwarongo	7.5	125
Outjo	7.7	235
Rehoboth	35.0+	110
Rundu	38.0	94
Swakopmund	12.0	171
Tsumeb	15.0	108
Usakos	31.1	47
Walvis Bay	14.5	198
Keetmanshoop	17.0	155
Khorixas	58.0	120
Mariental	9.4	133
Luderitz	22.0	75

Local Authority Area.	Unaccounted for water %	Residential Capita Water Consumption (l/c/d)
Okahandja	16.0	100
Omaruru	7.0	227
Ondangwa	35.0+	130
Ongwediva	35.0+	188
Opuwo	35.0+	167
Windhoek	10.0	130

Table 3.7 also shows the average residential per capita consumption vary between 47 l/c/day to 235 l/c/day in urban areas compared to almost 10 l/c/day in rural areas. A survey in squatter areas with standpipes in Windhoek indicated that the water consumption per person varies between 14 to 20 l/c/d. The average consumption for a low income household with a water connection varies between 80 l/c/d to 114 l/c/d in Windhoek and Grootfontein respectively. The disparity in per capita consumption is due to the large differences in income and high consumption in high-income areas. In Windhoek the different level of consumption for different income groups are indicated in **Table 3.8.**

Table 3.8 Water Consumption Pattern of Windhoek (1996/97)

Consumption Group	Population	Unit Consumption l/c/d	Water Consumption Mm^3/a
Squatters	35 250	20	0.26
Low income	85 590	80	2.88
Middle income	58 400	140	3.09
High income	17 650	309	2.09
Commercial			3.35
Industrial			0.99
Distribution losses			1.38
Total	**181696**		**13.74**

Clearly the high income groups have a higher per capita consumption than the low income groups. Indeed the income elasticity of water demand has been estimated to be 0.83 in Windhoek in 1995 (See Windhoek Case Study).

Policy Options.

Information on the extent to which the social indicators are being achieved across the board in urban areas is not directly available. The UN Human Development Report 1998 records that urban areas have 100% access to safe water supply. NEPRU 1996 suggest that 95% of urban dwellers have access to safe water. In actual fact it is unclear as to the true figure.

The factors acting against the achievement of the above targets have been outlined above. They include:

- Cost recovery adversely affecting the poor.
- High income groups can afford to over consume water.
- Unaccounted-for-water reducing the available water.

One approach that has been advocated as a policy tool to address the first two of these problems has been the use of increasing block tariffs. Embedded in this approach is lowering of water consumption of the high income groups and cross-subsidisation from rich to poor, thus helping the lower income groups to gain "access" to water.

The cost of saving the water through WDM has not been calculated for all of these towns, but the cost savings resulting from this type of approach have been shown to be significant in many parts of the world. In Windhoek for example, the cost per unit of water saved as a result of WDM implementation during the drought of 1996 has been calculated to be 24c/m^3 (SOER and Van der Merwe 1998).

It can be seen from the table above that there are over 9 urban centres with unaccounted for water in excess of 35%. This implies a poor monitoring of water and improper maintenance of infrastructure. Replacement of deteriorated water networks and water meters where needed implies that significant investment will be required in order lower unaccounted- for- water. It is estimated that at least 50% of the unaccounted-for-losses are related to poor management of infrastructure and administrative losses. This state of affairs is often the result of the institutional arrangements and as such the relationship between bulk water suppliers and Local Authorities needs to be addressed.

It is clear that in achieving social goals for urban areas, like improving access to services for the urban poor, increasing the amount of water available through WDM and at the same time improve cost recovery for urban water suppliers will only be possible through an integrated approach.

3.2.4 Perception of Water.

For many years water in Namibia was provided at little or no cost to users. This provision of water tainted perceptions across generations and across social groups of the value of water and the manner in which it *should* be provided. Water has been perceived as manna from heaven, something which people have a right to receive for free.

The idea of water as an economic resource, i.e. a productive input and valuable commodity subject to scarcity, has changed the perception of policy makers. Furthermore, the SIAPAC study has revealed a great desire for localized, self-financing solutions to water supply, with 80% of those asked willing to contribute and 80% willing to manage their water point.

3.2.5 Gender and Water Demand Management.

Gender refers to the **social differences** between women and men and how they interact with each other and their environment. In a report written by the World Bank for the 1995 Beijing Conference on women, gender equality is a matter not only of social justice but also of good economics. The report demonstrates the need for government action to improve the economic status of women and how public policies can support services and infrastructures most heavily used by women. For example, in Africa, women are the key mechanism in the usage of water. They are the ones who collect the water, as far as 10km from their homes, for domestic and agricultural use. The social objectives in section 3.2.1 relate directly to time and burden of water collection.

The National Gender Policy of Namibia outlines the framework and sets out principles for the implementation, coordination and monitoring of gender sensitive issues in the management and planning of the developmental processes in the different cultural, social and economic sectors of the Namibian nation. Women have an important role to play in the development of sustainable approaches to natural resource management, because they are more concerned about the quality of life for their families and future generations. For example, in Namibia, the depletion of natural resources, like water, would greatly add to rural women's poverty and increase their burden of time consuming unpaid work in the house; collecting water for cooking, washing etc.

NDP1 claims that women are still marginalised, by being denied access to productive resources that would enable them to enhance their economic activities. NDP1 aims to ensure that women not only participate fully and equally, but also benefit directly from development. In pursuing these general objectives, a specific objective is the integration of women in development and decentralization of gender issues meaning, that the concept of gender be fully understood and equipped in the rural communities.

Demand management attempts to manage the amount of water that people use through pricing, regulation and increased awareness on conservation. The type of water supply available in urban areas is different from that available in rural areas. The main difference is the proximity of water supply meaning that the issues for gender are likely to differ in rural and urban areas. Similarly, rural management of water supply is expected to be on a community basis.

In urban areas water supply are managed by the Local Authorities. In sqautter areas in Windhoek women play a major role in the different community committees when upgrading and the level of services to be provided are discussed.

Gender differences that exist with respect to access to cash and preferences within the community will have different gender effects in rural and urban areas in respect of the implementation of WDM. This will require tailoring policies for different sectors.

3.2.5.1 Rural Gender Issues

The roles of women in rural areas are very gender biased. In such societies women are seen in fixed social roles such as being responsible for collecting water, cooking, cultivating and raising children. Many rural women are also illiterate and thus have no decision-making powers concerning issues of the villages. Given this, since CBM is being advocated for water points in rural areas, it is clear that the gender roles must be addressed for this strategy, and any WDM strategy, to be a success.

A gender analysis study conducted in 1993 by Namibia Development Trust, discovered that of 600 women respondents in the Ohangwena region of northern Namibia, 52% made three or more trips per day to fetch water. Men do not make these trips and if they do it would be rare. Women are thus also more aware of any water problems in their areas. Accordingly, they are often more ready to assist in improving and maintaining water supply conditions in the village to lighten their task.

Gender evaluation is the assessment of the social interaction between the sexes. When one evaluates gender, one needs to look at three aspects, namely - the gender process, - the results and the - impact this process has. The extent to which men and women's involvement is taken into account in project formulation and implementation is the gender process. The result of gender sensitization of a project can be evaluated by looking at how the services reach and affect women and men respectively. Although improved water supplies will benefit the whole community, women and men may need water for different purposes and thus have different priorities in the improvements to be made. Such different needs influence a person's willingness to pay for any water supply improvements. With CBM policy being promoted in rural areas, the issue of gender related disparities in levels of willingness to pay could be a critical factor in the success of this policy.

Studies done by the International Water and Sanitation Centre showed that men are more reluctant to contribute to a better water supply system near the house, which he does not foresee as necessary. Men do not directly value saving women's time. Furthermore, women in rural Namibia do not in general have access to cash. Men are regarded as the head of the household in all matters. As a result women have no means, to pay for improvement of water supply lightening her daily tasks. Her lack of access to cash remains restricts willingness to pay, and given that women are seemingly the main players in the rural water sector, WDM through pricing or CBM may fail women unless payments in kind are allowed and/or allowances are made for the costs of collection time.

It seems clear however that women are a prime target group for WDM in the form of information and educational tools on account of their stronger interaction with the resource.

3.2.5.2 Urban sector

Very little information exists on the role of women with respect to water in the urban sector. Approximately 80% of all urban households have access to water closet facilities, in contrast to the rural areas where 86% of the households still use the bush as a toilet (Nepru:1994). The 1991 Population and Housing Census estimated that 98% of all urban residents have access to pipe borne water and 75% rural residents rely on wells, boreholes, rivers and canals for water consumption. Therefore the burden rural women have in comparison to urban women, in obtaining water for domestic use is clear. However, the question of ability and willingness to pay still applies.

3.2.5.3 Policy options

Several observations have been made on the subject of gender issues in water management:

- A first observation is that traditional management arrangements by women are utilized insufficiently.
- Secondly, the effectiveness of local management is related to the degree to which women concerned are involved as a group in making locally arrangements.
- Thirdly, improved two-way communication would also make women's involvement in water issues more effective. That is, if women are expected to contribute to maintenance by reporting problems and payments, they need to be kept informed by management committees on matters of relevance.

The sustainability of water supply institutions in rural and urban areas will be benefited by this type of gender based interaction.

3.2.6 Rural Urban Dynamics.

3.2.6.1 Introduction.

Rural to urban migration is a common feature of many developing countries. In Africa in particular the growing extent of urbanization is a typical feature of the population breakdown. There are several theories that explain these patterns ranging from geographic to economic explanations. In general there is both "push" and "pull" factors which influence migration decisions.

- Push Factors: Growing agricultural population putting pressure on land productivity, access to natural resources, reducing employment opportunities etc. Associated poverty, famine etc. All these factors are thought to initiate the migratory process.
- Pull Factors: The potential for higher wages, attractive living conditions and general economic enhancement. These are the factors that attract people to urban areas and can be real or imagined benefits.

More recently the combined factors of rural/urban wage disparity and probability of obtaining jobs in the urban areas have been cited as the main explanatory variables behind the rural urban migration and rising urban employment (Meier 1995). Cultural and personal circumstances are likely to have a major influence also.

The increasing size of towns and cities impacts upon the general resource availability. The resources required to sustain large cities are often acquired from outside of the urban areas. In Windhoek in particular the increasing population is the main driving force behind the steadily increasing demands for water services, making the import of water from other areas a possibility in the future

These factors mean that the demand for resources within Namibia's cities and towns will be increased. The demands on often under-capacity and deteriorating water infrastructure, and the dwindling number of water supply options, means that the need for water demand management becomes even more paramount.

3.2.6.2 Cost of Water Supply.

The movement of people towards urban centres will have an uncertain effect on the cost of supplying water to the nation. The reduction in relative population proportion in rural areas will mean that the cost of water supply will be reduced relatively. Concurrently water demands will increase in the urban areas. Whether overall costs increase as a result of this demographic change will depend upon the relative costs of water supply in urban and rural areas.

It is clear that the total costs of water will increase in every town that has an increasing population. In most cases the migrants are accommodated in informal settlements and as such water is often supplied from community standpipes. In most cases there is no monitoring of the water consumption for stand pipes and local authorities supply water to the populous in line with their responsibilities under the Local Authorities act 1992. Similarly, it is rare for local authorities to receive payment for the water supplied from these standpipes and volumetric pricing has not been noted for these sources. As such the costs of extra water supply will be borne by a combination of the water supply body and the paying consumers.

There are benefits to supplying water to urban areas that should not be ignored. Migration occurs on the basis of economic, personal and cultural factors considered by those who migrate. The reduced opportunities in rural areas, in comparison to urban areas contributes to the decision making process. Economic benefits are obtainable in urban areas and economic activity is more concentrated in these areas on the whole, Hence the development process can be aided to some extent by the migration of the labour force to areas where it is most needed. It is also likely that there are economic benefits that arise from the entrepreneurial advantages that occur as a result of the close proximity of a large market and the increased networking capability etc. There are also health benefits from securing a clean water supply that should also be considered. 95% of urban dwellers have access to clean water supply whilst in rural areas only 62% have access to improved water sources (SIAPAC 1995)[19].

[19] Access defined in rural areas as being within 2.5 kms of a water point.

The supply of water to urban areas could therefore be a worthwhile investment despite the rising costs that will prevail in, for example, Windhoek, Swakopmund and Walvis Bay.

3.2.6.3 Net Benefits

The net economic affects resulting from urban migration are unclear. It could be that water is more valuable and more efficiently supplied in urban areas. It is a question of whether economic development is best served by the prevalent forces of migration, or whether policy changes could achieve greater potential in the rural areas by addressing the rural push factors. A study by Tvedten (1995) calculated that the net economic costs of urbanisation in Windhoek, including water, electricity, increased wages education etc, were in fact negative. This meant a benefit of N$1.6m per year from urbanisation.

Opinions vary however. According to the National Report on Population
"The government has recognized the high rate of rural–urban migration as a factor militating against rural development and the major force contributing to the rapid rate of urbanization, growing urban unemployment levels and worsening social and economic conditions in the cities. In order to reduce the rate of rural-to-urban flow of population the government plans to promote rural development."

The government at least considers rural-urban migration a considerable constraint to development and plans to address the rural push factors in order to redress this. The rural population makes up almost 70% of the population and represents a significant potential for growth and development.

Water Demand Management is useful from whichever perspective one approaches the rural-urban migration issue because it encourages the more efficient use of water.

3.2.6.4 Water Demand Management in Response to Urbanization.

Whatever the benefits are of water supply, the advantages of water demand management are again clear. If it is possible to supply water services through reduced water requirements at a lower overall cost, as is often possible with WDM, then economic net benefits can be increased.

Urbanisation will also increase the quantities of wastewater. It is likely that a system of recycling and reclaiming water, as occurs in Windhoek at present, will have cost advantages under these circumstances. Rather than releasing water into the natural watercourses, it is sensible to recycle water for further use in situations where further water supply possibilities are expensive, as in Windhoek and many other towns.

3.2.7 Conclusions

The policy objectives for the rural and urban sectors are clearly defined. The current climate with respect to water supply and sanitation has put the emphasis firmly on cost recovery/community based management as the means of achieving social objectives in a sustainable manner. In general the perception of water will change as a result of this approach to achieving social objectives. Water will be perceived more as an economic good by suppliers and users alike.

Similarly the decentralization of water institutions seems to be the policy challenge in both rural and urban sectors. Localized responsibilities for water supply, and the tailoring of policies to the region circumstances, including WDM policies, is a practical approach to managing water resources and one which has been seen to work in Windhoek and is recommended by the WASP of 1993.

Decentralized institutional arrangements are constrained however by the lack of expertise in many fields relevant to water management. This highlights the need for sensible and appropriate provision of water supply in both rural and urban areas. On a rural level the training of extension officers and water point committees is one way in which this lack of expertise is being addressed. In urban areas it is likely that further training may be desirable within the municipalities and local authorities.

The sustainability of the decentralized water resources management in both urban and rural areas is constrained by three related factors:

- Financial
- Ecological/Environmental. (particularly groundwater)
- Institutional.

Related to all three of these factors is the issue of Gender. It is clear that the sustainability of the water management systems is dependent upon willingness to pay, the strength of the institutions and the environmental impacts of water use. The different gender roles in the water sector relate to these factors explicitly making consideration of the gender divide an important part of any water management strategy, including WDM.

The issue of rural-urban migration is of particular importance for the economic development of Namibia. The increasing levels of urban unemployment and underemployment that result are detrimental to the economic growth of the country and therefore policy should address this issue.

Decentralisation has been cited as one means to redress the imbalance of opportunities between rural and urban areas. There are three levels of decentralisation:

- Fiscal.
- Administrative.
- Political.

Each will have different implications for the problems of rural-urban migration and subsequently the demands and management of water resources.

The decentralisation of administrative systems to local, regional and intergovernmental levels has been advocated by the ICPD. In terms of water demand management it is likely that decentralisation on both a fiscal and administrative level will have positive effects on the efficiency of water supply, allowing water supply agents to be completely responsible for the service they supply. Water and its associated revenues will be under localised control and with independent budgets there will be an incentive to monitor the water usage, payment and service.

It is clear that WDM is not a primary policy tool with which to address rural-urban migration despite water and water services being one facet in the push-pull process. It is likely however that the concept of WDM should be incorporated in the decentralisation process in order to aid the efficient use of water in local and regional development efforts.

Another issue, which arises from the rural urban migration phenomenon, is the notion of encouraging alternative centres of population and development. For example at present the bulk of rural urban migration (40%) occurs towards the capital city Windhoek. As we have seen Windhoek has a relatively high cost for additional water supply, in comparison with other regions where water is more abundant. In this case there is an argument for encouraging the decentralisation of commerce, government and other such sectors to area's with a more accessible water supply. E.g. the northern regions where the Kunene and the Okavango rivers are relatively close by.

3.3. INSTITUTIONAL ARRANGEMENTS FOR URBAN WATER SUPPLY

Ben Groom.

3.3.1. Introduction.

The causes of inefficient and inequitable use of water, mismanagement, misallocation and subsequently wastage are numerous. Economists often cite the problem of under-pricing of water supplies as the main culprit behind the inefficient use of water. The situation may also arise where the price of water could reflect the resource costs of supply but all the other factors are against the efficient use of water. The institutions dealing with water, or the legal framework within which the water sector operates, lacks the guidance, legal power and coherence or incentive structure for water to be managed effectively and efficiently. Non-payment of water bills and lack of enforcement can be the upshot of this situation. The institutional framework provides what many have called the "enabling environment" for agents to use water in a more sensible and ultimately beneficial way. If the tools are lacking in the areas covered by the water sector, such as water planning, regulation, management and financing, we cannot expect to see water being effectively, efficiently and equitably managed.

Local Authorities' water supply responsibilities are governed by the Local Authorities act described in Box 3.1. It is upon this act that the institutional arrangements for water supply stand. Here we shall discuss the successes and failures of the present system and bring to light the potential areas for water demand management policy. This will be addressed by specific institution.

Box 3. 1. The Local Authorities Act.
Local Authorities, including municipalities, are subject to the Local Authorities Act of 1992 (act 23 of 1992). Section 30(1) states that the local authority must:

a. supply water to the residents in its area for household, business or industrial purposes
b. provide, maintain and carry on a system of sewerage and drainage for the benefit of the residents in its area.

In addition to this local authorities are able to make there own regulations with respect to the above services under section 94(1). Where no such regulations have been issued, under 94(2) states that the model regulations issued by the Ministry of regional and Local Government and Housing (MRLGH) will apply. Subsequently regulations differ from one municipality to another but remain the same in all other local authorities. The model regulations are:

i. Model water supply regulations promulgated under government notice 72 of 1996 dated 1 April 1996; and,
ii. Model sewerage and drainage regulations promulgated under Government notice 99 of 1996 dated 21 May 1996.

In those places where the local Authority lacks the resources to maintain these requirements the mandate falls to MRLGH.

3.3.2. Local Authorities.

In the current situation there are two main types of institutional arrangement for water supply to Local Authorities[20].

3.3.2.1 Case 1 Local Authorities

In **Case 1** the system is as follows. Namwater receives payment for water supplied to the various Local Authorities (LA) from the Ministry of Regional and Local Government and Housing (MRLGH). Payment occurs centrally and not from the LA responsible for the reticulation of the water. The water bills are sent directly from Namwater to the Ministry of Local Government and Housing. From there the bills are sent to the LA in question for verification and once confirmed paid directly to Namwater from the MRLGH.

Revenues collected from water (and electricity, refuse, property tax etc) go into the state fund under the name of “Municipal Services” from which the ministry motivates money under vote 024 “utilities”. Utilities include funds for electricity, refuse, telephones and water etc. Each aspect of the Utilities expenditure is motivated independently and the amount of money required for water is based on levels of previous demands. The towns and villages that are in the situation, which we shall call **Case 1** Local Authorities, are listed in **Table 3.9**

The direct payment of the bulk water account to NamWater means that Case 1 LA offices are detached from the costs of the reticulation function that they perform. Those who manage the water supply are not accountable for the costs and as a result there is no urgent need for the LA to account for, or necessarily monitor the water that gets used. In other words there are soft budget constraints. Furthermore, the collection of revenue from water and other utilities is completely divorced from the expenditure on those items and since payment is not the responsibility of the of the LA, the link between revenue collection and payment for services from Namwater is lost. Subsequently there is no incentive for balancing the water account and the emphasis is on satisfying local demands.

Perhaps as a result of this institutional arrangement there is a very high level of non-payment by consumers in Case 1 LA’s. For example, at the time of the survey, Gibeon had a bill of N$64000 outstanding. In Uis non-payment was said to be around 90% for the whole town. In Rundu, Opuwo and Khorixas non-payment was registered as a problem. This means that the revenue from water that the balancing the water account the LA collects will be less than the actual cost of the water used.

Table 3.9 Water Tariffs in Case 1 Local Authorities (1998).

Local Authority	Water Tariff	Namwater Tariff	Difference
Gibeon	2.16	1.96	10.20%
Tses	3.06	2.78	10.07%
Uis	2.56	2.33	9.87%
Berseba	2.72	2.47	10.12%

[20] Local Authority, LA, will refer to Town Councils and Village councils.

Local Authority	Water Tariff	Namwater Tariff	Difference
Opuwo*	2.19	1.99	10.05%
Khorixas*	2.33	2.12	9.91%
Okakarara	2.70	2.45	10.20%
Eenhana	3.06	2.78	10.07%
Rundu	1.78	1.62	9.88%

** These LA's assume a fixed consumption depending upon erf size, essentially a flat rate for water.*

Since there is a high level of non-payment, and because the government is paying the water bills centrally, where there is non-payment consumption of water is subsidized by the Government through the MRLGH. Ultimately it is the taxpayer in general who is paying for this water use as well as the high level of unaccounted-for-water in these local governments/town councils.

There is a subset of cases where the accounts of smaller so-called settlements have their budgets under the jurisdiction of the regional council. These villages include Aus, Tsumkwe, Kalkfeld, Grunau, Noordoewer, Warmbad, Talismanus and Ariamsvlei, suffer the same water accountability problems as the Local Authorities who are still on the budget of the Ministry of Local Government, Case 1 LA's. Similarly there are a whole host of village councils that fall under the same category.

3.3.2.2 Case 2 Local Authorities.

There has been a general move towards decentralization with many of the Local Governments becoming responsible for their own budgets, including water revenues and expenditures. The payment for water is as follows: Water bills are sent directly from Namwater to the LA in question, from where the money is transferred from the account associated with the LA back to Namwater[21]. The LA should feel the pinch of water costs.

The trend towards decentralization is a move in the right direction for the management of the water supplies. It makes the Local Authority in question more accountable for the water expenditures and receipts, and hence more likely to take an interest in balancing the budget by collecting revenues, monitoring leakages, and dealing with non-payers. The Local Authorities that fall into Case 2 are shown in **Table 3.10**.

[21] MRLGH indicate that it is they that transfer the money to Namwater but from the account associated with the LG in question, indicating a centralized componant to this process. Namwater has informed me that certain LG have not paid their bills which seems to suggest the arrangement described in the text.

Table 3.10 Water Tariffs in Case 2 Local Authorities (1998)[22].

Towns	Tariff	Namwater tariff	% difference	Namwater Cost Recovery Tariff	% increase for NamWater cost recovery
Luderitz	3.30	2.66	24.06%	5.81	118.42%
Ondangwa*	3.06	2.78	10.07%	4.01	44.24%
Ongwediva*	3.06	2.78	10.07%	3.47	24.82%
Oshakati*	3.06	2.78	10.07%	3.33	19.78%
Rehoboth	2.20	1.72	27.91%	2.82	63.95%
Villages					
Bethanie	2.05	2.10	**-2.38%**	2.21	5.24%
Kalkrand	2.05	2.23	**-8.07%**	5.04	126.01%
Kamanjab	2.05	2.47	**-17.00%**	7.81	216.19%
Leonardville	2.15	2.46	**-12.60%**	2.85	15.85%
Maltahohe	2.00	2.15	**-6.98%**	4.10	90.70%
Stampriet	2.35	2.23	5.38%	2.55	14.35%

✻ These are considered to be Municipalities, but still receive subsidies from MRLGH and so are included here.
✻ These are considered to be Municipalities, but still receive subsidies from MRLGH and so are included here.

At present many of the LA's receive subsidies from the MRLGH. In principle there is nothing wrong with this transfer of funds, since some of the functions that local governments provide need not be provided on a cost recovery basis. However, the transfers are not necessarily earmarked and as such can be used for the provision of other services including water. Again this implies a dependence upon these transfers for the payment of water bills to Namwater and again a soft budget constraint could occur. This has the financial and economic implications on water use described for Case 1 LA's.

The transfers are an interim measure that is required to enable the newly independent LA's to find their financial feet. As such any problems created by the subsidization of the LA for water and other expenditures, will be only short-term problems provided a management precedence is not created. It should be mentioned, however, that in some newly independent LA's (which in essence will become municipalities) have increasing debts to Namwater. Oshakati had not paid its bill for 4 months at the time of our visit, and similar stories were true of Ondangwa, Ongwediva and Rehoboth. Occasionally, Namwater sends bills to the MRLGH rather than to the LA in question, as a result of prolonged non-payment by said LA. More recently, Jan 1999, Namwater has threatened to cut off water supply to many nonpaying LA's (case 1 and 2) as a result of unpaid bills totaling N$40m (NBC news).

[22] There are many other examples of towns and villages that fall into this category of institutional arrangements.

Similar problems of non-payment for water were noted in many of the LA's listed in **Table 3.10** For example in Maltahohe, Stampriet[23], Oshakati and Kamanjab, problems with non-payment of bills were noted but it was impossible to determine the extent of non-payment in these Case 2 LA's[24]. There were a variety of reasons for this non-payment that included: lack of expertise in cutting off supply to non-payers, Government institutions being main culprits for non-payment, a belief in the LA that the payments from these Government Offices are made centrally etc. The diminishing quality of the water services required will inevitably reduce people's willingness to pay.

Tariff Setting

In addition to the institutional problems that arise is the problem of tariff setting. In most cases tariffs fail to reflect the true costs of water for one reason or another. Therefore, even with full payment of water bills, financial cost recovery will not be accomplished, effective subsidization of water consumption will occur and the wrong incentive signals will be given to consumers of water.

In Khorixas, Opuwo and Uis water tariffs are based on an assumed consumption of fixed units of water per month and the specific price for each town of a unit of water. This is essentially a flat rate that each household must pay and does not relate to the volume of water actually consumed. In this situation, given a fixed tariff, there is an incentive for users to consume water until their marginal benefit is zero, since essentially the private marginal cost of water consumption is zero. The other side of this coin is that there could be people consuming less than this amount and being unjustly charged for more. An example of the effect of this type of pricing regime is given by a comparison between the consumption that is assumed to take place as a result of the flat rate of consumption and the amount of water sold by Namwater to the towns of Khorixas and Opuwo. **Table 3.11** shows the results, which suggest that over-consumption is the average effect of this pricing policy.

The amount of unaccounted-for-water; here meaning water consumed but not reflected in cost recovery as shown in **Table 3.11.** This amounts to a loss in revenue for the Local Authority of around N$1 351 428 in Khorixas and N$524 132 in Opuwo in terms of what must be paid to Namwater.

Table 3.11 Underestimate of Consumption and Unaccounted for Water[25].

Town	Consumption (m^3)		Unaccounted for Water	
	Municipal Estimate	Namwater	m^3	%
Khorixas	465 519	1 102 985	637 466	58
Opuwo	376 980	640 363	263 383	41

[23] N$100,000 was owed here by a number of different consumers including government institutions.
[24] A study is underway in MRLGH at present to establish these figures.
[25] For Khorixas the Municipal estimate is based on the flat rate of assumed consumption, multiplied by the number of houses in the town assumed to be consuming. The large consumers are also included. For Opuwo the same structure of usage as in Khorixas is used for residential consumption with a detailed estimate of the main consumers added on. Both should be considered as estimates. The figures for Uis are unavailable.

There are several reasons for this state of affairs in each of the aforementioned locations. In Khorixas the water is “aggressive” and very hard. As such the infrastructure there is subject to rapid scaling and subsequent nonfunctioning of the infrastructure. Air valves become blocked, causing leaks, pipes erode due to the aggressive nature of the water, and meters stop working and need constant attention. As a result the local government in Khorixas charges fixed tariffs as a means of obtaining revenue in the absence of fully functioning meters. This is in combination with their request to Namwater to cut the supply for certain hours of the day in order to save water. It is ironic that there are technical measures to solve the problem but it is not explored at all.

In Opuwo, similar problems occur with the nonfunctioning of the meters and hard water. Each town has a problem with lack of maintenance to the reticulation system, presumably the upshot of a tariff structure that does not represent the full financial costs of supply (O+M+Capital), and the ubiquitous problem of non-payment of bills.

The unit costs are not covered by the tariff, and furthermore operation and maintenance of the reticulation are definitely not covered at all. Many of these places are in the process of proclaiming new tariffs, but as a result of the delays between the moment at which the Namwater tariff changes and the time at which the tariff is increased in response is often long. This means that financial loss and inefficient water usage occurs during that time.

It should be recognized that in all LA’s there are basic charges levied on all water users. These act as a very useful source of income to the LA’s and as such the revenue losses described above, although real losses, may not mean that the debt to Namwater is as extreme. However, in economic terms this type of cost recovery does not give the consumers of water the right signal in their water use decision. Water consumption decisions are made in terms of the marginal private cost to consumers. Flat rate tariffs do not affect marginal changes in water consumption. Furthermore the basic charges still suffer from the phenomenon of non-payment.

In both classes of tariff setting problem, the issue of financial sustainability arises. Similarly given the economic effects associated with erroneous water tariffs, there are questions of environmental sustainability.

Unaccounted-for-Water, Maintenance and Expertise.

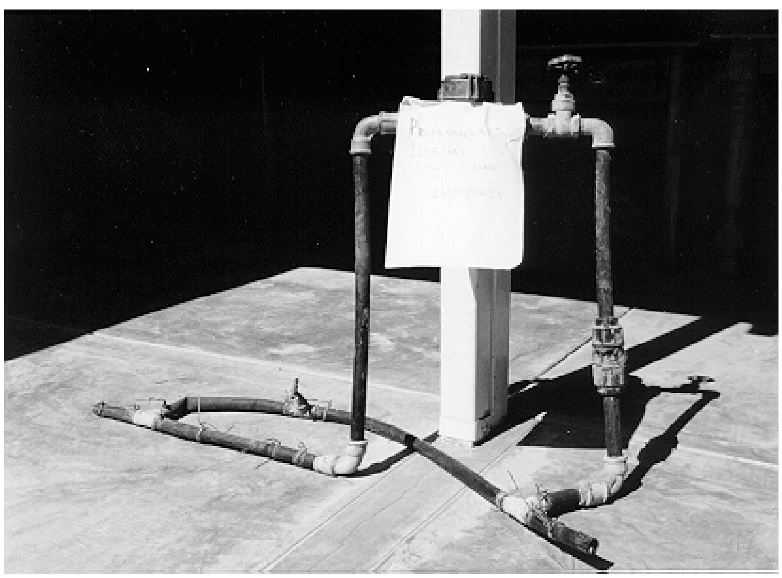
The unaccounted-for-water has been impossible to quantify accurately given the quality of the metering in most places. Unaccounted-for-water is generally related to administrative losses, illegal connections, leakage and meter errors etc. In the cases of Khorixas and Opuwo a large percentage of unaccounted-for-water can be water that the tariff system fails to account for. Unaccounted-for-water is also related to the frequency with which the system is monitored and subsequently repaired. The latter two factors are determined by the extent of expertise within the relevant LG office. The level of unaccounted for water in the Case 2 towns is shown in **Table 3.12**.

Table 3.12 Unaccounted- for-water in Case 2 Towns.

Towns	Total Water Production (m^3 1996/97)	Unaccounted for water %
Luderitz	834 009	22.0
Ondangwa	870 147	35.0+
Ongwediva	1 125 878	35.0+
Oshakati	1 773 799	35.0+
Rehoboth	1 904 374	35.0+

In many places, e.g. Gibeon and Oshakati, the lack of expertise; quality and quantity, has been cited as the main reason for leakage and maintenance problems being overlooked. In general in Case 1 LA's it seems that the expertise comes from MRLGH meaning a long delay between registering a problem, contacting central office, and the problem being resolved. Furthermore, the LA often lack "teeth" in so much as expertise does not exist for water supply to be cut off. This is one of the only strategies with which to deal with non-payment. Of course lack of funds has also contributed to this state of affairs. This feeds back into the problem of tariffs and non-payment that in turn relate to the shaky institutional arrangements.

Figure 3.1 Photo of an Illegal Connection in Oshakati.



Of the case 1 LA's Gibeon displays all the above problems. Expertise is lacking in the LG office within Gibeon and is not forthcoming from Windhoek or the regional office. This is true to such an extent that a pipe was seen leaking yards away from the LA office. Once questioned it emerged that the pipe had been leaking for 3 years without repair. Rundu had up to 50% of the meters out of action. Bills were made up of consumption estimates like those in Khorixas for these consumers. A similar story was true for Ruacana. In Noordoewer the meter for one of the main consumers, the school, was running backwards due to faulty installment.

In the Case 2 LA's, the presence of expertise was in general higher but the lack of funds seemed to be the thwarting the maintenance of many parts of the reticulation system. In Oshakati one of the biggest problems was that of illegal connections, an example of which is shown in **Figure 3.1**. Even one of the banks in Oshakati had an illegal water connection. Indeed as a result of having embarked on various strategies to find illegal water connections Namwater have many private connections in the Cuvelai region. The connections they find are "legalized" and an account created.

In both "Cases", the LA's suffer from being encumbered with an infrastructure that can only provide a limited service. Most of the reticulation systems have been designed for the smaller populations of the past and with rapid urbanization, a national average of 5.4% (NEPRU 1997), these systems soon become overloaded. The age and lack of maintenance of reticulation systems means that the maintenance costs and water losses are high whilst additions to the system are piecemeal and often inefficient.

3.3.3. Municipalities.

There are two models presented here, **Case 3** and **Case 4**. They represent the majority of cases for the Municipalities in Namibia.

3.3.3.1 Case 3 Municipalities

There are several examples of Municipalities that control their own water source and as such they are fully accountable for its management. The source is fully controlled by the Municipality, as is the responsibility for tariff collection. It is in the interests of the municipality to be diligent in its collection of water bills, since non-payers cost the municipality money and the lack of payment has an opportunity cost. Their budget is entirely separate from the central government, and this independence is the motivation for the strict water management with respect to supply and tariff collection. Similar problems of non-payment have been registered in these situations, however the municipalities have more political support than the local authority examples above, enabling them to be fairly ruthless with non-payers. The Case 3 Municipalities are listed in **Table 3.13**.

Table 3.13 Municipalities with own Water Supply.

Municipality	Tariff
Grootfontein	1.60
Oranjemund*	Free
Outjo	1.04
Tsumeb	1.25, 1.95, 2.25.
Usakos	2.8

* *Not strictly a Municipality yet but soon to be proclaimed.*

The main concern that arises in Case 3 is that the control of the water resource by the municipality, although having the benefits described above with respect to cost recovery, may evoke sub-optimal and unsustainable abstraction practices.

Groundwater, as an economic resource, is treated differently by economists to other forms of water. This results in the price of water consisting of elements which reflect the economic effects of a declining stock of groundwater, i.e. increasing marginal costs of extraction, and the opportunity cost of depleting a stock of capital. The question is if the institutional arrangement with little control on the resource will result in efficient and sustainable management of groundwater?

Economic Considerations of Groundwater.

Defining sustainability as maintaining a constant level of capital, natural and man-made, means that if we are to use a natural resource sustainability, any reduction in natural capital must be compensated suitably by an increase in man-made capital[26]. This condition applies primarily to exhaustible resources such as oil, however groundwater, although generally renewable through recharge, shares similar characteristics to oil in so much as it is possible to "mine" it. If groundwater abstraction exceeds recharge for a prolonged period, the resource will be "mined". It is still possible to mine groundwater and achieve sustainability provided the defined capital base is maintained. This would require the municipality to save a specific amount of money from the water charges in order to allow future generations to benefit from the resource. Therefore a premium for sustainability should ideally appear in the price charged for water. In general this is not a consideration that municipalities address.

As is the case in most economic analysis, the social costs and benefits determine the optimal usage of groundwater. The benefits of groundwater use relate to the demands for water that prevail in a certain area[27]. The social costs of groundwater usage depend on the characteristics of the aquifer but can include pumping costs, changes in pumping costs as a result of deeper water levels, costs to other users of the aquifer, environmental costs and the cost of alternative sources of water. The existence of significant wider social costs make the social cost of extraction higher than the pumping costs that the municipality faces. Where these costs exist, a municipality who bases its water tariff on capital, operation and maintenance costs will under-price water, leading to over abstraction[28].

There are currently no incentives for the municipality to think about the environmental costs that occur as a result of their abstraction decisions. At present groundwater abstraction is monitored by the Department of Water Affairs. The abstraction must be within the bounds set by the DWA and in line with the conditions of the permit. Although this offers regulation of the amount of water abstracted it does not ensure that economic efficiency or sustainability occurs as we have defined above. Since the environmental costs of groundwater abstraction are generally not measured, there is certainly no reason why the permitted extraction should reflect these linkages. Given that collapse, salt water intrusion, loss of vegetation etc. are associated with groundwater mining this is a critical point to address.

The policy that a municipality adopts with respect to pricing will depend on the expertise available, the legislatory system under which they operate and whether water is treated in an economically rigorous way. Sustainability depends upon the

[26] This is a definition of "weak sustainability' which assumes that appropriately valued substitution between natural and man made capital is possible.

[27] Demand here means a Price quantity relationship, not just consumption of water.

[28] It is worth thinking about whether the municipality will act like a monopoly and profit maximise in this situation. There may be benefits to such behaviour since the price will rise, perhaps closer to the social cost.

factors described above. Currently there is neither the expertise, the data nor the incentives for Case 3 municipalities to take these issues into account. Financial cost recovery is the most we can expect[29].

3.3.3.2 Case 4 Municipalities

In this last scenario Namwater supplies the Municipality. This is essentially the same scenario that the LG's would hope to achieve in their fully decentralized state. The municipality pays Namwater from its own budget. The budget is independent from government funds and made up from fees charged for water. Again the responsibility for tariff collection remains with the municipality, and the need for payment of water bills is a high priority due to the potential for the water supply to be cut off by Namwater and the opportunity costs of lost revenue. These municipalities have a "hard" budget constraint. **Table 3.14** shows the municipalities that fall into this category.

Table 3.14 Municipality and Namwater Tariffs Compared.

Municipality	Municipal Tariff	Namwater Tariff	% Difference Between Municipal and Namwater.	Namwater Cost Recovery Tariff.	% increase needed for Namwater cost recovery.
Gobabis	4.2	2.78	51.08%	31.69	1039.93%
Henties Bay	Block	2.16	NA	2.34	8.33%
Karasberg	3.11	2.47	25.91%	5.64	128.34%
Karibib	2.23	2.56	**-12.89%**	5.01	95.70%
Keetmanshoop	2.86	2.15	33.02%	2.15	0.00%
Mariental	2.53	2.17	16.59%	2.79	28.57%
Okahandja	Block	2.07	NA	2.99	44.44%
Otavi	2.60	1.53	69.93%	1.62	5.88%
Otjiwarongo	2.75	2.50	10.00%	3.27	30.80%
Swakopmund	Block	2.16	NA	2.57	18.98%
Walvis Bay	Block	1.80	NA	1.66	-7.78%
Windhoek	Block	2.40	NA	3.16	31.67%

Note: NamWater cost recovery tariffs are estimated and subject to change

Case 4 Problems.

This scenario is potentially the least problematic. The incentives for the municipality to manage its reticulation system, ensure payment, and come down hard on those that don't pay are enforced by the combination of the budget independence and the need for payments to Namwater.

However, Namwater is perhaps open to the same criticism as the municipalities who have their own water source. Namwater is regulated as a Government owned

[29] This could evoke a sustainable usage of the groundwater resource, but only through chance.

company, which means that the costs and benefits associated with pure monopolistic behaviour are absent. Problems could still arise in terms of the pricing of water resources.

Namwater has not yet achieved full estimated financial cost recovery in most places. However, when considering the environmental and other social costs of water, it is clear that even when the financial costs are represented by the tariff, the full economic costs may not. This is a transitional process, Namwater is currently aiming to achieve financial cost recovery in the next 4 years. This can be regarded as a move in the right direction, but the issues of groundwater and surface water pricing, sustainability, and the different approaches required should be brought to light at some stage.

Tariff Setting.

Three issues arise with respect to tariff setting in these “Cases”.

The pricing policy adopted by some municipalities is on the whole fairly ad hoc. According to the Local Authorities Act separate accounts should be kept for services. The different accounts are needed to be able to establish the income and the cost to render a specific service. In some cases water accounts are not dealt with as a separate distinct entity and as such the tariff setting bears little resemblance to the financial or economic costs of water supply. Tariffs are set on the basis of balancing the entire budget; if revenues do not equal expenditures then tariffs are raised across the board and water is not considered distinctly from other municipal services.

In larger municipalities like Windhoek, Walvis Bay and Swakopmund detailed breakdowns of the water supply costs and incomes are available which shows a systematic approach. In this case tariffs are raised to balance the account per service rendered.

However, it can be seen from Table 3.14 that municipalities have a greater autonomy over the levels of their water tariffs. Column 3 shows that there is no uniform addition to the Namwater tariff, as is the case with Case 1 LG’s. This suggests that more consideration is taken of the different costs to distribute water in the different urban areas[30].

Groundwater

Where water is supplied from municipality boreholes (Case 3), the price does not necessarily reflect the long-run costs. Evidence also suggests that the price does not reflect the opportunity costs of water supply and hence the price will not necessarily evoke the sustainable or efficient use of the boreholes. It can be seen from Table 3.13 that the tariffs in the Case 3 municipalities are some of the lowest in the country, and in some cases water is free.

[30] Although notice that some are less than the Namwater tariff.

Taking an example from Outjo, we find that the tariff seems to have been set on the basis of operations and maintenance costs. The budget for the financial year 1996/1997 shows that O+M costs amount to N$437,107[31]. The consumption of water for that year was 589,996m^3. This means that the effective unit O + M cost of water was N$1.35/m^3. The newly promulgated tariff in Outjo is N$1.40/m^3. The tariff for the financial year 96/97 was N$1.35. It is clear that the nature of the tariff setting covers only the O + M costs, bears little consideration of the true reticulation/groundwater abstraction costs, and the promulgated tariff increases are unlikely to be in line with inflation. Tariffs that do not rise at least in line with inflation are being eroded in real terms[32]. It is clear that the pricing does not include the rental value of the water stock, i.e. the demand side of water is not considered. Furthermore there are no incentives to consider the environmental costs since these probably accrue elsewhere and are perhaps accounted for in the setting of the allowable extraction in the borehole permit.

Tariffs and Inflation

Tariff setting within some Municipalities does not seem to endeavour to maintain the real value of the tariff over time[33]. It is only through the budget balancing process that inflation enters into the calculation of tariffs[34]. Again the real value of water supply may not be reflected through this mechanism since some factors may be hit harder by inflation than others, e.g. electricity, diesel or labour. Financial cost recovery is affected by this erosion of real tariffs. Furthermore these factors combine to ensure that a tariff is set at a low level, below the economic cost, and water is over-consumed.

Block Tariffs

Increasing block tariffs are used in several municipalities in Namibia. Windhoek, Swakopmund, Gobabis, Tsumeb, Walvis Bay and Henties Bay employ such tariff structures at present. The fact that these tariff systems are employed tells us something about the autonomy that municipalities have over their tariff setting. The issues surrounding tariff structures of this nature are discussed in Section 3.1. It is clear that care is required in constructing such a system. In Windhoek the introduction of block tariffs contributed to the success of the integrated WDM policy. However, taking the example of Tsumeb we find that the implementation of block tariffs lead to an increase in average household consumption. This is not a desirable response from a water use perspective, however it is unclear what the revenue effect for the municipality was. This emphasises the need for expertise in tariff setting to be available in Local Authority offices.

---

[31] Outjo does have a detailed breakdown of the water supply costs including labour, electricity insurance etc.

[32] Inflation averages 10% in general but this figure usually refers to Windhoek. How inflation affects the further removed urban centres is unclear but, inflation will feed through at some stage, with perhaps a time lag.

[33] The government gazettes document the proclaimed tariff increases. Often they are below inflation levels.

[34] The omission of inflation is also a problem for the Case 1 and Case 2 LG's

Unaccounted for Water, Maintenance and Expertise.

The level of unaccounted-for-water in the municipalities has been documented in **Table 3.15.** It can be seen from these figures are not calculated but may be estimates since some levels of unaccounted-for water are abnormally low. This may be as a result of meter drag on bulk supply meters or it may be related to the way in which water balances are done. The benchmark for these estimates is Windhoek, which, over the last 3 years, has had an average unaccounted-for-water of 10%.

Table 3.15 Municipalities and their Unaccounted for Water (1998).

Municipalities	Total Water Production (m³ 1996/97)	Unaccounted for water %
Gobabis	480 933	7.7
Grootfontein	2 887 587	20.9
Henties Bay	358 669	9.0
Karasburg	228 197	18.0
Keetmanshoop	1 653 419	17.0
Mariental	627 498	9.4
Otjiwarongo	1 551 167	7.5
Outjo	639 012	7.7
Swakopmund	2 793 197	12.0
Tsumeb	1 041 603	15.0
Usakos	123 925	31.1
Walvis Bay	4 515 087	14.5
Windhoek	13 741 731	10.0

On the whole it seems that the level of monitoring and expertise available in the municipalities was higher and more organized than that of the other LA's. This is a result of the decentralized institutional arrangements requiring the municipalities to be entirely responsible for their own revenue collecting and water management strategies. However, it can also be seen that, in some places, unaccounted for water could be reduced further when compared to the levels in Windhoek.

In many municipalities concerns regarding illegal connections and vandalism were noted, whilst in other newly proclaimed towns the reticulation systems are in a very bad state of repair. This is related to a shortage of money due to low revenue collection as well as negligence of proper infrastructure maintenance over a long period.

3.3.4 Government Offices

The agreement between Local Authority/Municipalities and Namwater is such that government offices pay the Local Government unless specifically supplied by Namwater. Until this financial year the "utilities" section of the entire Government was dealt with by the Ministry of Works. Now, each ministry is responsible for motivating for its own funds for utilities. The Ministry of Finance bases its budget for this vote on the estimates given by the Ministry of Works. As such the amount of money motivated by the Ministry of Works under utilities has fallen by nearly N$10m this financial year. However, the ministry of Works still remains the highest bidder at N$58m.

Many of the largest consumers in towns across Namibia are government institutions. Examples include Namibia Defense Force, Police Stations, Educational Establishments, Hospitals and Ministry of Works, all of which have consistently high levels of water consumption. For example: Oshakati Hospital which consumed 167 174m^3 in 1997/98, the Army camp at Grootfontein which consumed 639 565m^3 in 1997/98, the prison in Grootfontein at 98 643m^3 during the same period, the Ministry of Defence in Otjiwarongo at 37 096m^3 etc.[35]. Those who use the water within the government institutions do not pay, whilst payment comes from a transfer to the LA from the respective ministry's budget and is generally not felt by these institutions. As a result the hospitals, schools, police stations etc, are not encouraged to keep costs low, water conservation is therefore not a priority. Some idea of the ministries that are large users of water can be obtained from the amount of money they motivate for utilities. **Table 3.16** shows the 5 highest bidders.

Table 3.16 Government Ministries projected Budget for Utilities.

Ministry	Utilities. Vote 024. 1998/99 (N$ Million)
Works and Communication	58,89
Ministry of Basic Education and Culture	37,88
Regional and Local Government and Housing	22,04
Ministry of Health and Social Services	21,26
Ministry of Defense	7,57

The figures in **Table 3.16** are only partially explanatory since the Utilities vote contains items such as electricity, telephone and postal charges. Given the estimates made by the Ministry of Works for the requirements of different ministries water makes up about 1/3 of this budget. This will vary from one ministry to another depending upon its function. Therefore these figures should be treated with caution. However, this is indicative of the way in which water accounts, and hence water usage, are not distinctly monitored in government institutions.

The high level of water consumption is unavoidable to an extent since many people are passing through places such as schools and hospitals, and none should necessarily be expected to pay for water. Similarly, it is difficult to put these figures in a relative context without knowledge of the number of people using the facilities. In an

[35] In the year of 1996/97, Namwater supplied over 1.3Mm^3 to government institutions. This is only marginally less than was consumed by the whole of Rundu. This of course only includes water supplied by Namwater, not LG's.

absolute sense these figures are high compared to most businesses. What can be said is that, given the experience of Windhoek, the level of consumption in many of the government offices can be reduced through the introduction of fairly simple water demand management strategies e.g. information/education. For an example of the water savings made see the Windhoek case study.

A further problem is that of non-payment by government institutions. As we have seen the Municipality and sometimes the decentralized LG is more able to deal with non-payment. However, in many cases both LA's and Municipalities struggle to obtain money from these consumers. At present the extent of non-payment of water bills is not known, and these assertions are based on anecdotal evidence and the meter cards[36].

3.3.5 Conclusions and Recommendations.

Water demand management has various tools at its disposal. Pricing is one of the main strategies that is proposed as part of any WDM package. For pricing to be effective requires that the institutions responsible for water supply have the capability, the expertise and the incentives for tariffs to be set properly, bills to be issued, revenues collected and unaccounted for water to be minimized. Only if this is the case will pricing yield economic benefits, ensure financial cost recovery and be an effective WDM tool.

The main issues that have arisen from this analysis of the institutional arrangements that exist for urban water supply in Namibia are as follows:

- **Soft budget constraints.**

The Case 1 and 2 Local Governments who supply water do not account directly for the costs. The bills to Namwater are either paid by central government (MRLGH) or are paid from central government transfers. There is no incentive to reduce these costs since payment is outside of their responsibility. Furthermore, in Case 1, and potentially Case 2, since all revenues go to the state fund, not to the relevant Local Authority, there is no incentive to increase collection rates.

- **Water Accounting.**

The way in which water is financially accounted for means that it is often impossible to determine whether or not the water part of the budget balances or not. I.e. the extent to which water is making a loss is obscured by the accounting process.

- **Tariff Setting.**

We have seen that the problems associated with tariff setting fall into several distinct categories:

- **Non-volumetric tariffs**: These tariffs arise as a result of non-functioning meters in many urban centres. These charges could potentially yield financial cost recovery but do not have the desired economic and hence WDM effect. Evidence seems to suggest that financial losses occur as a result of these charges.
- **Tariffs Incommensurate with Reticulation Costs**: In Case 1 LG's there tends to be a uniform 10% increase in the Namwater tariff to cover water related costs. In general this is not seen as enough to cover normal reticulation costs. The

[36] It is difficult to attribute the non-payment specifically to water since the bills contain electricity charges as well.

municipalities have greater tariff setting discretion it seems, however the example of Outjo implies that only operations and maintenance are generally considered.

- **Groundwater**: Tariffs are not set in consideration of the principles of groundwater management. This is no surprise however, since it may not be a simple process. However, considerations of the future costs of water supply should be considered.
- **Inflation**: It can be seen from the Government Gazette that tariff increases do not in general increase in real terms in many places (Case 1, 2, 3 and some of 4). The real price is in fact eroded by this practice.
- **Environmental Costs**: Always excluded from the tariffs. This is not surprising because there is no incentive for the water supply institution to account for this.

- **Unaccounted- for- water and Expertise**:

Unaccounted for water has shown itself to be a significant factor in water consumption in all urban centres. The reasons for this vary from one "Case" to another but depend largely upon the three factors:

- The level of expertise: this tends to be less in Case 1 and 2. This factor has also been noted by NEPRU 1997.
- The monitoring of the water system,
- The age/history of maintenance of the reticulation system.

- **Non-payment**:

Non-payment of water bills is a common feature in all case 1,2 and 3 urban centres. In total it has been recently estimated that the MRLGH and various Municipalities owe Namwater in the region of N$40million in unpaid water bills. This represents and average of 4 months of free water for the towns involved. This will adversely affect the sustainability (financial, institutional and environmental) of water supply in many places.

- **Government Institutions.**

Government institutions tend to be some of the highest users of water in the urban centres. Those who use water in these institutions do not have to pay for water. Although this is true for private firms also, private firms have an incentive to keep costs low whereas government institutions tend to see water as just another recurrent expenditure. This can lead to "wasteful" use.

End Conclusion

There is evidence to suggest that this movement towards decentralization invokes a better management of water due to the incentives in place. This can be seen in the greater autonomy in tariff setting and the seemingly reduced levels of unaccounted for water in municipalities in general.

In the case of municipalities, the problems of water management are less pronounced. Their decentralized situation allows them to be more ruthless with non-payers and also leads to incentives to monitor and maintain water effectively. Provided the water source is monitored carefully in case 3 municipalities, there are good incentives for the resource to be used efficiently. For economically optimal decisions to be made, awareness of external costs that water abstraction causes and the cost of alternative water sources is required. Monitoring by central government at present is based on establishing the sustainable yield of the aquifers. For sustainability to occur in an economic sense requires sound knowledge of the environmental linkages and opportunity costs. At present this does not occur. In Case 4 the question of the role of Namwater arises, e.g. how does Namwater price the water resource? Is there an incentive to supply more than economically or environmentally sustainable? etc.

There is a vicious circle in terms of non-payment of water bills. Once significant non-payment occurs, as a result of the soft budget constraints, lack of control over consumers, a general reduction in the quality of the infrastructure tends to occur and this manifests itself in a general reduction in the willingness to pay of more people within the community. This will manifest itself in reduced revenues for the LG or municipality and an increased inability to supply a good quality service. Ultimately it is the consumers who suffer from water wastage and reduced quality of service[37].

On the whole it seems a pragmatic approach is necessary to establish a desirable water management institutional arrangement. Although thus far the arguments have centred on the desirability of decentralization of the management of water resources, the role of the central authority is still paramount. In other words:

> *"It is likely therefore that some mixture of top down control, regulation and allocation of entitlements [and] bottom up decision making is efficient. Such mixed institutions have, in fact, been used with success, both with and without government sanction". (Roumaset and Chakravorty, 1988***)***

Furthermore NEPRU1996 concludes that:

> *"in Africa decentralization has been a failure because central government hands over tasks but not money, personnel and power to local structures"*

This indicates that there is level of expertise and power required for the decentralized local authorities to work function properly.

The decentralization policy, as indicated in the WASP 1993 and the Constitution itself, offers potential improvements for water management and the implementation of WDM policies such as pricing. However it is imperative that the process of decentralization is given the full backing of Central Government in terms of training, finance and power.

---

[37] Some LG's and Municipalities have taken to implicitly charging more for their electricity to make up the shortfall in water revenues. Since many people have pre-paid electricity meters it is easy to simply give them less electricity when people recharge their cards, equal to the amount of the water bill owed. This of course will make people use less electricity, but not water since usually they are not informed of the manner in which they are implicitly paying for water.

Recommendations.

There is a general move towards decentralization within the MRLGH and the LG's. This will be a move in the right direction for water management judging by the discussion above. However, there are several areas which need further investigation in the arena of institutional arrangements for water supply. They are listed below.

- The movement towards decentralization needs to be monitored. The extent to which decentralized responsibilities are being successfully undertaken will require some centralized involvement.
- Tariff setting behaviour in all institutions must be addressed with respect to the problems mentioned above. NEPRU 1997 suggests that guidelines for good practice should be developed for the variety of different tasks that local authorities undertake. Tariff setting is one of those tasks.
- The extent of non-payment and unaccounted-for-water should be addressed in order to establish the sustainability of supply in certain areas. Unaccounted-for-water, non-payment and tariff setting should be monitored over time to indicate the effectiveness of the new management regimes.
- The extent to which savings in water could be cost effectively achieved in the government institutions should be investigated.
- The accountability of different water users needs to be established at each supply node, e.g. Namwater, LA/Municipality, and consumers (residents, businesses and government institutions). It seems evident that a firm grip on water accounts in each of the institutions is required for water to be effectively managed.

REFERENCES CHAPTER 3

Bathia, R., Cestti R. and Winpenny J. (1993). *Water conservation and reallocation "Best Practice",* Cases Improving Economic Efficiency and Environmental Quality. International Bank for Reconstruction and Development / The World Bank.

Bebi, H. Blaauw, L. Nias, P. Nepru Working Paper No. 58. (1997). *Training Needs Assessment Strategy Programme for Local Authorities in Namibia*

Boland, J.J. Whittington, D. (1999) *The Political Economy of Increasing Block Tariffs in Developing Countries* IDRC.

Bradley, R.M. (1994). *Institutional Development of Sri Lanka's water supply authority.* New World Water 1994. (The international review of water and wastewater in developing countries.)

Dasgupta, P. Maler. K-G. (1995). Beijer reprint series No. 55. Beijer Institute. *Poverty, Institutions and the Environmental Resource Base*

Department of Water Affairs (1993). *A Digest of the Water Supply and Sanitation Sector Policy of the Government of Namibia.* File No: 7/3/78/1, 8/1.1/2 (V)

Forster, S.F. and Mirrilees, R.I. (1993). *Appropriate valuation of water - a way to improve the sustainability and effectiveness of water supply to developing communities*. Imiesa Vol.19, No.9, September 1993.

Gleick, P.H., Loh, P., Gomez, S.V. and Morrison, J. (1995). *California Water 2020 - A sustainable Vision.* Pacific Institute for Studies in Development, Environment and Security

Government Notice No 72, Government Gazette No 1283, 1 April 1996. *Model Water Supply Regulations.*

Government Notice No 99, Government Gazette No 1311 , 21 May 1996. *Model Sewerage and Drainage Regulations.*

Hardoy, J. Mitlin, D. Satterthwaite, D. (1995). Earthscan. London. *Environmental Problems in third world cities.*

Interconsult, Windhoek Consulting Engineers, Desert Research Foundation Namibia. (1998) *State of Environment Report: Water* (DRAFT)

Lebel, O., Varszegi, C. and Duckworth, B. (1993*). The relationship between water saving and water price.* Paper presented at the International Water Supply Association Conference in Budapest, 1993.

Melber, H. 1996. Nepru Working Paper No. 48. *Urbanisation and Internal Migration: Regional Dimensions in Post Colonial Namibia*

National Planning Commission. (1995). *First National Development Plan of Namibia*

Netherlands Development Assistance. *Management of shared river basins* Focus on development No.8.

Roumasset, J. Chakravorty, U. (1988). Environment and Policy Institute. East-West Centre, Hawaii. *An Economic Approach to Water Use Planning*

Thirlwall, A.P. (1994) Macmillan. London. *Growth and Development*

UNDP, Windhoek. (1998). *Namibia Human Development Report*

Water Resources Research 27(2) (Feb 1991). *Water pricing as a policy variable in managing urban water use: Tucson Arizona.*

Water Transfer Consultants (1997*). Feasibility Study on the Okavango River to Grootfontein Link of the Eastern National Water Carrier*. Ministry of Agriculture, Water and Rural Development. File No. 13/2/2/2

Winpenny, J. (1994) *Managing water as an economic resource.* Routledge ODI London.

Chapter 5

5 RURAL WATER SUPPLY SECTOR.

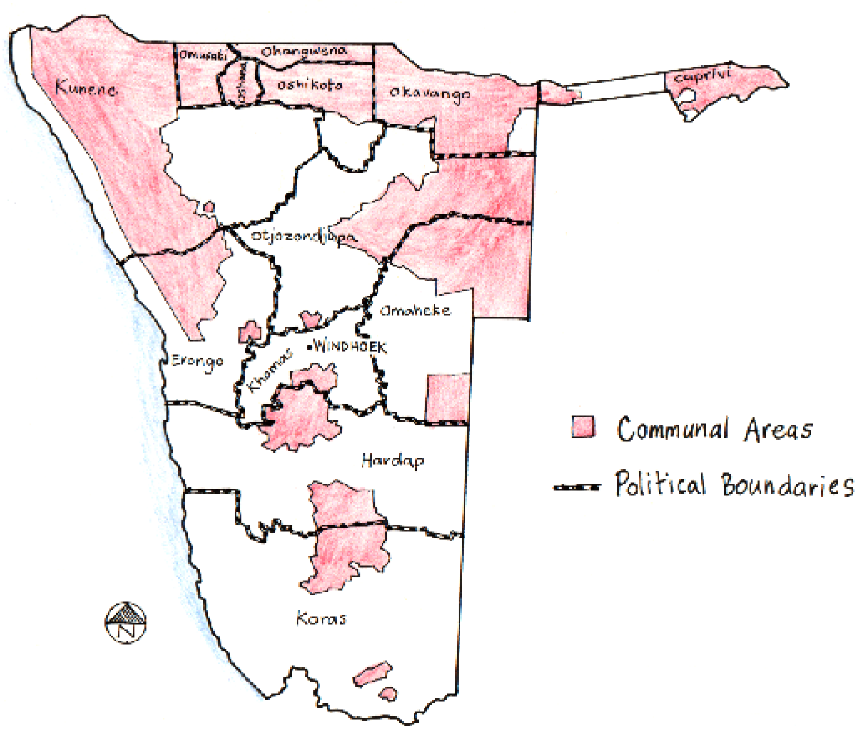
Ben Groom.

5.1. INTRODUCTION.

It has been estimated that 57% of all water usage in Namibia is in rural areas[1]. This figure includes irrigation water consumption in communal areas. Groundwater contributes 54% of all rural water supplies and represents 62% of the total groundwater production. As such the rural water sector is a significant user of water and worth consideration from the point of view of Water Demand Management[2].

The political boundaries and rural areas are indicated in **Figure 5.1.**

Figure 5.1 Map of Communal Areas and Political Boundaries of Regions



The Directorate of Rural Water Supply (DRWS) is charged with the task of ensuring a sustainable supply of safe water to people and livestock in rural communities in communal areas. These communal areas are shown in **Figure 5.1**. This will be achieved through the implementation of Community Based Management (CBM) of rural water resources such that the water users are ultimately responsible for the operation and maintenance of their water resources. This will be a gradual process involving a period of partnership between government and communities in managing

[1] Lange 1997.

[2] These figures include households, communal livestock and crops.

the water resource until the year 2007 when it is hoped that all water points will be managed by, and under full ownership of the users. In this way cost recovery for water infrastructure will be attained, management of water will fall on the users and there will be associated improvements in the efficiency of water use.

According to the targets set out in the National Development Plan (NDP1), by the year 2007 DRWS will have 80% rural access to potable water. Access is defined as being within 2.5kms of the home, whilst users should not have to wait longer than 30 minutes for water.

5.1.1 Water Demand Management.

Historically, supply of water to rural areas has been undertaken through a sense of social justice and as such the government did not recover the costs of water supply. The movement towards community based management (CBM) has been instigated to encourage water users to become responsible for their water supply thereby recovering the financial costs of supplying water. This is to be achieved through the creation of Water Point Committee's (WPC's). The combination of this strategy, awareness campaigns and training means that the efficiency of water use will be increased by this policy and therefore the same or better services will be provided with reduced amounts of water. Furthermore, given the fragility of the groundwater resource base in some areas, and the need for maintenance free operation of water points, appropriate technologies are used to reduce water wastage and to reduce maintenance costs.

The supply of water to rural areas has been stated as a priority in the social objectives of the water sector of NDP 1(see section 3.2). WDM has not been directly considered as a policy for rural areas.

5.2. WATER POINT COMMITTEES.

The movement towards CBM has already begun with Water Point Committees (WPC's) being established countrywide under the recommendations of the Water Supply and Sanitation Sector Policy of 1993. This goes a step further than the Cabinet Policy entitled "Decentralization, Development and Democracy" distributed on 12 December 1996 which stated that rural water supply should become the responsibility of regional councils. WPC's will consist of a body of people elected by the community at the water point. The committee will be responsible for the running of the water point on behalf of the community and will consist of a caretaker, a treasurer, a chairman and a secretary as well as other community members. The caretakers are trained by the government in the maintenance of the water points, be it knowledge of the diesel pumps, wind pumps etc, and will be provided with basic tools to undertake operations and maintenance.

Many WPC's have already been established and many more are planned. **Table 5.1.** gives examples of the numbers of established and planned WPC's in the different regions of the country. The shift of responsibility for the water resources from government to water point committees essentially changes the resource from an open-access resource to a common property resource. The management advantages of such a change in the management institution are well documented internationally (e.g. Jodha 1989) but include[3]:

- Establishing the demand for water supply in particular areas.
- Development of Human resources within the community.
- Revealing the appropriate responsibilities of the community and the Government.
- Greater sustainability of water points.
- More adaptive policy formation through participatory approach.
- Encouragement of local initiative.
- Improved service may lead to greater willingness to pay by the community. A virtuous circle may develop.

Table 5.1. Numbers of Regional Water Point Committees (1997/98)[4].

Region	No of Water Points in Region	% of Communities with Water Point Committees.
Karas	456	78
Hardap	NA	14.8
Otjozondjupa	NA	71.5
Omaheke	348	55.8
Erongo	NA	83.8
Kunene	1632	64.1
Omusati	507	37.8
Oshana		33.3
Ohangwena		15.0
Oshikoto		6.7
Okavango	520	29.4
Caprivi	502	18.1

[3] WHO 1996.
[4] Taken from rural water supply quarterly reports and information gathered on the field trips. Data for Hardap, Otjozondjupa and Erongo regions is unavailable at present.

Under open-access regimes private individuals often have an incentive to consume more of the resource than is socially optimal[5]. In deciding how much water to consume often individuals do not consider the wider costs of their actions e.g. the increase in the depth of the borehole and subsequently increased pumping and maintenance costs etc[6]. Once the resource becomes a common property resource, as is the case with the establishment of WPC's, there is an incentive for the community to become more diligent in their management of the resource since the costs of pumping and maintenance etc. fall on the community. The costs no longer fall on some external agency, the government, and there are good incentives for the community to manage their water points sustainable given the long–run dependence of their livelihood upon water.

Examples of the changes this policy will make have been quoted as[7]:

- Increased feeling of responsibility and ownership increasing the incentives to manage water.
- Reduction in vandalism of water points with "absentee" owners.
- Increased willingness to contribute under ownership.

5.3 COST RECOVERY

Ultimately the capital, operations and maintenance costs will be borne by the community through a system of contributions made in money or in kind. The contributions will be managed by the treasurers and used to pay for spare parts, fuel and replacement of equipment (capital) as and when required. Indeed in many regions the established WPC's hold bank accounts for proper accounting of the contributions of the community to the water point. The government's role change from provider to facilitator. Efforts will be made to provide an enabling environment for the gradual hand-over process and for those communities unable to manage water points initially.

Reductions in the amounts of diesel given to water points have already been instigated with a 25% reduction in the free allocation on 1st August 1998. Further reductions will be phased in over time. The effects of this policy are uncertain with respect to water consumption but senior officials in the Directorate of Rural Water Supply suspect that there is good reason to believe that water consumption will be reduced rather than extra diesel purchased at the cost of the Water Point Committee.

5.3.1 Costs and Methods of Cost recovery

The costs per household per annum in the northern region of Namibia are represented in **Table 5.2**. This shows the financial costs of obtaining water from different sources and as such bears no relation to the economic costs of time and effort put into

[5] Marginal Social benefits outweigh Marginal Social Costs.
[6] This really depends upon how the aquifer is affected by abstraction from other water points. I.e. water levels may drop regardless of ones own water use.
[7] From Swakopmund 3 proceedings. DRWS 1997.

obtaining water. It says nothing about the quality of the water supplied either. These should be seen in light of median annual household incomes in this region of approximately N$4500, i.e. annual costs are between 2.5% and 6.5% of income (SIAPAC 1996).

Table 5.2 Costs of Different Types of Water Supply.

Type of supply	Water pipeline	Diesel borehole	Handpump
N$/household/ annum	118	296	57

*Source: Nepru-Fg, 1997***.**

One of the main issues concerning CBM of water points is the question of livestock. Livestock consumes on average 6.4 times as much water per capita as is used by people (SIAPAC. 1996). Furthermore livestock owners from outside of the community managing the water points often use these water points. The question of how to collect contributions from these water users is paramount to the efficient and sustainable use of the water resource.

One of the methods of cost recovery, in addition to the contributions from the community associated with the water point, is a fee per head of livestock. **Table 5..3** shows the cost recovery tariffs in different regions as a result of two types of water charge; a household fee and a livestock unit fee.

The cost recovery charge per household varies from one region to another, as does the charge per head of cattle or Large Stock Unit (LSU). Much depends upon our definition of costs. In some regions diesel pumps are the only option. In general these are expensive compared to water supplied from pipelines in the Cuvelai. Factors affecting the fixed capital costs include:

- the depth of the groundwater,
- climatic conditions: wind and sunshine determine the use of windmills and solar panels.

If we take the fixed costs of the given water point the charges will vary as shown in **Table 5.3.** The variation across water points with similar fixed costs is due to factors such as:

- **Population density**: The number of households forming the community around a water point will have implications for the costs that each household must bear.

- **Number of livestock**: The fee per head of cattle will vary with the amount of cattle using the water point.

Table 5.3 Costs per Annum of Water Supply in Different Areas by Different Methods of Cost Recovery

Area	Cost Recovery Charge/ Household in N$/a	Cost Recovery Charge/ LSU Equivalent N$/a
Kunene	1820	60 – 120
Cuvelai	151	28 – 56
Caprivi	119	18 – 36

Sources: "Financial management of rural water supply" MAWRD report by FG Consult and NEPRU 1997; Unpublished NRA communal area livestock accounts derived from Veterinary services data adjusted for drought effects.

The range given for livestock reflects the range of livestock present in the area dependent on rainfall in preceding years. Hence when rainfall are lower livestock numbers follow and hence the cost (which is mainly fixed) per head of livestock rises. 1994 was chosen as the base year, reflecting 10-15 years of recovery from the severe drought of the early 1980s. The higher bounds for the tariff reflect a halving of cattle numbers in drought years.

Different regions have different population and livestock characteristics. For example the cattle to person ratio is much lower in Kunene than in the Cuvelai. Hence the fixed costs per head of cattle are likely to be higher as cattle per water point is likely to be lower. Similarly, population density is much less in Kunene region in the Cuvelai area. The fee per household for a given fixed cost will be smaller as a result.

However, there are also variable costs of water supply. At a borehole for example each unit of water pumped will cost an input of diesel. In this sense there may be no reason for the tariff per household or per capita of livestock, at a given borehole, to vary depending on the factors outlined above. If a charge is levied per head of cattle, and this reflects the cost of pumping its daily requirement of water, the variable costs incurred by the water point will be covered. However, these are just variable costs, and for fully decentralized management, and efficient use of water, water points will need to provide for future capital.

In so much as capital costs are a significant proportion of the overall water supply costs for a particular water point, it is likely that water costs will vary from one water point to another based on the population and livestock factors listed above. This essentially states that the cost of water in particular areas will depend upon demand (households and livestock) and supply (cost of water supply).

5.3.2 Willingness to Pay.

The costs per household shown in **Table5.3** should be considered in the light of the incomes of particular regions. **Table 5.4** shows the median annual household incomes for all of the regions of Namibia.

Table 5.4. Median Income by Region.

Region	Median Income in N$/annum
Karas	9387
Hardap	7065
Otjozondjupa	6619
Omaheke	5916
Erongo	8633
Kunene	5262
Omusati	5254
Oshana	5453
Ohangwena	4096
Oshikoto	4754
Okavango	5631
Caprivi	3586
National Average	**6233**

Source: Siapac 1996.

This indicates that the annual fee for water in the Kunene region, shown in Table 5.3 amounts to around 35% of annual median income. In the Cuvelai the average household cost of water is around 5% of annual median income, whilst in Caprivi water costs are approximately 3% of annual income. It seems clear that the regional variations in cost and income levels are going to affect the rate at which cost recovery is achieved in different regions. Willingness to pay has been found to be up to 10% of income in other rural areas of developing countries, although 5% is often used as a rule of thumb (Whittington et al 1990). This can act as a yardstick for reasonable levels of cost that households will be willing to pay.

The effectiveness and suitability of pricing/cost recovery as a WDM strategy will vary regionally also.

5.4 INFORMATION AND AWARENESS.

As a result of interviews with the regional offices of the Directorate of Rural Water Supply it was possible to ascertain the extent to which water awareness is promoted. In general water awareness is promoted through the process of training members of the WPC's. In addition to this there are many awareness campaigns promoted by RWS informing people about the need to be diligent with their water use. In many places; Khorixas, Opuwo and Oshakati, the involvement of NGO's in the field water awareness was noted. NGO's such as SIDA and NOLIDEP were cited as useful sources of information.

On the ground one of the main sources of information and monitoring comes in the form of the agricultural extension officers working through the RWS regional offices. It is their responsibility to monitor the progress of WPC's and register any problems that may be occurring. The extension officers are seemingly in the best position to disseminate information on water awareness but frequently find their tasks difficult as a result of the large area of responsibility they have.

Since the move towards CBM is a participatory process, a great amount of knowledge is exchanged through the consultation process. On the whole the findings of the Swakopmund workshops suggest that there is widespread agreement with the policy of CBM.

5.5 APPROPRIATE TECHNOLOGY.

In designing the water points a process of optimization with respect to water flow and costs is undertaken by the engineers at DRWS. This means that technology appropriate to the supply requirements is encouraged. These methods are essentially supply restriction methods rather than purely water Demand Management strategies but their imposition generally has behavioural and hence demand oriented effects.

For example, for less than 60 people hand-pumps are encouraged since the initial cost and the operation and maintenance costs are low. Since the private costs of pumping are reasonably, high in terms of time and energy, users generally only use what they find necessary rather than over pumping in the case of certain diesel boreholes. For 100 people and associated livestock, a standing tap supplied by a mechanical pump is used. For 200 people two standing taps are used but design recommendations state that they should be no closer than 200m. On top of these broad design rules the optimization process allows differences is certain design variables such as pumping pressure, height and size of storage tank etc. These variables relate to the use to which the water supply is to be put.

This procedure ensures that water supply capabilities are tuned to the scenario, are cost effective and do not lead to the excessive wastage of water.

5.6 CHALLENGES FOR RURAL WATER SUPPLY.

5.6.1 Water Point Committees.

Despite the successful establishment of over 1000 WPC's and the implementation of reductions in the amount of support given to water points in the form of reductions in diesel allowances, problems have been cited which may slow down the movement towards full CBM for all water points.

i) Willingness To Pay:

a. There have been several studies into the extent of Willingness to Pay for water supply in rural areas. On average the willingness to contribute towards water as a % of all households was 78.6%. However, the ability to pay, as measured by the 5% of income rule of thumb, suggests that many families may not be able to afford to maintain the community water supply.

b. Willingness to pay is affected by unclear stipulation of water point responsibilities in some areas.

c. Willingness to pay is reduced as the quality of the service is reduced meaning that careful monitoring of the quality of service the water point provides is required for institutional sustainability.

ii) Breakdown of WPC's:

In many areas WPC's breakdown after they are established. For the benefits of common property resources, stated in Section 5.2.2, to be realized requires the sustainability of the institution, the WPC. No firm records are available as to the extent of this problem but various reasons have been cited to explain the phenomenon:

a. The notion of static community based management is contrary to the nomadic/pastoral nature of certain communities. The need to move livestock in search of pastures leads to difficulty in sustaining the WPC.

b. The borehole water supply is not constant in quantity or quality leading to the movement of communities to other water sources.

c. Urbanization and the general search for employment is often cited as the reason for the breakdown of the WPC's.

d. Conflicts due to uncertainty over property rights to the water point and free riders on the community management

e. Often the elder people of the community are left to look after the water point. Often their illiteracy reduces their ability to manage the water point effectively.

If it is true that there exists an inability to finance the water point, some sort of financial assistance will be required if the targets set out in NDP1 are to be pursued. Furthermore it seems clear that the benefits that accrue in terms of water demand management from the establishment of WPC's will not be sustained should those factors affecting their stability remain unaddressed.

5.6.2 Planning

There is concern within DRWS about the behavioural effects that the current planning practices might have. The planning horizon is currently 15 years meaning that the supply infrastructure must cater for current demands and the demands expected in 15 years time. This means that the infrastructure is necessarily over capacity in year 1, which often leads to the belief amongst the community that there is a plentiful supply of water. This leads to high levels of water consumption as people use this capacity to the fullest extent. As a result the capacity of the water supply may not be sufficient to cater for demands later on in the planning horizon.

This type of behaviour is synonymous with short-run marginal cost pricing of water supplied from infrastructure that cannot be supplied in small segments. The "lumpiness" or indivisibility of water supply infrastructure means that the marginal cost pricing, i.e. pricing in relation to the costs of supplying extra units of water, can give misleading signals to consumers of water. The implication is that there is over-consumption since the true costs of water supply are not reflected by the private costs incurred.

In general the short-run marginal costs to the community of water from a borehole are just the pumping costs, which increase with the depth of the water. However in reality the consumption of water also has a long-term cost component, i.e. a new borehole once the current capacity is fully used. Only if the community internalizes the long-run marginal costs (including capital) will this cease to be a problem since consumption will then occur to the point at which economic benefits are maximized; where marginal benefits equal marginal costs.

Presumably the WPC's will have some forward planning in their management which means that there will eventually be some consideration of the long-run marginal costs, but at present it seems that the life of the schemes does not correspond to their planning horizon. The behaviour that arises due to the initial over-capacity leads to a shortened life span. It has been suggested that supply restrictions may prolong the life span of the projects but economically speaking this is an arbitrary approach since the extent of water supply should depend upon the demand for water in the vicinity of the borehole. The proper pricing of the water would theoretically have the required behavioural/Water Demand Management effects for efficient usage of water. Questions regarding ability to pay, equity and the speed at which WPC's can internalize the long-run marginal costs, arise as a result of this analysis. This suggests that a trade off between economic efficiency and achieving the targets of water supply set out in NDP1 and the DRWS mission statement need to be addressed.

5.7 USEFULNESS OF WATER DEMAND MANAGEMENT DURING DROUGHT

During periods of drought more boreholes were drilled in rural areas in areas with more grass to elevate the plight of rural residents with their livestock. This approach can be regarded as supply driven and was not sustainable in certain areas. Fodder was also made available through government grants.

The new approach is to lower the numbers of livestock to a minimum through a system where market subsidies are paid to farmers. This approach is driven on the basis that the demand for fodder and water are reduced during periods of drought. Food aid was also given to vulnerable groups like children and the elderly members of rural communities.

The reduction of reliance on primary resources like water and fodder through the lowering of stock numbers can be regarded as the management of the demand for such a resource.

5.8 CONCLUSIONS AND RECOMMENDATIONS.

The issue of policies to reduce water demand in Rural Water Supply has not been specifically addressed in policy for very good reasons. Recent studies have shown that in rural areas the national mean per capita daily water consumption is 9.9litres. The median is approximately 8.3litres. In Namibia the acceptable minimum water consumption required for good health is stated to be 15litres per capita per day while the WHO guideline is 20 l/c/day. The capacity of boreholes is planned using design consumption figures of 45litres per day for a large livestock unit and 15litres for small livestock units. The average consumption of cattle is approximately 30 litre per animal per day. It can be seen that the average daily consumption is less than that recommended for good health and subsequently to look towards this consumption as a potential area for water demand management policy seems illogical. The issue of equity in respect of domestic water consumption needs to be taken into account with the proposed policy on cost recovery.

However, since livestock are larger users of water, using between 50 and 75litres per day, individuals in the DRWS have stated that this is an area that is receiving attention. It has been suggested that a fee per head of cattle may be one management technique. The SIAPAC report of 1997 states that livestock consumption was on average 6.4 times that of humans varying from 3 times as much to 67 times as much depending on the region and the number of livestock.

Cost recovery is an important factor in sustaining supply of water to rural areas. The movement towards CBM creates common property resources for which the community is responsible and through which costs will be covered in time. There are regionally varying factors that may result in cost recovery being more successful in certain regions. Ultimately this may require an alternative management system to the creation of static water point committees in areas where movement of cattle and people is the prevailing behaviour pattern.

It can be seen from the discussion that the current planning procedure is an area that requires further research. From the long-run perspective it can be seen that there may be some dynamic behavioural benefits from the restriction of the supply to individuals faced with excess capacity in order to ensure the infrastructure is used optimally. Whether these benefits are worth the costs of restricting supply, remembering that there are benefits from the use of water, will depend on a variety of factors including:

- The economic benefits (Levels of demand backed by willingness to pay).
- The increase in costs that occur as a result of bringing forward of supply investments.
- The benefits foregone from the postponed infrastructure.
- The environmental effect of groundwater depletion[8].

Further questions remain as a to how these benefits should be achieved, through supply or demand management? This is an area for future research.

[8] There are some pricing principles specific to groundwater that might also be addressed.

REFERENCES CHAPTER 5

FG Consult (PTY) ltd. NEPRU. (1997) *Financial Management of Rural Water Supply.*

National Planning Commission. (1995). *First National Development Plan of Namibia* Vol 1.

Social Impact Assessment and Policy Analysis Corporation (SIAPAC). (1997). *Community Consultation and Survey Programme.* Integrated Summary Report

CHAPTER 6

6. AGRICULTURAL SECTOR- IRRIGATION.

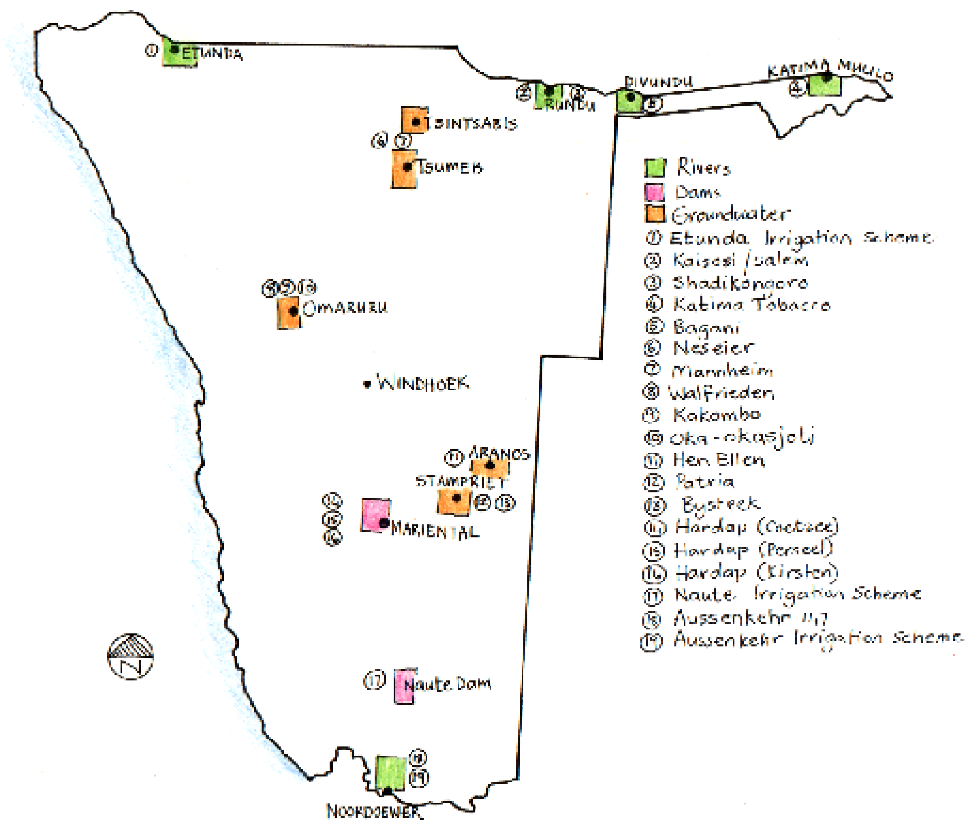
Leon Hugo, Tersius Basson and Ben Groom.

6.1 INTRODUCTION.

Approximately 6,000 ha of land is currently under irrigation in Namibia, over 90 percent of which was on private-tenure and parastatal farms. Marginal expansion has taken place since independence, but there is still potential for further development of irrigation up to a maximum of 25000ha in total (MAWRD).

The different irrigation schemes visited are indicated in **Figure 6.1**

Figure 6.1 Map of Irrigation Schemes Surveyed



Government policy towards agriculture has been clearly defined in its National Agricultural Policy. The objectives are to:

- Achieve growth rates and stability in farm income, productivity and production;
- Ensure food security and improve nutritional status;
- Create and sustain viable livelihood and employment opportunities in rural areas;
- Improve the profitability of agriculture and increase the investment in agriculture;
- Contribute towards the balance of payments;
- Expand vertical integration and domestic value-added for agricultural products;
- Improve the living standards of farmers and their families as well as farm workers;
- Promote the sustainable use of the nations land and other natural resources;
- Contribute to balanced rural and regional development based on comparative advantage.

These objectives are to be achieved by promoting participatory approaches to the development process concentrating on communal farming activity. Government policy towards irrigation is also clearly stated in the National Agricultural Policy. Guidelines for future irrigation development include:

- Minimising direct government intervention in irrigation schemes;
- Increasing the participation of women;
- Providing research training and extension services;
- Minimising public health consequences from irrigation development;
- Training of planners and irrigation engineers to plan and implement irrigation projects.

Previous economic analyses indicate that agricultural production under irrigation in Namibia is only economically viable when irrigation is used to produce high value crops in areas that have access to the appropriate markets. Pre-independence developments in the smallholding sector have met with limited success, despite a high level of subsidies and other Government support, which have created an attitude of dependency. Current and planned developments in the smallholder sector are technically sound, but of concern is that these schemes have been developed without regard for the fact that they are most likely to be marginally economic. Extension and training services are generally weak. The existing NDC managed schemes are technically sound, but financially and economically unsound, mainly because they are growing low value basic food crops under sometimes meager management. Consequently they will increase the demands on Government's recurrent budget for the foreseeable future. The guidelines above will aim to rectify this situation in the future.

6.1.1 Economic Contribution of Agriculture[1].

It has been estimated that the agricultural sector contributed almost 9% to GDP in Namibia in 1996. Of this commercial agriculture contributed 5.4% and subsistence agriculture the remaining 3.6%. Commercial agriculture consists of both livestock and crops (including irrigation). It has further been estimated that the contribution of the agricultural sector to GDP per unit of water used is close to N$7.20/m^3. This compares to N$65.60 for mining, N$292.80 for manufacturing and N$574.50 for services. The contribution of irrigation itself is difficult to assess because agricultural data is not desegregated enough at present to differentiate between rain fed and irrigated crops. However estimates by Blackie (1998) suggest that the value added by irrigated crops could be close to N$0.50/m^3. The contribution to GDP by agriculture is low and the productivity of water in agriculture as measured by the value added per cubic metre is also low compared to other uses of water[2]. The commercial irrigation sector is estimated to use approximately 41% of the total water used in Namibia. The water consumption for livestock is approximately 21% of the total water supply. The value added through livestock farming is estimated at N$ 20.26/m^3 water consumed.

Given these facts it seems an appropriate place to address the issue of Water Demand Management in the irrigation sector.

6.2 METHOD.

A questionnaire was drawn up to establish the extent of knowledge of Water Demand Management techniques in the irrigation sector. The questions endeavored to find out the crops grown, the inputs used and their costs, the techniques used in irrigation, climatic conditions and soil conditions. From these responses it was hoped that information about the irrigation techniques for different crops and climatic conditions as well as water supply situations would be established. Of over 50 questionnaires distributed only 20 were returned. The responses will be dealt with by region and water source and summarized in the following section.

6.3 RESULTS.

Irrigation schemes in Namibia obtain their water from three sources: perennial rivers, groundwater aquifers, state dams and some small farm dams. We address the irrigation schemes by source.

[1] Figures quoted here are from Table 3.3 in Chapter 3.
[2] Value added includes profits and labour costs and as such these figures include the employment in each sector.

6.3.1 Perennial Rivers.

Orange River.

Irrigation along the Orange River include a number of commercial farms at and east of Noordoewer, as well as the farm Aussenkehr, approximately 50 km west of Noordoewer. The farm Aussenkehr is a privately owned enterprise of 100,000 ha, some 1000 ha of which are irrigable. Government purchased a portion of ±627 ha and is in the process of developing approximately 300 ha under irrigation.

Aussenkehr Farm

The Aussenkehr farm is made up of the government scheme and the De Koch farm. The Orange River abstraction permit for the whole scheme is 14.3Mm^3/a and this private section of the scheme uses approximately 5.4Mm^3/a. The owner of the farm Aussenkehr has ±170 ha under table grapes which are irrigated by means of micro irrigation systems. Recent developments at Aussenkehr include the development of another 200 ha of vineyards (micro irrigation) through joint ventures with other individuals, while another 300 ha are in the planning process. Grapes are a relatively high value crop attaining a gross margin of around N$36,000 per hectare. The water requirements for this crop are correspondingly higher at around 2100mm per annum as opposed to 1200mm for Maize, for example.

Water is supplied from the Orange River from 3 diesel pumps and applied to the crop through Micro sprinklers. The scheme has been designed professionally. The water demand management techniques involve only careful monitoring of the irrigation pipes and the use of a tensiometer at the pump to control the pumping pressure and hence the amount of water pumped and the level of leakage in the system. Water application efficiency can be regarded as good.

Water is paid for to the Department of Water Affairs through the per hectare levy system. N$7.27/ha/annum is paid for the first 30 hectares whilst N$37.34/ha/a for additional hectares. Given that the use of water per hectare is in the order of 15000m^3/a, as stated in the questionnaire, the implied unit price is 0.04c/m^3 for the first 30ha and 0.4cents/m^3 for additional hectares. The allocation for the permit is based on the usage of 20000 m^3/ha/a and as such the implied price is much less.

Aussenkehr Irrigation Scheme (Government, MAWRD*).*

This scheme is implemented by the National Development Corporation (NDC). Production on the commercial farms at Noordoewer includes crops like Lucerne, vegetables and more recently mangoes and table grapes. Flood irrigation is used in most cases for the Lucerne and vegetables, while micro irrigation systems are being installed for the mangoes and grapes. Although the flood irrigation systems are not very efficient compared to other systems in applying water to the crop, strict water application management is adopted. This could however have a detrimental effect on yields during periods of extremely high evaporation, which often occur at

Aussenkehr. The same water tariff is applied here as is applied to the non-government farm at Aussenkehr.

This development includes 60 ha under lucerne (centre pivot), 60 ha under citrus and mangoes (centre pivot) and 10 ha under date palms (micro irrigation). All of which, bar lucerne, are reasonably high value crops, for example citrus has a gross margin of N$17000 per hectare (MAWRD). Another ±120 ha will soon be developed for the settlement of smallholders and table grapes, dates and vegetables will be produced under micro and drip irrigation systems. There were no distinct WDM practices undertaken here other than the irrigation systems being used.

Kunene River

Irrigation in this region is limited to the Etunda Irrigation Scheme and the Epalela scheme. The Etunda Irrigation Scheme is a State owned scheme operated by the Namibia Development Corporation (NDC) on behalf of the Ministry of Agriculture, Water and Rural Development. The total irrigated area at the moment is 600 hectares, but the project will eventually be expanded to1200 hectares.

The project was designed to include two components, namely a settlement component and a commercial component. The two components are equal in size, but the settlement part is subdivided into 3 hectare plots with conventional sprinkler irrigation systems, while the commercial part is subdivided into 30 hectare units equipped with centre pivot irrigation systems. The reason for the split is to encourage commercial entrepreneurs to invest in the area and to stimulate economical activities through the introduction of know-how, research, transport and employment creation. It is debatable whether or not the promotion of the commercial component will have a positive influence on adjacent settler farmers and whether or not this is most efficient use of economic resources in alleviating poverty.

Water for irrigation purposes is abstracted from the Kunene River at Calueque in Angola. It is then conveyed via a concrete lined canal towards Ogongo and Oshakati. A concrete lined Service Canal conveys the water from the bifurcation just south of the Namibia/Angola border to the irrigation Project. Water application efficiency is good, but the sandy soils necessitate better scheduling in order to improve water consumption.

In this instance, water is paid for per cubic meter and should definitely encourage more efficient use of water. However the charge for water in in the region of 10c/m^3, far below the full cost recovery tariff, quoted by Namwater as being N$2.78/m^3 in Oshakati and around N$1/m^3 for offtakes from the canal. Furthermore doubts have been raised in the planning section of the Department of Agriculture about whether these tariffs have ever been paid[3].

A cost benefit analysis of the Etunda irrigation scheme, undertaken by the Ministry of Agriculture, Water and Rural Development, Planning Division (1996), revealed

[3] Martin Fowler pers comm.

that there are economic losses attributable to the government funding of this scheme. The discounted financial costs of capital have been estimated as being approximately N$28.6 million in 1995/6 constant prices. The present value of the crop output less operating and variable costs have been estimated over 25 years as N$6.2. This means an economic net cost of N$22.4 million.

The extent of these losses is linked directly to the low value crops that were being grown on the land at that time. The scheme was instigated in order to stimulate development and create employment. However it is clear that the production of higher value crops would increase the income generating effect of this project, increase the employment required and reduce the economic losses the government incurs.

Okavango River.

The Namibia Development Corporation is operating four commercial irrigation farms in this region to produce mainly maize, wheat and groundnuts which is regarded as medium value crops. Of these schemes only Shadikongoro, of 250ha, and Salem with 34ha of irrigation replied to the questionnaire. Centre-pivot irrigation systems are used in all cases and water application efficiency is potentially good. However, management is generally poor and very little is done to improve overall water demand management. No scheduling techniques are in place and irrigation is applied when the manager feels it is necessary. The capital cost and operation and maintenance cost form part of the project cost.

A number of small irrigation projects also exist along the river, most of which use sprinkler irrigation systems. Efficiency is generally poor due to a lack of expertise and training.

Zambezi River.

Irrigation in this region is very confined and the only project of significance is the tobacco farm at Katima Mulilo. Approximately 90 ha are cultivated under centre pivot irrigation and because it is a private venture, irrigation techniques are more accurately controlled. The possibility of a 10,000 ha sugar estate in the Liambezi lake is currently under investigation and if developed, it will make use of both flood and sprinkler irrigation systems. Water usage will however not be optimal, because water will have to be conveyed via a 40 km long earth canal with consequently high seepage rates and evaporation. A concrete lined canal will be much more expensive and will also create a physical barrier to animal movement in the region. There are also questions about the high level of extraction that will be required from the Zambezi River, as well as general concerns about the economic viability of the scheme.

6.3.2 Groundwater Aquifers.

Omaruru River Alluvial Aquifer.

The Omaruru river is not a perennial river and abstraction techniques therefore differ. Sub-surface water is abstracted from boreholes in the river. Irrigation systems are not always very efficient and water usage could be improved through better practices. Problems have been noted with the water supply in this region since the Omaruru River has not flowed in Omaruru for over a year due to lack of rainfall. This has manifested itself in reduced pumping times for riverside boreholes and a subsequent reduction in the availability of water.

The farms in this region included Walfrieden, Oka-Okasjoti and Kakombo. Water Demand Management practices included;

- Drip irrigation in places,
- Scheduling of sprinklers for days without wind.

These farms make up a small percentage of the total irrigation in the area. It was noted that at the time of the study some commercial water users operated without a water abstraction permit.

Gobabis-Stampriet Aquifer.

The Gobabis-Stampriet basin consists of an aquifer with high yield boreholes, some of which are artesian and very little or no pumping is required. In some parts of the Stampriet artesian aquifer, saline water overlies the freshwater and poses a contamination threat to the freshwater. Farmers in this area are now required to use a specially designed borehole that seals off the overlying salty water. Commercial farmers utilise the water for the production of crops like table grapes, melons, citrus and vegetables. Irrigation systems also vary and flood irrigation, sprinkler, micro and drip irrigation systems are encountered.

Farms in this region that were surveyed include Patria, Bysteek and Hen Ellen as shown in Table 6.2. The Water Demand Management techniques used in this region include;

- The use of drip irrigation (and other efficient systems),
- Attention given to the irrigation system and
- At Patria plastic covers are used for the soil to reduce evaporation.

Karstveld Aquifer.

The Karstveld basin, underlying the Grootfontein, Tsumeb and Otavi area, is one of the most controversial aquifers. Although the Department of Water Affairs as well as other organisations have done extensive surveys in the area, the exact size and safe yields of the different synclines (compartments), are still not known. In the Karst (limestone) areas, excessive pumping from boreholes can result in the deeper lime-rich water being exposed to oxygen and thereby causing the lime to precipitate and block the borehole. The borehole then has to be abandoned or re-drilled. This has led to a conservative approach by the Department of Water Affairs when issuing permits for the abstraction of water. Although this policy has attracted a lot of criticism from some farmers, others feel that too much water is already abstracted.

However, there is irrigation farming in the area and crops such as maize, wheat, citrus and vegetables are produced. Irrigation systems include, flood irrigation, centre pivots, sprinkler irrigation, micro and drip irrigation. Farmers generally also lack the skills required for optimal irrigation techniques to be undertaken and extension services could improve the water consumption figures substantially.

In one irrigation scheme in this area water metering has been noted. Tariffs are not charged for the groundwater and the only limiting factor for the amount of water that gets used is the limits prescribed by the (free) permits from the DWA and the extent of the irrigated area. This area receives significantly more rainfall than other areas in Namibia and as such irrigation requirements are reduced in the rainy season in relation to the rainfall. The level of rainfall has been lower than average over recent years, putting greater pressure on the groundwater.

Of the farms in this area Mannheim, Neseier, and Excelsior responded to the questionnaire. The water demand management practices exhibited by these farms include;

- checking for leaks
- general maintenance of the irrigation system.

At Excelsior, which is a newly emerging small scale resettlement project low pressure water pumps have been installed by Rural Water supply, whilst a level of informal education occurs on the ground to instil good water use practices.

6.3.3 State Dams.

Hardap Dam.

The Hardap Irrigation Scheme is about 2000 ha in size, consisting of plots of approximately 50 ha each. The scheme is supplied from the Hardap Dam (300Mm³ capacity), via a reticulation network of concrete lined canals and was originally designed to use flood irrigation only. Initially only lucerne, maize, wheat and cotton were produced, but during recent years farmers began to install centre-pivot irrigation systems as well as micro irrigation systems for the production of table grapes. Due to the prevalence of flood irrigation techniques, concrete lined open canals and the high level of evaporation in the region (2500mm/a), water use efficiency is generally low.

Until recently water has been charged on a per hectare basis, meaning that the incentives for private consumers to save water were low. From June 1997 volumetric tariffs have been charged at a level reflecting only 31% of the full cost recovery tariff. Table 6.1 shows the current water tariffs at Hardap dam. As a result, Namwater in this region is keen to establish new connections for paying consumers in order to increase revenues[4].

Some environmental problems were noted during the visits to Hardap Dam. Salination of the soil was apparent. Ultimately this affects the productivity of the land and this is compensated by the application of more water on occasion. There was also the problem of excessive reed growth in the irrigation canals noted by one farmer. It is speculated that this may be the result of runoff containing fertilizer residue.

Of the farms answering the questionnaire, Perseel, Kirsten and Coetzee obtain water from Hardap dam. Water demand management techniques involve laser leveling of the land to avoid excessive losses from the flood irrigation (pooling and flooding etc.), general optimizing of irrigation scheduling, and at Coetzee, the use of special varieties of crop which have short growing periods.

Naute Dam

The Naute Irrigation Scheme draws its water from the Naute Dam (80,000,000m^3) in the Lowen River. Centre pivot irrigation systems are used to irrigate 180ha of lucern, wheat and maize. 84ha of date palms and another 20 ha of grapes are irrigated by means of micro irrigation systems.

Water demand management practices include:

- Tensiometers for scheduling purposes
- Research into the determination of the water requirement of date palms.
- Payment for water is on a per cubic meter basis.

The tariffs for water are shown in **Table 6.1.** The tariffs at Naute dam represent 26% of the full cost recovery tariff.

Table 6.1. Current and Full Cost Tariffs at Hardap and Naute Dams*.

Dam	Current Tariff c/m3	Full Cost Tariff c/m3	% Subsidy
Hardap	12	38	69%
Naute	12	46	74%

[4] Personnel comment from Namwater representative at the Hardap office. This implies that the fixed costs are the main factor in the tariff, which seems reasonable in this case.

6.4 DISCUSSION

Very few farmers indicated that they have a good understanding of their systems and the respective advantages or weaknesses. It is evident that most farmers see irrigation merely as watering their crops and know little about the interaction between the crops, water and the soil. As discussed above, farmers are not encouraged, nor forced to save water and are therefore not really concerned about the volume of water used. This fact is alarming and should be addressed as a matter of urgency.

It is clear that irrigation schemes in Namibia do not generally pay for water on a volumetric basis. Exceptions appear to include Hardap, Naute and Etunda where nominal tariffs are levied by Namwater/NDC on the irrigation water. It can be seen that the tariffs levied do not represent the full financial cost of the water supply and as such will not yield a demand response synonymous with economic efficiency in the use of water. Furthermore, little evidence exists that these bills have ever been paid adding further to the diminished demand management effect.

Irrigation schemes have been implicitly subsidised through cheap water for many years and scope still exists for “special subsidies” to be applied to water if “wider social benefits” allow[5]. It has to be asked whether the lack of WDM measures noted from the questionnaire responses is a direct result of the historically low prices for water. It seems intuitively likely that the low prices have not offered incentives to farmers to save water, introduce water efficient techniques and grow higher value crops.

Questions were asked as to the extent to which further water saving techniques could be applied. In general the responses were either negative, or an awareness of techniques was stated but their suitability to the present crops was questioned. For example the expense of introducing drip irrigation was given as a reason for not implementing such technology.

6.4.1 Irrigation Efficiency.

Water Demand Management has been defined as the promotion of more efficient use of water with a view to sustaining environmental systems and livelihoods. It has also been stated that for this to be done effectively requires a holistic and integrated approach. The same philosophy applies to the irrigation sector in Namibia. It can be seen from the discussion above that the contribution to GDP of irrigated agriculture is small. It can also be seen that often this is the result of growing low value crops such as Maize and Lucerne. Often these crops are promoted by the government schemes such as Etunda and those along the Okavango, although even private agents often choose to irrigate these low value crops through water inefficient means such as flood irrigation. This is seemingly the upshot of low or non-existent prices for

[5] Stated in the Water and Sanitation Policy of 1993. It is not clear how these wider benefits are to be appraised.

water and the desire of government at about the time of independence for promote self-sufficiency in basic grains[6]. Since this sector of the economy uses approximately 40% of the total water consumed in Namibia the issue of irrigation design, efficiency of water application and contribution of crops to the economic development of the nation is an important point to address.

Irrigation demand depends upon a variety of different factors. The Orange River Replanning Study cites the following:

- The crop responding to its specific growing environment. These are evapotranspiration losses, and include evaporation from wet soil.
- The characteristics of the irrigation system…
- Irrigation management and scheduling.

Each of these factors can be considered as areas for application of technical and management measures for WDM and conservation strategies.

6.4.2 Crop Choice.

From an economic efficiency point of view, where water is the limiting factor for development within a region or a country, the maximum economic returns should be obtained from the water. If water is used for irrigation then crops with a high value per unit of water should be chosen. Examples include grapes and citrus. From an agricultural point of view it is obvious that a crop suitable to the climate, water availability and soil is required.

In Namibia low value crops have been the norm until recently. If the returns of existing irrigation were to increase the income generating capacity of agriculture, both locally and nationally would increase. Higher value, water efficient crops also tend to require more labour inputs than cereal/basic grains production. There are also less opportunities for substitution by machinery. Therefore the employment prospects from these crops are greater and more certain than for cereals.

6.4.3 Irrigation System efficiency.

The efficiency of different irrigation systems is shown in **Table 6.2**. Economic conditions, e.g. input and output prices and subsequently financial returns, govern the suitability of certain crops to certain systems.

[6] Self sufficiency is mentioned as a target in NDP 1 and WASP 1993. The nation agricultural plan is more realistic in its discussion of self-sufficiency.

Table 6.2 Irrigation System Efficiency*

Irrigation System.	Efficiency. %
Surface Systems (flood)	55
Conventional Sprinkler	75
Mechanical (centre Pivot)	80
Micro Jet	85
Drip	90

**Source: "Water Demand Management". ORRS, DWAF, RSA. 1998. This assumes the same climatic conditions, soil and crops.*

Table 6.2 shows that a wide variety of irrigation techniques with varying degrees of efficiency are used throughout Namibia. The 55% efficiency associated with flood irrigation means that of the water used in irrigation only 55% arrives at the crops, the remainder being lost to evaporation or deep infiltration for example.

It is clear that the more efficient use of water by current irrigators would allow the "saved" water to be put to other uses where water is the main constraint to further developments. It is not difficult to envisage such a situation in Namibia, where there are likely to be limits placed upon water abstraction from the perennial rivers such as the Orange River or sustainable yield of aquifers. For example, should all irrigation schemes in our sample become 90% efficient in the use of their water, as is the case for drip irrigation, water savings of 4.48 Mm^3/a could be realized. This means a 14% saving in water usage in this sample and $14Mm^3/a$ nationwide[7].

There are costs and benefits to such a strategy. Firstly there are obviously high economic/financial costs involved in the upgrading of irrigation schemes to 90% efficiency. These will include:

- Capital costs,
- Decommissioning costs,
- Increased recurrent costs.

The costs of implementation are often easy to calculate. There will also be benefits that arise from such an investment including:

- Cost savings through reduced water bills.
- The use of high value crops. (only these justify the high capital costs)[8]

[7] This is based on the total consumption of Namibia being $250Mm^3/a$ and irrigation using 40% of the water

[8] It is likely that there will be a change in the pattern of crop growth in response to need for WDM.

- Increased export potential and the associated balance of payments effects,
- Increased employment[9],
- More efficient use of water enabling further economic activities to be undertaken[10].

Whether it is wise to invest in the technical measures of WDM will depend upon the assessment of the whole range of costs and benefits. If the external social benefits are high there may be a role for government in assessing these benefits and encouraging WDM policy as a result. Often the benefits are difficult to assess.

Whether the move towards more efficient water use occurs by itself is another question. It is clear that some of the benefits of water demand management of this type do not accrue directly to the private individuals/irrigators. They accrue rather to society as a whole; new water users, new employees, macro-economic benefits etc. As such it may be unreasonable to expect private agents to unilaterally embark on such a strategy since they would bear all the costs. Furthermore the costs savings that accrue to farmers as a result of water savings are at present likely to be small as a result of the low tariffs for water (see table 6.1). Overall the incentives to implement WDM are low.

The benefits that accrue to society may also be questionable. The opportunity cost of the water saved as a result of increased efficiency will be low or zero if there are few or no alternative uses for the water within the country. Again this is the narrow view since if the water is a resource shared between nations the opportunity cost may be determined by uses in another country[11]. In this sense there may be no incentive to save water in Namibia, unless a mechanism exists for the "international" opportunity cost to be impressed upon Namibia's behaviour. If for example RSA would be willing to pay for water from the Orange River currently being used by Namibia, and a mechanism was in place for such a transaction, there may be an incentive for Namibia to introduce water demand management/efficient use of water since water will have an opportunity cost equal to the willingness to pay of RSA. Again, only if this is an opportunity cost for individual farmers will this "international" opportunity cost of water use act as an incentive to privately increase water use efficiency.

6.4.4 Irrigation Management.

In addition to the savings that could be made as a result of changing the system, there is potential to improve the manner in which current systems are used. Scheduling of

---

The need for WDM may be driven by higher prices for water.

[9] High value crops are generally more labour intensive.

[10] Provided that water is the primary constraint to development and not quality land or credit finance for example.

[11] If we are considering the optimal use of a shared watercourse or groundwater source then all parties should be considered. Ordinarily there may be no incentive to think about the effect that the use of water in ones own country might have on the other users. This would necessitate a degree of cross boundary planning.

irrigation, maintenance of the system, and the adaptation of existing systems e.g. changing of sprinkler nozzles to a more appropriate size etc. Furthermore, where water is supplied from the bulk supplier as is the case in Hardap and Etunda, the efficiency of supply can depend upon the quality if this infrastructure. We have noted that at Hardap the level of maintenance of the concrete channels was low; canal lining has been seen as one way to conserve water cheaply. Evaporation in these supply canals is a significant water loss in many countries.

All of these adjustments mean that the same returns are yielded from the use of less water technical measures. Indeed should the irrigation be scheduled with a greater understanding of the needs of the crops, an improved yield response may result. This will mean greater returns from perhaps reduced amounts of water.

Table 6.3 Irrigation Systems Used In Irrigation Schemes.

Farms	Irrigation System	Crops Grown	Hectares	Total Consumption (Mm^3/a)	Water Savings (Mm^3/a)
Etunda	Pivot	Maize	300	4.5	0.26
	Conventional Sprinkler		300	4.5	0.28
Kaisosi Salem	Conventional Sprinklers	Cabbage, Maize, Onions, Tomato	34	0.51	0.03
Shadikongoro	Conventional Sprinklers	Veg. Maize	6	0.09	0.01
	Pivots	Maize Cotton	240	3.6	0.21
Katima Tobacco	Pivots	Tobacco	45	0.675	0.04
		Maize	45	0.675	0.04
Bagani				0	
Neseier	Micro Sprinklers	Citrus	15	0.225	0.01
	Pivots	Carrots	40	0.6	0.04
Mannhiem	Sprinklers	NA	NA	NA	NA
	Micro Sprinklers	Oates	5	0.075	0.00
	Pivots	Maize	20	0.3	0.02

Farms	Irrigation System	Crops Grown	Hectares	Total Consumption (Mm^3/a)	Water Savings (Mm^3/a)
Walfrieden	Flood	Veg	1	0.015	0.00
	Drip			0	
Oka-okasjoti	Overhead Sprinklers.	Veg	16	0.29	0.02
Hen Ellen	Pivots	Lucerne	16.3	0.42	0.02
Patria	Drip	Veg	20	0.14	
Bysteek	Drip	Veg	11	0.165	
	Sprinklers	Lucerne	2	0.03	0.00
	Micro Sprinklers	Onions	1	0.015	0.00
Hardap (Coetzee)	Flood	Lucerne,Maize, Wheat	64	0.96	0.26
Hardap (Perseel)	Flood	Cotton	76	1.14	0.30
		Lucerne			
		Maize			
Hardap (Kirsten)	Flood	Cotton	46	0.69	0.18
		Wheat			
		Maize			
Kakombo	Flood			0.054	0.014
Naute Irrigation Scheme	Pivot	Lucerne	180	2.7	0.16
	Micro Sprinklers	Grapes	84	1.26	0.07
		Dates	20	0.3	0.02
Aussenkehr 147	Micro sprinklers	Grapes	375	5.6	0.31
Aussenkehr Irrigation Scheme	Micro Sprinklers	Dates	10	0.15	0.01
	Pivots	Lucerne	60	0.9	0.05
		Citrus	30	0.45	0.03
		Mango	30	0.45	0.03
Excelsior	Conventional Sprinklers. (In the process of development)				
TOTAL				**31.48**	**2.4**

6.5 USEFULNESS OF WATER DEMAND MANAGEMENT DURING DROUGHT

The reduction of the water demand on irrigation schemes was handled through the reduction of irrigation areas. A yearly quota for irrigation water is determined in advance. This normally gives an indication to farmers on the availability of water for the coming two seasons if no inflow in the supply reservoirs should occur. Most of the crops grow in one season and farmers can plan ahead not to loose any crops as a result of a shortage in irrigation water.

In the case of other crops like table grapes and trees with a life span of several seasons the installation of more efficient irrigation systems (drip etc.) to lower the water demand is normally used. At this stage there is not a way to guarantee water to farmers with perennial crops. There are cases where farmers sell their water quota to other farmers during periods of drought.

Both approaches can be classified as demand driven, because it reduces the pressure on the primary water source.

6.6 CONCLUSIONS AND RECOMMENDATIONS.

In terms of contribution to GDP the irrigation sector in Namibia is very small. Furthermore, it is a relatively unaccustomed field to most individuals. Consequently, farmers lack expertise and this, combined with the very high establishment and operational costs, lead to poor viability of most of the schemes. Farmers are not aware, in general, that water demand management can be implemented with only minor changes in their irrigation practices. Institutional strengthening of extension services provided for farmers may increase awareness of water demand management and disseminate technical skills and innovations.

It seems likely from the questionnaire responses that, with the current level of water tariffs, the private financial incentives to increase water efficiency are weak. The system of charging farmers on a per hectare levy basis for water is totally ineffective. Whether he uses 10,000m³ or 30,000m³ per hectare per annum, the charge stays the same. If water is charged for per cubic metre, farmers will be forced to irrigate more efficiently and if a certain quota is then allocated, farmers who irrigate more efficiently, will be able to irrigate a larger area. Volumetric pricing of irrigation water will help to impress on water users the resource costs of water supply. The opportunity costs of water used for irrigation are generally considered to be high, thus the willingness to pay for water is low compared to alternative uses (Briscoe 1996). This is particularly true of publicly operated schemes, which are heavily subsidised. In Namibia all irrigation schemes are implicitly subsidised through the water tariff and inefficient water use arises. The opportunity costs of the water use are less clear, in many area's, e.g. along the lower Orange River, the alternative uses for water are few and perhaps the opportunity costs are low. This is something that should be investigated for all irrigation in Namibia.

During a survey done in 1993 for the SADC region, the following recommendations were made to improve the irrigation sector in Namibia:

Government should begin the process of formulating a policy for irrigation development in order that all efforts can be guided in the right direction. This is not to suggest that Government should rush into hasty decisions regarding policy: given the fact that the present contribution of irrigation to the economy is minimal, a year or so delay will not be a major disadvantage to the country.

Policy recommendations are:

- The private sector should be encouraged and assisted to develop irrigation at its own risk and for its own profit including, where necessary, the development of water resources.

- Government should minimize its direct involvement in irrigation and leave development to take place at its own pace, principally on the initiative of farmers, large and small-scale.

- Consequently Government should seek to divest itself of its existing managerial responsibilities in irrigation farming operations to appropriate commercial enterprises. As far as financial involvement is concerned, the Government should limit itself to financial assistance to create basic infrastructure in order to create an enabling environment for irrigation development.

- Government role in irrigation should be restricted to the facilitation of development of irrigation through encouraging foreign investment and providing extension services and appropriate forms of credit to prospective farmers. Investment of public funds in irrigation and related development including the construction of new dams, must be shown to be economic [ie an Economic Internal Rate of Return (EIRR) of at least 12 percent]. I.e. a feasibility study including an environmental impact assessment must be undertaken and the scheme found to have an EIRR higher than 12%[12].

- Notwithstanding the above, Government should act as the catalyst for irrigation development, by identifying the potential for new schemes large and small and by providing technical advisory service to all prospective irrigation farmers.

- A pilot project should be launched at the Hardap Irrigation Scheme to address the issue of WDM in a practical way to demonstrate to farmers exactly what is meant by the term. Adequate facilities are available at the research station. A project proposal to do this has been compiled and now requires the necessary funds to be implemented. Farmers may be involved in the project subject to the guidance of

[12] It is not understood from where this test discount rate has been derived.

suitable personnel. True economic impacts of the project can also be studied. This information will be vital to determine the real benefit of WDM for irrigation schemes.(See the Annexure on the way forward)

REFERENCES CHAPTER 6.

ACIL Australia PTY LTD in association with Snowy Mountains Engineering Corporation LTD and Stewart Scott NCL, Zimbabwe. (1992) *Regional Irrigation Development Strategy, Country Report, Namibia.*

Kathy Eales, Simon Forster, and Lusekelo Du Mhango Consultants, Economic Project Evaluation (Pty) Ltd, Rivonia, South Africa, (1996). *Strain, Water Demand, and Supply Direction in the most Stressed Water Systems of Lesotho, Namibia, South Africa, and Swaziland*

BKS and Ninham Shand. Department of Water Affairs and Forestry RSA.(1998) Draft. *Water Demand Management. Orange River Development Project Replanning Study.*

7 THE MINING SECTOR.

Ben Groom

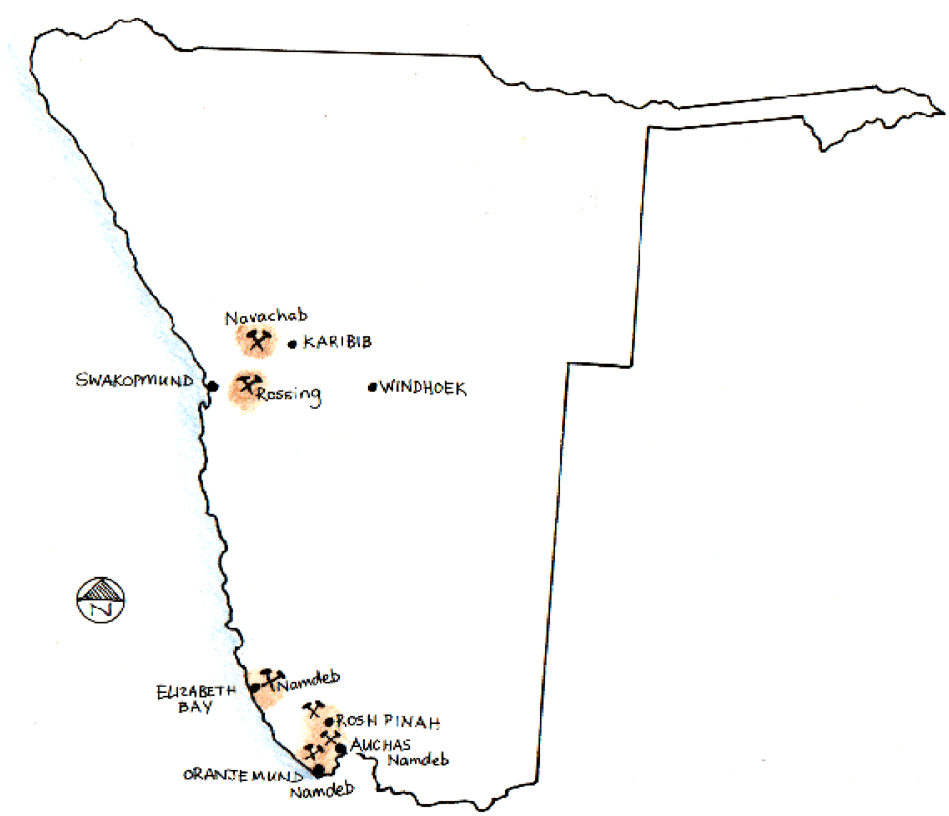
7.1. INTRODUCTION.

The mining sector is one of the most important economic sectors in Namibia. As a whole the mining sector's contribution to GDP fluctuates. In 1990 mining contributed 19.3% to GDP whilst in 1993 it was at a low of 11.2%. More recently, in 1996 the contribution climbed to 15.1 % of GDP. Namibia relies heavily on the mining sector for foreign exchange with around 50% of annual export earnings being made up of mining exports and almost 2/3 of this being made up of diamond exports.

As for water usage, the mining sector as a whole-consumed 7% of the total water consumed in Namibia in 1995[1]. The output per cubic metre of water input for the mining sector as a whole was N$86.60 whilst the value added per cubic metre was N$65.60 in 1993 and 1997 respectively. This compares favourably to other sectors. (See section 3.1.2) These factors make mining a high value and important user of water and hence worthy of investigation.

The location of the mines that were surveyed are shown in F**igure 7.1.**

Figure 7.1 Map of Mines Surveyed



[1] This figure will have been reduced recently as a result of TCL mines in Tsumeb closing down.

7.2. METHODS.

A questionnaire was designed for the industrial and mining sector and during the course of the field trips they were distributed to the mining industry. The technical nature of the questionnaires lent itself better to the mining industry than to the other industries. This we attribute to the general level of expertise in the mining sector, and the important role that water plays in the mining processes. The questionnaire contained questions relating to water supply, water demand, water quantity and quality and the costs incurred by the individual mines. Although the responses were clear on the whole, and the mines disclosed high quality information with respect to water management practices, certain areas of the questionnaire remained unanswered in general, e.g. the breakdown of costs.

7.3. RESULTS.

Table 7.1 Consumption Levels for Mining Sector[2].

Industry	Product	Water Supply	Annual Consumption Mm^3/a (1997/8)
Navachab Gold Mine	Gold	NamWater	2.39
Namdeb Auchas Mine	Diamonds	Water Affairs	1.00
Namdeb Elizabeth Bay	Diamonds	NamWater	0.01
Namdeb Oranjemund[3]	Diamonds	Borehole	6.85
Rössing	Uranium	NamWater	2.54
Rosh Pinah	Tin	NamWater	1.36

The results shall be summarised by particular mine and a comparison shall be made where possible. **Table 7.1** shows the mines that have been addressed. It can be seen that the level of water consumption associated with the mines is quite high. To put these levels in perspective, taken together, the mines in **Table 7.1** consume around $15Mm^3/a$, whilst Windhoek consumes approximately $17Mm^3/a$

The water consumption of the mines that have not been studied with respect to their water demand management practices, are shown in **Table 7.2.**

[2] There are other mines in operation in Namibia but they have not been subject to a questionnaire. These are the main consumers.
[3] This is for the Town of Oranjemund itself.

Table 7.2. Water Consumption by Smaller Mines in Namibia[4]

Mine	Estimated consumption Mm^3/a
Namib Diamond Exploration	0.11
Leotemp Namibia (pty) ltd	0.002
Otjihase	0.08
Diaz Point Exploration	0.0007
Karibib Mining and Construction	0.04
Brazil Benguela (pty) ltd	0.09
Ocean Diamond Mining	0.003
Okorusu Flourspar	0.37
Tanatalite Valley Minerals (Pty) ltd	0.24
TOTAL	**0.94**

7.3.1 Namdeb Diamond Mines.

The diamond mining industry contributed 7% of GDP in 1993 and consistently makes up between 30 and 40% of Namibia's export earnings. As such it is an economically important industry. Namdeb controls three mines in the Southern region of Namibia. In Oranjemund the coastal diamond mines operate. Along the Orange River itself there is the Auchas Diamond Mine which has a semi-permanent and a mobile operation. Elizabeth Bay Mine operates at the coast just south of Luderitz. Each mine has a slightly different situation with respect to water supply for industrial and domestic uses.

7.3.1.1 Namdeb Oranjemund.

The figure in **Table 7.1** for Namdeb Oranjemund shows the amount of water consumed by the town of Oranjemund as a whole. The industrial processes that this venture undertakes use only seawater and as such freshwater is not directly used therein. In many ways this production technique represents a good water demand management practice since the opportunity costs of the seawater are likely to be small[5]. If we imagine the volume of freshwater that may be necessary to undertake these processes without seawater being available this technique makes freshwater savings. Furthermore Namdeb as a whole is party to the ISO 14001 standard environmental management system which helps to ensure both government and shareholders that a certain level of environmental integrity is maintained.

[4] Source: Water Demand of Namibia. Unpublished Report from Planning Division, Department of Water Affairs.
[5] It is likely that these processes are not entirely environmentally benign.

However, Namdeb provides water to the citizens of Oranjemund at no charge. Water is paid for through the general taxation in the town and as such the marginal costs of water usage to the residents are zero. This leads to the huge figure of water consumption given in **Table 7.1**, and an average over the past 7 years of $6Mm^3/a$. This is comparable to other mines, such as Rosh Pinah and Navachab, however this consumption of water is only for the residents of Oranjemund. Putting this in perspective, this level of consumption is equivalent to approximately 16 000 litres per household per day. In Windhoek we find that the consumption averages about 200 litres per person per day for middle/high income households (average per capita consumption is 130 l/c/day). If the average household has 6 persons then this leads to a consumption of 1200 litres per household per day, 13 times less[6]. This is quite evidently a result of the free availability of water designed to be a perk to those who work at Namdeb. This tarnishes the good practices used in the processing side of Namdeb somewhat.

It is interesting to note that there are concerns in Oranjemund that the water supply could be running out. The boreholes used to supply Oranjemund are vulnerable to salt water intrusion due to their proximity to the coast and the inflow of salt water back up the Orange River. It is likely that a reduction in the pumping rate of the borehole will help to combat the salt-water intrusion, adding further weight to the need for, and the potential benefits of Water Demand Management in Oranjemund. Similarly there is a belief that the borehole will not recharge in the future as much as in the past due to the lower flows of the Orange River over the past few years. This lower flow has been attributed to the infrastructure along the Orange River upstream in RSA and Lesotho.

Given this situation some fairly bad management practices were noticed by the researchers in Oranjemund. For example many of the lawns were being watered throughout the day. Even during what must be the regular fog events in Oranjemund the water sprays were operating whilst the trees were dripping with condensed fog. By far the worst management practice with respect to water in Oranjemund is the free supply of water to a population who could in general easily afford to pay.

Table 7.3. Reuse of Water in Oranjemund for Irrigation.

Water Source	**1995** m^3	**1996** m^3	**1997** m^3	**1998** m^3
Reclaimed	645 000	573 000	512 000	516 000
Borehole	5 060 000	5 850 000	5 280 000	6 330 000
Reclaimed %	12.75%	9.79%	9.70%	8.15%

[6] This number of people per household could be an overestimation.

In conclusion, the situation in Oranjemund is slowly changing. We have been informed that the town is soon to be proclaimed and a feasibility study carried out to ascertain the viability of the town run as a municipality. This will eventually mean that tariffs for water consumption will be set, hopefully volumetric tariffs. At present there is a wastewater treatment facility in Oranjemund that treats approximately 10% of the total volume extracted from the boreholes (see **Table 7.3**.). This water is used for the golf course and a row of palm trees along the outskirts of the town.

Lastly, the borehole used by Oranjemund requires no permit for extraction from the Orange River. This is because any borehole further than 100 metres from the main flow of the river is exempt from requiring a permit.

7.3.1.2 Namdeb Elizabeth Bay.

This mine was not specifically visited, however a questionnaire was completed and an analysis of the Water Demand Management practices has been made.

The mine uses similar industrial practices as Namdeb Oranjemund. Seawater is used in vast quantities, estimated at 8.3Mm^3/a. Potable water, supplied by NamWater at a price of N$11.00/m^3, is only used for human consumption. The estimated consumption at Elizabeth Bay is 6000m^3/a. This quantity cannot be put in relative context, but it can be seen that the use of seawater, despite being a quirk of the geographical location of the mine, saves the provision of a vast amount of water for industrial processes. As such the output per unit of freshwater used is extremely high. As a rough estimate it is possible to use turnover/quantity of water. In this case this works out to be over N$3500/m^3 of freshwater, likely to represent a very high value use of water.

7.3.1.3 Namdeb Auchas Mine.

Auchas Mine is a relatively new diamond mining development on the Orange River. In fact the mine itself is in the bed of the former flow of the Orange River[7]. At present Auchas Mine operates in an almost unique way with respect to obtaining its water supply. The current water extraction permit has been acquired from the Department of Water Affairs (**DWA**), as is normal for extraction from a border river. What is unusual is that Auchas Mine pays a volumetric fee of 1.5c/m^3, which is supposed to be paid to DWA. Furthermore the mine itself is responsible for the metering of its own water usage. This low price and self metering have not been noted elsewhere and theoretically could lead to incentive problems.

[7] Former means millions of years.

The average total consumption is recorded as 1.1Mm^3/a over the past 5 years[8]. The breakdown of uses of this water is as shown in **Table 7.4.** There are between 130 and 140 workers at Auchas, and water is supplied to them from the Orange River. This implies that a per capita consumption of between 0.6 and 0.63m^3 per day. This is quite large compared to Windhoek, but since 95% of water usage occurs in production, perhaps this is not the most important factor.

Table 7.4. Breakdown of water usage at Auchas Mine.

Production	Administration	Hostel	Workshops
95%	0.5%	3%	1.5%

In terms of water usage strategies Auchas Mine has some interesting facets. There are two mining processes associated with Auchas, the mining of the old riverbed and the mobile mining unit. In the former, water is taken from the Orange River in compliance with the permit conditions. However, large amounts of the water used is reclaimed and used again. **Table 7.5.** gives precise figures. Care is taken to avoid spillage's of water on site since such spillage's can result in a dangerous working environment. Furthermore, attempts have been made to reduce the evaporation in the slimes dam, from which the water reclaimed, through the use of plants therein.

Table 7.5. Recycling of Water at Auchas Mine.

Water Source	1993 m^3	1994 m^3	1995 m^3	1996 m^3	1997 m^3	1998 m^3
Orange River	766 978	754 880	892 906	1 337 778	1 103 476	1 760 000
Reclaimed	382 989	322 940	196453	668 889	591 738	630 000
Reclaimed %	49.93%	42.78%	22.00%	50.00%	53.62%	35.80%

The mobile mining unit is a self-contained factory. The technology involved, including self contained sand filters, allows the recycling of water within the unit such that a relatively small amount of water is used per metric ton of material processed. The figures we have indicate that an average of 0.45m^3/ton is used. This compares to a level of 1m^3/ton in the riverbed operation.

Auchas has some reasonable examples of water demand management strategies, instigated for a variety of reasons including safety considerations, the need for

[8] More than the permit of June 1998 allowance of 414 720m^3 for 6 months, or 829 440m^3 per year.

mobility etc. The cost of water is probably not a consideration in the motivation behind water management. The tariff of 1.5c/m3 is relatively low, and the costs of water registers approximately N$16 500 per annum, small by most standards.

7.3.2 Navachab Mine.

Navachab Gold Mine consumes on average 1.0Mm^3/a. In 1998 consumption was 1.1Mm^3. A further 54000m^3/a is extracted from boreholes. Approximately 60% of the water used is reclaimed from the slimes dam and reused in the industrial processes and for the control of dust on site. On average for the year 1998 43% of the water that was disposed of in the slimes dam was reclaimed, this equates to 38.6% of all water consumed. **Table 7.6** shows the level of water reclamation and consumption over the past 5 years.

Table 7.6. Water Reclamation at Navachab Gold Mine.

Water Source	1994 m^3	1995 m^3	1996 m^3	1997 m^3	1998 m^3
NamWater	955 556	956 818	1 096 684	863 063	1 194 668
Borehole*	54 000	54 000	54 000	54 000	54 000
Sub-Total	1 009 556	1 010 818	1 150 684	917 063	1 248 667
Reclamation **	583 651	584 380	634 022	530 178	784 884
TOTAL	1 593 207	1 595 199	1 697 417	1 447 241	2 033 551
Reclamation %	35.5%	35.5%	35.5%	38.6%	38.6%

*Estimates based on the 1998 extraction.

**Estimates based on the % of reclaimed water in 1997.

Navachab Gold Mine shows some good water demand management practices. The quantities of water used are monitored carefully such that detailed knowledge of how much water is used in each process can be obtained. The accuracy of the monitoring is such that the unaccounted for water, i.e. the difference between the calculated water consumption and actual NamWater consumption is as little as 2.3% on average for 1998[9]. This is important in so much as the most water intensive activity is of course the production side of the operation as shown by Table 4.4.7. and high standards in monitoring are a prerequisite to good water management. Furthermore, recycling practices mean that the water supplied by NamWater is much less than it

[9] More than this % is lost in the slimes dam of course. In fact 57% of water in the slimes dam is lost to evaporation, the point is that these losses are monitored and "accounted for".

need be, and with water costs at present making up 1.6% of total costs it can be seen that recycling 38% the water from the slimes dam presumably saves around 0.6% of total costs[10].

Table7.7. Navachab Water Use.

Process Water	Administration	Geology	Other
90.25%	0.32%	1.23%	8.20%

In conclusion it is difficult to put the levels of water consumption in context with other mines since we do not know the level of output. However, we do know the specific water consumption per ton milled. For the year 1997/8 in plant specific consumption was 0.745m^3/ton whilst the mine as a whole used 0.852m^3/ton of ore mined, from which comparisons can be made to other mines.

7.3.3 Rosh Pinah

Rosh Pinah mine is supplied with water from the Orange River through NamWater infrastructure at a rate of 1.2Mm^3/a, on average. This figure refers to water consumed by the industrial processes, mining and beneficiation, and the town of Rosh Pinah itself, i.e. residential usage. The breakdown between these uses is estimated as shown in Table 7.8.

Table 7.8. Breakdown of Water Usage at Rosh Pinah Mine[11].

Water Use	Mining	Town	Beneficiation	Total
m^3/a	255 500	657 000	730 000	**1 642 500**
% of total	15.56%	40.00%	44.44%	

Rosh Pinah town consists of 150 houses, all of which are owned by the mine. Although active since 1971, only this year have meters been introduced to the town to measure water consumption. In 1997/98 the town consumed 657 000m^3 of water. This works out at 12m^3 per household per day. It can be seen that this is an astronomical amount of water compared to Windhoek which, given an average household size of 6, consumes about 1.2m^3 day per household. This level of consumption is in part due to the fact that water is supplied for free to those who live in Rosh Pinah. At the time of our visit plans were afoot for the residents to start paying for their water, coinciding with the plans for meters to be installed in the

[10] 38% of 1.6%. This is a very rough estimate.
[11] This information has only been available for the past year. Previously this breakdown could not have been measured because of the lack of meters.

town. It was also discovered that the high level of consumption was the also result of old and damaged infrastructure within the reticulation system. These will gradually be replaced. Furthermore the town is soon to be proclaimed, leading perhaps to more control over the water supply through increased municipal management.

Water from the mining processes mostly enters the slimes dam. Unlike Navachab and Auchas Mines, none of this water is reclaimed. However, water that emerges from underground is pumped out of the mine and used for drilling purposes. Similarly, varying the amounts of thickener used in the extraction process can have effects on the amount of water required. It is not clear how much water these processes could save.

At present Rosh Pinah pays N$1.70/m^3, 17c/m^3 less than the NamWater full cost recovery price as quoted by NamWater. It has been stated that price is one of the factors that the mine company will consider in its decisions on water management. If prices go up considerably then more could be done within the mine and the town to conserve water. This suggests considerable scope for further water demand management practices based on economic considerations. It would be useful to monitor the change in water consumption by the residents of Rosh Pinah as a result of the introduction of metering and volumetric charging.

7.3.4 Rössing Uranium Mine.

Rössing Mine is supplied with water by a variety of sources. Freshwater is supplied by NamWater, whilst additional water used for mining purposes is extracted from the Khan River and further supplies come from the recycling of water.

The water from the Khan River is brackish and as such is not suitable for human consumption without treatment. The recycled water comes from the tailings dam as a result of redirecting the seepage via cut-off trenches and dewatering wells. Further water losses have been curtailed through addressing the vast evaporation that occurs in the tailings dam. Through reducing the wetted surface area of the tailings dam by 20%, whilst reducing the size of the main ponds, the evaporation losses from the tailings dam have been reduced. It is unclear how this reduction in evaporation can reduce the amount of freshwater or brackish water demanded by the mine itself, unless the level of recycled water from the seepage diversions is increased as a result. However, water required to maintain the rotation of the tailings dam, flushing of pipelines and the like, has been reduced by keeping the tailings slurry at the highest possible density.

Since 1977 the amount of freshwater used by Rössing Mine had reduced dramatically from 26000m^3/day (9.5Mm^3/a) to 7500m^3/day (2.7Mm^3/a) in 1997. However, the total amount of water used by Rössing has returned to 1977 levels, the remainder being largely made up by the use of recycled water. This comparison is made in Table 7.9.

Table 7.9. Breakdown of Water Sources at Rössing Mine*.

Source	**1977 (Mm^3/a)**	**1977 (%)**	**1997 (Mm^3/a)**	**1997 (%)**
NamWater	9.5	100	2.6	27.66%
Recycled	0	0	6.5	69.15%
Brackish	0	0	0.3	3.19%
TOTAL	9.5		9.4	

**These figures are based on information contained a booklet called "the Story of Water at Rössing Uranium Mine". These are estimates based on a graph therein.*

Furthermore if we look at the specific consumption of water, i.e. the amount of water used per ton of material milled, these levels have more or less stayed the same over the same time period, at around $0.9m^3$/ ton. This indicates that although the sources of water have changed at Rössing Mine, in essence moving away from NamWater supplied bulk water to recycling and brackish Khan River water, the efficiency of the water use has not changed at all[12]. Whether or not this is a good water demand management practice depends on the economic costs of the water sources and the benefits of freshwater conservation.

It is evident that Rössing Mine finds the new water management strategy less costly than obtaining all its water from NamWater. A brief financial cost benefit analysis by Rössing themselves shows that the benefits outweigh the costs by approximately N$67m (1994) and as such, there are obvious incentives for them to undertake these measures.

The water supplied to Rössing from NamWater comes from alternative groundwater sources on the Kuiseb and Omaruru Rivers. These aquifers also supply Swakopmund and Walvis Bay at present and as such intuition tells us that diverting water away from these urban centres is likely to have a higher opportunity cost than using recycled water or water from the Khan River at Rössing. However, the environmental role of the brackish water is still an issue that is being addressed through continual monitoring of the Khan river vegetation for signs of adverse impacts as a result of dewatering.

[12] Recycling of water makes up only a small percentage of the total water usage.

7.4 USEFULNESS OF WATER DEMAND MANAGEMENT DURING DROUGHT.

Rössing Mine is a good example of sound WDM practises. They have a WDM programme to monitor the water consumption on a ongoing basis. Most of the mines take decisions based on sound economics. If the price of water increase during periods of drought it was experienced that mines did not have to cut back on production but they are able to keep production rates through higher water efficiency and water reclamation.

During the 1996 drought the Nawachab Mine applied for a larger water quota which was only partially approved. Production was increased through higher efficiency in water use and improved reuse techniques. Water savings in Windhoek was well above expectations and being supplied from the same bulk supply sources it was not necessary to cut back on production at the mine.

One of the most important drivers for higher efficiency at mines is related to the cost of water. The use of WDM measures on a continues basis with further emphasis during periods of drought and long term water shortages has proven to be successful at some mines in Namibia.

7.5 CONCLUSIONS.

On the whole we have found that the mining industry is fairly diligent when it comes to the management of water for industrial purposes. This diligence arises for a number of reasons including:

- The large amount of water used by the individual mines.
- The proportion of costs that freshwater supply makes up.
- The need for precise inputs of water in the mining processes
- The proximity of certain mines to alternative inputs like seawater.
- The proven financial benefits of alternatives like recycling.

It has become viable for some mines to take unilateral action to save water. Examples include Rössing and Navachab Mines, both of which are fairly large and sophisticated and can seemingly exploit economies of scale in water saving techniques such as large scale recycling. Mines it seems are confronted by economies of scale when it comes to water saving strategies due to the sheer amount of water they use[13].

[13] It should be recognised that the water costs to mines are also very often only a small percentage of costs. Their absolute value is high however, and the net benefits from WDM are also high in an absolute sense.

However, it is clear from the data that there are considerable savings possible in many of the mines addressed. Obvious examples include Oranjemund and Rosh Pinah Mines where, although certain water management practices are undertaken in the mining processes themselves, the practices undertaken in the towns associated with the mine leave something to be desired. Indeed if the household consumption in Oranjemund and Rosh Pinah were reduced to the levels attained on average in Windhoek, approximately one tenth of the water could be used. This would mean savings in the order of $6Mm^3/a$, and $0.6Mm^3/a$ for Oranjemund and Rosh Pinah respectively. Considering that both obtain their water from the Orange River this quantity of water represents a significant proportion of the $40\text{-}50Mm^3/a$ proposed by Namibia as entitlement from the Orange River.

For a thorough investigation into the mining industry and its water use, it is recommended that attention should be paid to the existence of economies of scale in WDM techniques. Similarly the reaction of the mining industry to price changes may also be a useful avenue to pursue as a means of determining the future levels of demand and as a means of estimating the value of water in this particular use. This information could be an invaluable planning tool for the water supply agency and for water policy itself.

Information on the specific water intake for the different type of mining operations will also be useful even on a regional basis.

8. TOURISM SECTOR WATER DEMAND MANAGEMENT STUDY.

Ricky Pieters and Ben Groom.

8.1. INTRODUCTION.

Tourism is one of the fastest growing industries in Namibia with the greatest potential for future growth. Thirteen per cent of the country is set aside for tourism (mostly in arid and semi-arid areas) and yet further potential exists in the communal areas. The tourist industry in Namibia is mainly wildlife and wilderness based and as such the quality of the tourists experience is strongly related to the quality of the environment and the quantity of other tourists. The ecosystems that Namibia sustains are very sensitive to overuse, making the carrying capacity of the land a crucial limiting factor and a guide to sustainable land use. These factors have combined to make the main thrust of the tourism development strategy (The Tourism Development Plan of 1992, and the White Paper on Tourism approved by cabinet in March 1994) to attract fewer, but higher paying tourists. In this way the tourist industry is able to extract the highest value from the assets tourists come to see, whilst maintaining sustainable use patterns.

The contribution of Tourism to the GDP of Namibia is significant. In 1996 hotels and restaurants contributed 1.6% of GDP, whilst this does not reflect the full contribution of Tourism to the country, it reflects the importance of this sector for the economy. Between 1993 and 1996 the visitor arrivals grew at a steady 21.85% which stabilized to 9% since 1996, giving an average of 15% since 1993, with most coming from the Republic of South Africa.

8.1.1 Tourism and Water use.

The limiting factors to the sustainable growth of the tourism industry are largely environmental. These factors include degradation of the wilderness, effects on the wildlife and the availability of water. This will have a regional context, Kaokoland being more prone to drought then Caprivi.

Water use for Tourism has not been researched in great depth. However, estimates of water usage based on the government owned tourist facilities have been made. These calculations suggest that the tourist industry uses 0.5% of the total water used in 1993. This figure is surely higher once the tourist resorts along the Okavango River and the Private lodges in Caprivi and the rest of Namibia, which were previously excluded are included. The Planning Division of the Department of Water affairs estimated the tourist water demand to be in the order of $0.9Mm^3/a$, based on numbers of tourists, a daily per capita use of $0.15m^3/day$, and an average stay of 15.4 days. This figure could be an under estimate. The value added per m^3 of water has been estimated to be N\$258/m^3. This is one of the higher value uses of water in Namibia.

Since most of the tourist centres either use groundwater through private boreholes and pumps, or water from perennial rivers, it is likely that many parts of the tourist sector are not paying the full price of water. Also, water use in the tourism sector is in competition with water use in the other sectors as well as the environment (opportunity costs). Similarly, since the users of tourist resorts do not themselves pay volumetrically for water, they do not necessarily have an incentive to save water. As result of these observations it was felt necessary to pilot a questionnaire investigating water usage at tourist resorts and the extent of Water Demand Management in the tourism sector.

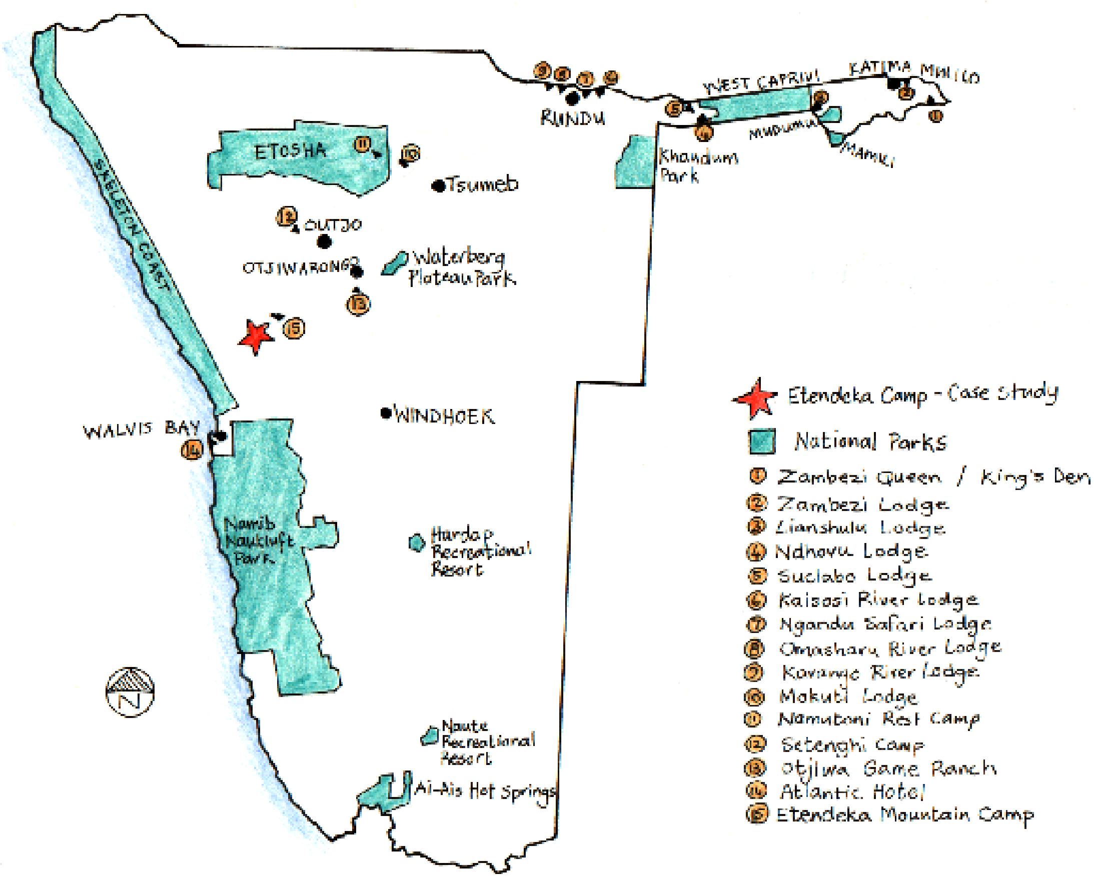
8.2 METHOD.

The study endeavored to collect information from a variety of different tourist resorts ranging from government resorts, to private lodges. Questions included water usage, Water Demand Management strategies, tourist numbers, revenues and costs and environmental impacts, (see questionnaire attached). The questionnaire was aimed to find out:

- Tourist water consumption per capita, or per visit.
- Average daily water usage (including the pools and the gardens etc).
- Amount of water used in different ways.
- Water Demand Management practices.
- Water supply and quality problems.

Water Demand Management study of the Tourism sector was only incorporated in the later stages of the study, and as such only limited tourist facilities were visited during the study period. However, questionnaires were distributed to most tourist centres affiliated to the *Hospitality Association of Namibia (HAN)* and *Namibia Resorts International*, and a more detailed analysis can be done once all responses are received. During the study, fifteen questionnaire returns were received. The responses received were often incomplete or contained insufficient data and therefore no proper statistical analyses could be done.
The tourist facilities that were surveyed are indicated on the map in **Figure 8.1.**

Figure 8.1 Map of Tourist Facilities Surveyed



8.3 RESULTS.

Most responses received were from lodges or resorts located in areas with a relatively higher rainfall and/or situated next to perennial rivers in the Kavango and Caprivi regions. The following resorts responded to the questionnaire, but as can be seen only nine provided information on water consumption.

Table 8. 1 Water Supply and Consumption Tourist Centres

Region	Tourist Centre	Water Supply	Annual Consumption m^3/a
Okavango River	Kavango River Lodge	Municipality	2000
	Omashare River Lodge	Municipality	8888
	Ngandu Safari Lodge	Municipality	NA
	Kaisosi River Lodge	Okavango River	NA
	Suclabo Lodge	Okavango River	3650
	Ndhovu Safari Lodge	Okavango River	5475
Eastern Caprivi	Lianshulu Lodge	Kwando River	NA
	Zambezi Queen/King's Den	Chobe River	NA
	Zambezi Lodge (lawn)	Zambezi River[1]	100000
North-central	Namutoni Resort	NamWater (boreholes)	196662
	Mokuti Lodge	Boreholes	131127 (9 months)
	Camp Setenghi	Boreholes	244 (4 months)
	Otjiwa Game Ranch	Boreholes	NA
	Etendeka Mountain Camp	Boreholes	120
Coast	Atlantic Hotel	Municipality	NA

8.3.1 Okavango River

The lodges along the Okavango River are mainly stop-over points for tourists on route to Victoria Falls (Zimbabwe) or Etosha National Park and the rest of Namibia. The activities offered mainly include canoe and fishing trips, sunset cruises and bird watching.

Kavango River Lodge is situated in Rundu on the banks of the Okavango River, overlooking southern Angola and the surrounding floodplains. Accommodation consists of chalets and only showers are available. There is no swimming pool at the lodge and the lawn covers 500 m^2.

Omashare River Lodge is also situated in Rundu. The lawn covers about 6000 m^2 and is irrigated with sprinklers while the swimming pool has the capacity of 50 m^3. There are no pool covers and the pool is filled up once in two weeks. Dishes are washed by hand whereas washing machines are used for linen. Flow restrictors are installed on showers. Most of the water use, from municipal supply, is by the customers.

[1] Figure for lawn water use

Ngandu Safari Lodge is situated in Rundu. Accommodation is offered in budget or luxury rooms. The lawn is about 1500 m^2 and the swimming pool has the capacity of 20 m^3. The swimming pool is not covered and is topped up weekly. Dishes are washed by hand while linen is done by washing machines. Most water use is for watering the garden, which is about 10 m^3 per day. Water costs accounts for 2.5% of the total costs incurred at the lodge.

Kaisosi River Lodge is situated about 7 km east of Rundu, in the Vungu-Vungu area, on the banks of the Okavango River. Accommodation is in standard or luxury thatched chalets all with en suite bathrooms as well as a camping site. There is a large and a luxurious swimming pool that is topped up weekly. Most water use at the lodge is for the garden.

Suclabo Lodge is situated near Bagani downstream of Popa Falls, on the western bank of the Okavango River overlooking the Caprivi Game Park. The lawn covers about 150 m^2 while the swimming pool has the capacity of 32 m^3. The swimming pool is not covered when not in use and is re-filled once a year. All washing is done manually at the lodge. Most of the water is used for watering the plants and lawn. The water costs, pumping and capital costs, only account for 1% of the total costs incurred at the lodge.

Ndhovu Safari Lodge is situated 20 km south of Bagani Bridge, on the western bank of the Okavango River, overlooking the Caprivi Game Park. Accommodation is offered in luxury tents and chalets each with own en suite bathroom facilities. The lawn covers about 6 ha and the swimming has the capacity of 30 m^3. The swimming pool is not covered when not in use and is topped up once a week. All washing at the lodge is done manually. The average water consumption is 10-15 m^3 per day, most of which is used by customers, kitchen and for the garden.

8.3.2 Eastern Caprivi

Lianshulu Lodge is situated in the Mudumu National Park, on the bank of Kwando River. The lawn covers about 1 ha and the swimming has the capacity of 25 m^3. The pool is not covered when not in use and is topped up every third day, more in summer. Dishes are washed by hand whilst washing machines are used for laundry. Most water use is for irrigating the lawn. A new lodge, *"Lianshulu Bush Lodge"*, with reed chalets and en suite bathrooms had been opened recently 2 km south of Lianshulu. Indigenous trees are used in the garden. The water costs, pumping and capital costs, accounts for 2% of the total costs incurred.

Zambezi Queen/King's Den is situated on the banks of Chobe River, overlooking Kasikili Island. Accommodation consists of luxury, en suite chalets with over-hanging balconies on the river and thatched bungalows at the *King's Den Lodge* plus rooms in the *Zambezi Queen* moored at the lodge. There is a large lawn and a swimming pool at the lodge.

Zambezi Lodge is situated in Katima Mulilo, on the banks of the Zambezi River, overlooking Zambia. The lodge is set in tropical gardens and surrounded by trees indigenous to the area. Facilities include a nine-hole golf course. The lawn covers about 5 ha and the swimming pool has the capacity of 9 m^3. The pool is not covered when not in use and is topped up twice a year. Most water is used for irrigating the golf course and lawn. The municipal water bill accounts for 3% of the total costs.

8.3.3 North Central Area

Namutoni Resort, owned by the government, is situated in the Etosha National Park. Game viewing is main activity offered. The irrigation system is not metered. There is a big lawn and a swimming pool at the resort.

Mokuti Lodge is situated on the farm, Klein Begin, near the Namutoni Gate and offer game viewing as the main activity. The lawn covers 2 ha and there are two swimming pools with capacities of 45 m^3 and 370 m^3. The swimming pool is covered when not in use and is topped up every second day. Industrial machines are used for dishwashing and laundry. Low-flow showerheads are installed and the guests have the option to re-use linen during their stay at the lodge.

Camp Setenghi is situated along the Kalkveld road, in Outjo area and is still a new establishment. There is no lawn at the camp, but aloes and other plants requiring less water are planted. The swimming pool is topped up once a month. All dishwashing and laundry is done manually, and only showers are offered. Grey-water, from basins and showers, flows into the bush and garden, and the backwash from the swimming pool is used to water plants. The water consumption is 2 m^3 per day, with the customers using the most.

Otjiwa Game Ranch is situated in Otjiwarongo area and is one of oldest established game farms in Namibia. Accommodation is provided in converted mobile homes and self-catering units located a few kilometers from the main camp. The lawn at the farm covers about 9600 m^2 and there is a swimming pool with the capacity of about 20 m^3. The swimming pool is not covered when not in use and is topped up once a week. Dishes are washed by hand while laundry is done with a washing machine. Most water is used for watering the garden. Linen is not changed daily if the guest stay for a longer period and the guest is informed about the importance of water in Namibia.

Etendeka Mountain Camp discussed in detail in the case study is a very good example of a camp situated on the fringes of the Namib desert where water resources are very scarce and precious. The camp shows that tourists are prepared to endure some hardship in respect of services to be able to experience the beauty of the desert in a responsible way. Integrated WDM was used in a successful way in the Etendeka Mountain Camp.

8.3.4 Discussion on River Lodge Water Consumption

Something that has been brought to light is the fact that the daily per capita usage by tourists may not be as little as has been assumed in, for example, the Planning Division Report of the Department of Water Affairs on water demand of 150l/c/day. **Table 8.2.** shows the levels of per capita usage calculated from the questionnaire responses.

Table 8.2. Calculation of Daily per Capita Water Usage.

Lodge Name	Daily Per Capita Usage. M^3/c/day
Suclabo Lodge	1.00
Omashare River Lodge	3.09
Ngandu Safari Lodge	0.08
Zambezi Lodge	6.21
Ndhovu Safari Lodge	1.09
Namutoni Resort	1.91
Lianshulu Lodge	0.38

The average daily per capita water consumption as calculated from this sample is of the order of 1.25m^3/c/day. The sample is not representative because of high water consumption of the river lodges that use water for aesthetic purposes.

8.4 USEFULNESS OF WATER DEMAND MANAGEMENT DURING DROUGHT

In urban areas the tourism sector is subject to the same measures as discussed in Chapter 4 on urban water consumption. They are also subject to block tariff and in some cases quotas may even be set. In Windhoek the larger tourism hotels are linked to the irrigation water system for watering of gardens.

In other tourism camps outside municipal areas water are supplied by the owners of lodges. The reuse of water can be an important substitute for potable water for the irrigation of gardens. WDM measures implemented can play an important role in normal times and periods of drought. In Windhoek the co-operation of the Tourism sector, management and tourist alike gave excellent reductions in water use during the 1996 drought.

8.5 CONCLUSIONS AND RECOMMENDATIONS

The northeastern region of Namibia receives a relatively higher rainfall, average 650 mm, and all the lodges responses were received from are situated on the banks of the perennial rivers. Only the lodges situated in towns, *Kavango River Lodge, Omashare River Lodge, Ngandu Safari Lodge* in Rundu and *Zambezi Lodge* in Katima Mulilo are supplied by the municipalities and are charged for their water consumption at cost, although minimal when compared to Windhoek, for example. Lodges outside towns normally supply their own water infrastructure and pay their own operation and maintenance cost. Water forms such a small percentage of the operation cost of a lodge (less than 0.3% according to a survey in Windhoek) that there is no financial incentive for water conservation at the lodges sampled. Therefore, Water Demand Management in the form of awareness and technical measures is not a major concern for the lodges sampled. Most of the lodges and hotels do not wash towels everyday unless required by the client.

Water supply and quality problems are experienced in both Rundu and Katima Mulilo as a result of network problems and improper water treatment practices
The central area receives a higher rainfall compared to the rest of Namibia. Tourists' centres sampled in the central area use groundwater, which in some cases is metered, such as at Namutoni Resort and Mokuti Lodge. The tourists' centres in this area are more aware of the importance of water conservation and there is an interest shown towards water awareness. Some technical measures such as retrofits at Mokuti Lodge and water efficient gardens at Camp Setenghi are used. These cases, although limited, show that Water Demand Management can be implemented at tourist centres.

The only true example of integrated Water Demand Management was found to be operating successfully at Etendeka Mountain Camp.

During our stays at different hotels during the field trips to all the regions in Namibia, few Water Demand Management practices could be seen. Some hotels, a minority, only offer showers. It was obvious that there is little to no concern for efficient water use and facilities are aimed rather at customer satisfaction. This consumer satisfaction could be achieved however with lower water inputs.

The study has shown that further research is required to properly assess Water demand Management in the Tourism sector. It is clear from the discussion above that an integrated Water Demand Management approach has a potential and can be implemented in the north central areas of the country. It is important that further research be focussed within national parks, which are exclusively tourist centres and where some previous information is available, and on camps in the more arid areas where tourism offers a more sustainable form of income generation than conventional farming does.

BLANK PAGE BEFORE CHAPTER 10

10 CASE STUDY ON WATER DEMAND MANAGEMENT IN WINDHOEK

Ben van der Merwe

10.1 CASE STUDY METHODOLOGY

An integrated Water Demand Management policy was developed and approved by the City Council of Windhoek in July 1994. Implementation of the policy started in the second half of 1994.

The information collected for the development of the WDM policy, water demand projections made on the basis of unrestricted demand done in 1993 by Joint Venture Consultants were used to asses the success of the implementation. Detail Surveys on residential water consumption surveys that were done in 1985, 1995 (calendar years) and the 1997/98 Municipal Financial Year (July 1997 until June 1998), provided large amounts information to evaluate the success of WDM in Windhoek.

The financial benefit as a result of the implementation of the strategy was quantified. Losses on the Water Account as a result of lower water consumption during the 1996 drought were obtained from the Financial Statements of the City.

10.2 DESCRIPTION OF THE STUDY AREA AND WATER SUPPLY SCHEMES

10.2.1 Background Information on Windhoek

Windhoek, the capital of Namibia, is situated in the Central Highlands of Namibia, approximately 1 600m above mean sea level. The nearest perennial river, the Okavango, is 700km from the city on the north-eastern border of the country. The average annual rainfall is 360mm while the average evaporation is 3400 mm. The water to the City of Windhoek is supplied from three surface reservoirs in ephemeral rivers, groundwater and reclaimed water.

The estimated population for mid 1998 is approximately 213 000. According to the Residents Survey Report of 1995, the average population growth rate per annum of Windhoek was 5.44% over a period of 5 years from 1991 to 1995. The natural population growth rate in the city over the same period was only 1.52% per annum, which results in a net annual migration of 3.92% from rural areas to the City. An estimated 595 people moved to the City every month between 1991 and 1995 (TRP, 1996).

The residential areas in the City vary from high income areas with low densities and large gardens to high density lower income areas with small or no gardens. Several settlement areas were started to accommodate new settlers since 1990.

According to the Namibian Economic Research Unit (1996) the following scenario gives an indication of the importance of development in Windhoek in relation to the rest of the Country:

"*Windhoek being the legislative, administrative, judicial and financial headquarters, enjoys the highest economical growth of the country. With the attainment of independence in 1990, the dominance of Windhoek over other towns has been further manifested.*

Windhoek has 51 % of manufacturing, 96% of utilities, 56% of construction and trade, 94% of transport and communications, 82% of finances and business services and 68 % of community and social services in the country. The city produces 47 % of value added, and private consumption expenditure totalled 35% of the country. In contrast only 8% of production comes from the North where 60% of population resides and where 33% of private consumption expenditure takes place. Part of the difference between the location of private consumption expenditure and value added expenditure will arise from the fact that Government expenditure and investment are concentrated in Windhoek".

Over the past 5 years at least 66.6% of all the building activity in the country was concentrated in Windhoek. This causes a higher water demand on the existing water resources and places a heavy strain on the development of new water supplies and the extension of water reticulation infrastructure.

10.2.2 Water Sources Available to the City of Windhoek

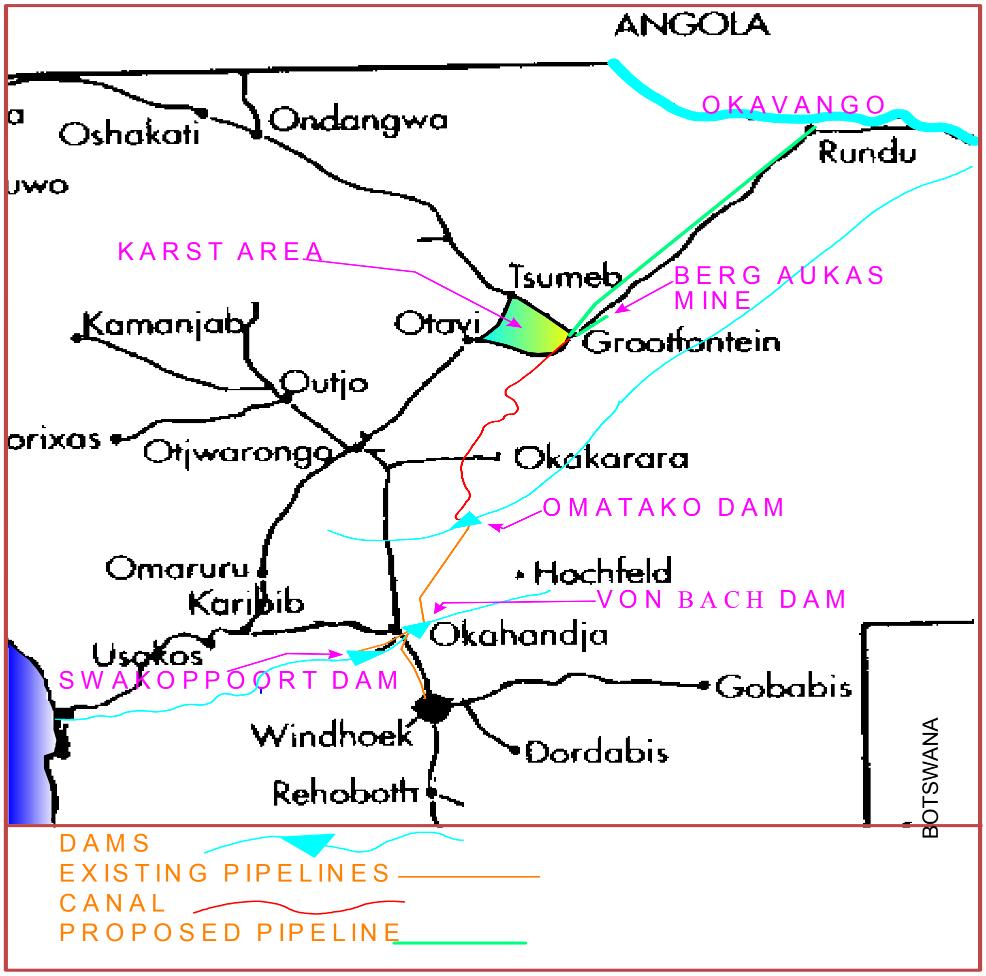
The first humans settled in Windhoek because of natural springs in the area. The water from the springs and shallow wells that were dug in the early years were not sufficient to provide water for the growing settlement. The first Municipal production borehole was acquired in 1912 from a private person. Until 1933 Municipal production boreholes were able to provide sufficient water to the town. There are 50 Municipal production boreholes in Windhoek with a safe yield of 2.3 Mm^3 per annum. Two small surface reservoirs (Avis and Goreangab dams) were constructed in rivers near the City in 1933 and 1959 respectively with a combined 95% assured safe yield of 1.2 Mm^3 per annum.

In 1968, the Goreangab Water Reclamation plant was built to reclaim water directly from domestic sewage effluent to augment the potable water supply to the City. The process as well as the capacity of the plant was upgraded and increased at various occasions over the past 30 years. The existing capacity of the plant is 2.9 Mm^3 per annum with a maximum capacity of 3.65 Mm^3 during drought situations.

Towards the end of 1960 the Government started to create bulk infrastructure in rivers further from Windhoek to provide water to the City. In 1998 the bulk water supply system was transferred to NamWater, a company which was established by the Central Government to provide bulk water to urban areas and other bulk consumers.

The map in **Figure 10.1** gives an indication of the bulk water infrastructure, which supply water to the central area of Namibia including Windhoek. Infrastructure like existing dams, canals and the pipeline to Berg Aukas Mine which is under construction as well as the proposed future link to the Okavango River are also indicated. Only systems that supply water to the City of Windhoek are indicated on the map.

Figure 10.1 The Eastern National Water Carrier and Infrastructure



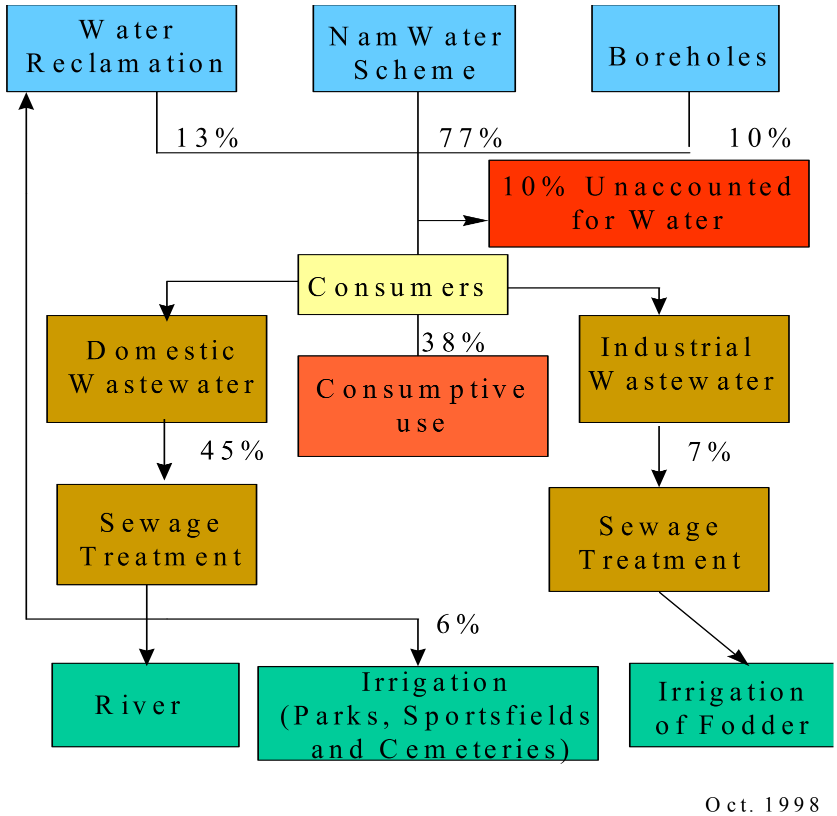
The Von Bach Dam was added in 1970. The Swakoppoort Dam was completed in 1977 while the Omatako Dam was completed in 1982. The safe yield based on 95% assurance supply of the three dams is 20- 25 Mm³. Of this volume 17 Mm³ is available for supply to Windhoek. The open canal for the transfer of groundwater from the Karst Area was completed in 1986. During the drought of 1996 it was decided to link the Berg Aukas Mine to the ENWC. The project was only finalised in 1998 with an assured safe yield of 2 Mm³ per annum and an emergency supply of 4 Mm³ per annum over a maximum period of 2 years. Groundwater in the Karst Area is regarded as an emergency back-up system and is not included as a water source to the central part of Namibia at this stage.

With normal inflow in the dams the supply capacity of the different sources is:

NamWater (three dam system only)	17 Mm³
Goreangab Reclamation Water Works	2.9 Mm³
Windhoek boreholes	2.3 Mm³

that give a total available supply of 22.2 Mm³ per annum based on 95% reliable supply from the dams. **Figure 10.2** gives an indication of the present production capacity of existing bulk water supply and local water resources in Windhoek.

Figure 10.2 Existing Bulk Water Supply Water Sources to Windhoek



Note: All percentages relate to the total water production capacity of 100%.

10.3 DRIVING FORCES FOR IMPLEMENTATION OF WATER DEMAND MANAGEMENT

The water production to Windhoek increased by 13.6% during 1990/91. This was related to high population growth and influx of people from rural areas in Windhoek in the first year after independence. It was recognised that the existing water sources would not be able to cope with such a high growth in water consumption. In 1992, a public campaign was launched to lower the water consumption. This situation was further complicated due to the security of water supply as result of low inflow in the 1991/92 rainy season (October 1991 to May 1992) in the dams that supply water to the city. The campaign realised savings of only 5%. In the second half of 1992, permanent rising block tariffs were introduced as a management tool to curb high water consumption and to control the high annual growth in water consumption. Water Demand Management principles were implemented in Windhoek on an ad hoc basis from 1992 to 1994

In the early 90's water consumption in Windhoek was inflated because water was not sold at a full cost recovery price i.e. the capital charges of bulk infrastructure was not reflected in the water tariff. Capital charges for bulk supply schemes was financed through income tax. An important function of the permanent block tariffs since 1992 was to determine the relationship between price and water consumption. This will prevent major capital investment on bulk supply schemes which may run into financial problems when the water consumption drops as a result of increased water prices. This is especially important if all capital cost of schemes will be recovered from new bulk supply schemes (Van der Merwe, 1994). Opportunity cost and environmental cost are also not taken into account to determine bulk supply cost according to existing pricing policies.

The removal of excess consumption through the rising block tariffs and more efficient use of water in all sectors was an important driving force. It was recognised that it will have a major influence on the size as well as the timing of any further bulk water augmentation scheme.

Considering the high population growth rate, the importance of Windhoek as an economic growth centre, the high capital investment needed to make more water available to the Central Area and environmental aspects; WDM is the only viable option to use existing resources more efficiently. Most of the growth in Namibia is concentrated in the Central Area and all the easily accessible water sources are already developed.

During a workshop on the Central Area Water Master Plan held in Windhoek in November 1993, WDM and water tariffs were identified as a first priority to 'buy time' for planning and construction of further bulk water infrastructure. (Joint Venture Consultants, 1993).

An integrated Water Demand Management policy for Windhoek was developed during the first half of 1994 and approved by the City Council. Implementation of the policy started in the second half of 1994. Since then the policy was further refined and more attention was given to an implementation strategy.

There is a political will and commitment by the Windhoek City Council to the successful implementation of an integrated WDM policy. According to the targets set for the Water Sector in the National Development Plan 1, access to potable water in urban areas should be maintained at above 95 %. If the increase in bulk water supply to urban areas should be restricted to 3 % per annum, then in spite of other factors such as urbanisation, the implementation of an integrated WDM policy is the only option.

Further extension of the ENWC to the Okavango River will be subject to the approval of other basin states i.e. Botswana and Angola. The Okavango River provides water to the internationally known Okavango Delta in Botswana. It may take years for the completion of the required environmental impact studies and to reach an internationally acceptable agreement on water abstraction to supply the Central Area of Namibia.

10.4 SUMMARY OF THE INTEGRATED WATER DEMAND MANAGEMENT POLICY IN WINDHOEK

In July 1994 an integrated WDM policy was approved by the City Council. It was planned to implement the policy over a period of 5 years. The prevailing drought in 1996 did not permit the gradual implementation of the WDM policy and a large percentage of the inhabitants of the City associate the implementation of WDM with the restrictions for water conservation that were implemented in response to prevailing drought conditions.

WDM involves the adoption of policies and investments by the Water Supply Authority to influence the demand for water. There is a wide range of demand management measures that were classified in Windhoek as **policy issues, legislation, technical issues** and **public education and awareness**. None of these measures should be seen in isolation because the success of the implementation of the measure may be linked to other measures that form part of the WDM policy.

10.4.1 Policy Matters

The policies that were approved and implemented in Windhoek are summarised in **Table 10.1.** Results of the implementation of the different policies are also briefly summarised.

Table 10.1 Summary of Policies Approved and Implemented in Windhoek

Policy Issue	Result of the Implementation
#Block tariff system	• A permanent block tariff system, to reflect the real cost of water and to curb excessive water use, was implemented. This has proved successful in changing water use habits.
# Maximum reuse of water	• 1,1 Mm^3 semi-purified effluent per annum for irrigation has replaced potable water previously used for irrigation in Windhoek. • 3,65 Mm^3 per annum of potable water can be reclaimed at the Goreangab Water Reclamation Plant. This plant will be upgraded to produce 7,5 million m^3 per annum from the year 2000. • Grey water is reused on private premises in Windhoek. A local brewery in Windhoek, Namibian Breweries reuse up to 200 m^3 of water per week.
# Plot sizes and higher densities in all existing developed areas	• Residential plot sizes in new development in Windhoek are reduced. • Higher densities (two houses per residential plot) are allowed in existing urban areas. • In older parts of the city rezoning to business and town houses are allowed
# Urbanisation	• Guidelines were developed for the handling of urbanisation.
# Reduction of Municipal water use	• Consumption of water on municipal gardens has been reduced by up to 50%.
# Wet industries	• Guidelines are given to wet industries on a continuous basis for the efficient use of water • New wet industries planned for Windhoek will have to reuse water.

10.4.2 Public Campaign

Without public participation, any strategy on WDM is bound to fail. Strong emphasis was placed on the points as summarised in **Table 10.2**

Table 10.2 Summary of Public Participation and the Public Campaign

Programme	Method of Implementation
# Education programs	• Lectures in schools and other institutions of learning on the subject of water management. • Radio and television appearances. • Advertisements in the printed media. • Pamphlets on saving water in and outside houses was compiled and distributed with accounts.
# Consumer advisory service	• Advice on all water related issues including reduction of water losses and pressure reduction. • Information on how to detect water leaks on premises is supplied.
# Advice on water efficient gardening methods	• Advice on suitable shrubs and trees for Windhoek. • Advice on efficient garden watering practices.
# Community empowerment in former neglected areas	• A programme to train community based plumbers was initiated but not implemented yet for proper maintenance of water installations on private residential plots. • Training of gardeners was identified as an important task that should still be addressed.

10.4.3 Legislation

Existing legislation was outdated and new Water Supply Regulations were promulgated on 16 December 1996 to address the conservation of water in Windhoek.

Table 10.3 Requirements of the Water Supply Regulations and Implementation

Regulation Requirement	Method of Implementation
# Prevention of undue water consumption on private properties	• Wastage of water on a private properties can be addressed immediately. Windhoek is the only city in Southern Africa with a Water Control Officer in its employ.
# Water efficient equipment	As from 16 December 1996 the following is compulsory in new developments in the city: • Metering taps must be used in hostels • Taps outside non-residential buildings must be self-closing or lockable. • Only low flow showers are allowed. • Toilet cisterns must be 6/3 litre dual flush units. • Automatic flushing devices without activation by the user are prohibited. Retrofitting of existing inefficient water devices is compulsory within 3 years

Regulation Requirement	Method of Implementation
# Groundwater	Groundwater abstraction from private boreholes and groundwater levels are controlled
# Gardens	Watering may not be done during high evaporation times, i.e. between the hours of 10:00 and 16:00.
# Swimming pools	• Swimming pools must be covered when not in use.
# Prevention of water pollution	• Regular testing of underground fuel tanks is mandatory. All tanks were registered.

10.4.4 Technical Measures

The technical measures that were approved and implemented in Windhoek are summarised in **Table 10.4.**

Table 10.4 Technical Requirements and Methods of Implementation

Technical Requirement	Method of Implementation
# Lowering of "Unaccounted-for-water"	• Leakage detection is being done on a continuous basis. • Repair programs are in place. • Water audits are being done on a continuous basis. • Proper management of water meters is done. • A systematic pipe replacement programme is in place.
# Efficient ways of watering of gardens	• Most municipal gardens are irrigated through proper irrigation systems. • Advice is given by the Municipal officials, private nurseries and providers of irrigation equipment on water efficient irrigation systems for gardens
#Artificial recharge of the Windhoek Aquifer	• Enhancement of natural and artificial recharge of underground aquifers was investigated. Research started in 1996 and it is foreseen that full-scale recharge will be implemented as from May 2000 subject to the availability of water.
#Rainwater harvesting	Some residents do rainwater harvesting on a small scale by collecting rainwater from building roofs.

"Well planned and implemented WDM measures can reduce a water authority's cost significantly, primarily through avoiding or deferring the need for new capital works and also by reducing operating costs associated with pumping and water treatment." The main purpose of WDM is to enhance the efficient use of water that entails a reduction in the water used to perform a particular task without sacrificing the level of customer service. For example, the use of a low flush toilet and an efficient showerhead does not influence the level of service to the user. (White, 1994)

10.5 ECONOMIC/FINANCIAL MEASURES

Sound economic and financial measures are the most important tool to influence the water demand. In the case of Windhoek an estimated weight of at least 60% can be attached to sound economics for the successful alleviation of the pressure on conventional water sources.

10.5.1 Income Elasticity of Water Demand

In the case of Windhoek approximately 58% of the residential consumers with individual water connections used less than 15 m^3 of water per month in 1997. They consumed only 14% of the total water consumption. The high number of lower income families in Windhoek will have a major effect on increased water consumption if incomes improve as a result of higher economic growth in Namibia. The huge income disparity in Windhoek can be directly linked to the major difference in water consumption of the different income groups.

The income elasticity of residential water demand is high in Windhoek. The elasticity for all the income groups was approximately +0,83 in 1995. According to the income elasticity, the water consumption of a household will increase by approximately 83 % if the income of the household increases by 100 %. No major deviations were detected with respect to the different income groups. The relationship between income and water consumption is illustrated in **Figure 10.3**

Figure 10.3 Relationship Between Income and per Capita Water Consumption in Windhoek

10.5.2 Price Elasticity of Demand

A general discussion on price elasticity of demand was included in Section 3.1.3. An estimate was made in 1996 for the price elasticity for residential water use in Windhoek. With a price increase of 100 % it is estimated that the in-house consumption will reduce by 5 % while the outdoor use will reduce by 20 %. (Price elasticity -0,05 for in-house use and -0,20 for outdoor use.) With a further price increase of 100 % additional saving on in-house use was estimated at 2,5 % and the outdoor use was estimated at 15 %. (Price elasticity -0,025 for in-house use and -0.10 for outdoor use.). The estimated price elasticity figures for Windhoek are low in comparison with figures in international literature, because the demand is already 30 % to 35% lower than the unrestricted demand.

Little information is available on the commercial and industrial sectors, but savings that are at least similar to the in-house use may be realised with price increases of that magnitude. In Windhoek at a few commercial and industrial enterprises, where management was committed and clear goals for water savings were determined, savings from 20% to 40% were achieved. At most public institutions calculated savings in excess of 50% are possible but were not achieved. This is related to the fact that there is no direct responsibility for the payment of the water account by the institution. Accounts are normally paid directly through the relevant ministry.

There is no accurate way to forecast the effect of price increases exactly. The careful application of a fair rising block tariff system (which can be defended towards the higher consumers of water) can be used to manipulate water consumption and the growth in water consumption to a large extent. In the end, consumers can make an informed decision based on sound economic principles. This may be the reason why most of the residential consumers in Windhoek owning swimming pools have bought pool covers for their swimming pools. The reduction of water losses due to evaporation saves on the cost of water in the higher tariff block and the cost of a pool cover is recovered within three years, excluding savings in the cost of chemicals and electricity.

10.5.3 Water Pricing Policy

The price of water charged in Namibia does not reflect the scarcity of water. This may be related to the fact that bulk supply to urban areas is still subsidised with respect to capital charges. Phasing out the subsidy will increase the full financial cost over the next 3 to 5 years and bring home to the consumer the value of water as a scarce commodity in Namibia. In some cases full economic cost needs to be charged to bring home the value of water.

10.5.3.1 Water Tariff Guidelines in the City of Windhoek

The tariff principles approved by the City Council of Windhoek in 1991 provided the following guidelines for tariffs in Windhoek:

Revenue efficiency: Water utilities are natural monopolies, therefore the Municipality can recover all costs from consumers. Local authorities should therefore, set prices in the public interest: a full recovery of costs (capital charges) and operation and maintenance cost from the consumer) in the short and long term, with no additional financial burden on the taxpayer.

Equity and fairness: The most equitable tariff structure is one in which consumers pay the same rate per unit of water. The point is that tariffs must have a basis in cost and must not be set arbitrarily.

Ease of understanding and implementation: A balance should be maintained between complex tariff systems and maintaining simplicity for administration purposes.

Economic efficiency: The usual requirement for application of normal economic efficiency arguments is not applicable to water utilities. The notion of prices as a signal for allocating consumer spending among alternatives is a good one. However it is the “lumpiness” of water supply infrastructure investments which makes pricing difficult in terms of the neo-classical economic ideals. Ideally economic analysis would tell you that marginal cost pricing is the optimal strategy. However, this strategy is impractical when dealing with cost structures that involve the need for huge over capacity investments at given points of time, for example when a cost pricing will lead to large fluctuations in the price; low between investments and high at the time of the investment. This pricing strategy may give consumers the misleading signals about the scarcity of water. In cases of water scarcity economists use an approximation of the long-run marginal cost to price water supply. This can be given by an Average Incremental Cost calculation which gives a unit cost for water taking into consideration all the future capital investments required and operating and maintenance costs, as well as the amount of water supplied. Infrastructure that already exists is considered “sunk” and not an economic cost. This type of estimate will smooth the fluctuations that may occur with pure marginal cost pricing. The development of a real awareness in consumers of the incremental cost of water is essential in order for them to make an informed choice.

Conservation: Water is a primary natural resource without a practical substitute. Supplies in Namibia are limited, especially during unpredictable drought years and water conservation should always be encouraged through an appropriate tariff structure. It should be noted that the price elasticity of demand for water is such that all differences in tariffs for different consumption blocks do not materially alter water use patterns. Large rate differences cannot be justified on a cost basis. Under unusual circumstances such as severe droughts and **periods of continuous water shortages**, block tariffs are an important tool for curbing excessive water consumption. This is economically justified since scarcity of a commodity normally leads to higher prices.

Assistance to lower income customers: It has become a practice for many public- and private utilities world-wide to embrace a programme for assistance to needy consumers. The assistance should be restricted to a minimum level for the maintenance of a decent health standard (20 - 40 litres per capita per day).

In 1991, the security of water supply to the City changed to a situation in which there is a constant threat of water shortages with below average inflow in the supply reservoirs. Under such circumstances permanent block tariffs are the most efficient way to provide incentives for efficient water use.

The tariffs are based at the moment on several additional principles complimentary to the approved guidelines of 1991. These are:

- Water for standpipes is charged at the bulk water supply price levied by NamWater. (Average using 20 litres per person per day.)

- Baseline water supplied for basic health purposes is restricted to 6m³ water per family per month. This is based on 33 litres per person per day for a family of 6 (Average family size in high density areas). The price is calculated at bulk supply price plus 10%.
- A further block of between 7 m³ and 15 m³ per month calculated at the total production and distribution cost excluding capital charges.
- A block tariff between 16 m³ and 36 m³ calculated at the present Municipal cost recovery price which includes full capital charges and operational and maintenance cost. This price also include the cost recovery of the subsidy on the first two consumption blocks.
- A block tariff between 37 m³ and 45 m³ calculated at the medium run marginal cost. (Including the full cost recovery price by NamWater that may include provision for capital charges of infrastructure under construction like the Berg Aukas Mine.)
- A block tariff for consumption above 45 m³ based on the long run marginal cost to supply water to Windhoek. (i.e. bringing water from the Okavango river)
- The tariff for bulk industrial and commercial consumers should be increased over a period of 3 years to the full cost recovery price of water (no subsidy on bulk supply cost), provided that the annual tariff increase does not exceed 25%.

The cost recovery tariff in Windhoek covers full capital charges, bulk water supply cost and full operation and maintenance cost as well as an administrative levy of approximately 9% to cover overhead cost of the Municipality. Environmental and opportunity costs are not included in the tariff structure yet. During periods of drought and water shortages the volume provided per block tariff will be lowered. The subsidised block tariff between 7 and 15 m³ will perhaps be phased out over the next three years.

In a developing country it may be difficult to recover the full cost of water based on the replacement value of infrastructure, because some people will simply not be able to afford the service at all. However, it is strongly suggested that all consumption of water on residential, commercial, industrial and other uses which can be classified as "over consumption" or ineffective use be charged at the full cost recovery price of water. The inclusion of environmental and "opportunity cost" in the cost recovery tariff and higher block tariffs will be the only way for long term sustainable provision and maintenance of water supply systems in Namibia.

Affordability may be a problem in urban areas, especially amongst the poor. Studies elsewhere in the world have indicated that poor families are prepared to spend more than the accepted rule of thumb figure of 5 % of their income on potable water. According to Arimah and Ekeng (1993) and Rogerson (1996) the best way to establish the payment capacity in developing countries is to carry out proper surveys to determine the "willingness to pay" of customers. In areas where water vending is done on a large scale the figures can be as high as 10% of the family income.

In Windhoek the willingness to pay concept is applied successfully in the squatter areas to determine the level of services to be provided to individual plots after people has been provided with a basic level of service which needs further upgrading.

10.5.4 Tariffs for Industrial Effluent

Industrial effluent charges based on the "polluter pays" principle have significant impacts on the effective use of water by industries. The industrial water consumption in Windhoek is below 8% but with the national policy to attract more industrial development the percentage may increase in future. The efficient use of water in industry is mainly driven by industrial effluent or pollution charges to protect further degrading of the environment. Gleick *et al* (1995) give an indication of saving realised in California as result of higher pollution charges and this is summarised in **Table 10.5.**

Table 10.5 Improvements in Industrial Water Use Efficiency in California (1985 To 1989)

Industry Group	1989 Water Use Index (1985 = 100)
Paint	46
Computers	50
Vehicles	57
Electronic Components	56
Fruits and Vegetables	61
Aircraft	63

Gleick et al, 1995

From the table it is clear that the biggest improvement was in the paint industry that in 1989 used only 46% of the water consumed in 1985. The savings were mainly realised as a result of more water efficient manufacturing machines and higher pollution charges.

The same tendency is detected in Windhoek even with relatively low industrial effluent charges. The driving force for higher water efficiency can be related to the expected higher water price as well as expected increases in the industrial effluent charges.

10.5.5 Role of Incentives

With the financial losses made on the Water Account as a result of the water shortage during the 1996 drought it will be difficult for the Municipality to give financial incentives or direct contributions to consumers for retrofitting at this stage. It is planned to first start with proper maintenance programmes on taps and cisterns in areas where maintenance was neglected. This will reduce unaccounted-for-water and lower financial losses and help to finance such a programme.

With the extension of the Goreangab Water Reclamation works and the irrigation water system all the available wastewater will be used by September 2000. It is estimated that a permanent saving of at least 5 % in consumption can be realised through retrofitting toilets with low flush cisterns in Windhoek. With the construction of further water augmentation schemes after 2005 this may become a viable option to investigate.

10.5.6 Total Least Cost Planning

The principle of integrated least cost planning (integrated resource planning) entails that the water supply authorities and distribution authorities determine the options which, at the lowest cost, will provide their customers with the water related services they need, rather than with the water itself. Integrated least cost planning recognises that customers do not actually want more water, but the services that water provide, such as clean homes, dishes and clothes, sanitation and pleasing landscapes. (White, 1994)

The best example of the principle is the potential saving for residents of Windhoek with the installation of low flow showerheads. If conventional showerheads are replaced with water saving showerheads, the following calculation can be made:

The present price of a water saving showerhead is N$100.00. If a family of four each take a four-minute shower daily, an annual saving of 47 m^3 of water can be realised. At the present cost recovery tariff of water this relates to a saving of N$178.60 per annum. The amount of electricity used to heat this water, corresponds to a cost of N$262.33. The total saving in the first year amounts to N$340.93 per annum after the cost of the new showerhead is subtracted.

Acceptance of the principle of total least cost to the end consumer will enhance the efficient use of water and it will also save money in respect of the investments needed for main sewers and the provision of wastewater treatment facilities.

10.6 PUBLIC AWARENESS

10.6.1 Media

Through the National Water Awareness Campaign, the Department of Water Affairs, Municipality of Windhoek, Desert Research Foundation of Namibia (DRFN), Wildlife Society, other NGO`s, private nurseries, businesses and the Department of Forestry information was supplied on a national basis about the effective use of water and appropriate gardening methods. The media (newspapers, radio services and television) was used effectively through radio and television appearances as well as advertisements in the printed media.

10.6.2 School and Community Education

The Enviroteach programme sponsored by Swedish SIDA will contribute to make the youth more aware of water as a precious resource in Namibia. The implementation of successful WDM depends largely on the success of public awareness. The Municipality of Windhoek, in collaboration with DWA gives lectures in schools and higher institutions of learning on the subject of water management and provide information to school children. Due to manpower constraints it is not possible to reach all schools every year.

Groups such as the Chamber of Commerce, Embassy staff, the Wildlife Society and other professional societies and interest groups are addressed on a regular basis. Discussions with these groups are very positive and valuable comments are gathered for implementation.

10.6.3 Consumer Advisory Services

Consumer advisory services on the efficient use of water are provided in Windhoek in collaboration with nurseries. The publications and discussions should be followed up with demonstration garden projects, but this has not been done yet due to manpower and financial constraints.

Water audits and technical information on water saving methods are provided free of charge to large industries. Residential consumers are also advised on technical aspects like the reduction of water wasted through the installation of pressure reducing valves. In cases where water leaks cannot be detected by plumbers on private premises, the Municipality assist to solve the problem.

During the 1996 drought, individual letters were addressed to residential consumers with relatively high water consumption. The response and the co-operation were very positive.

10.6.4 Community Development

Community development forms an important part of WDM. In Windhoek it was established that people in high density (lower income) areas do not know how to fix a leaking tap. The cost to get a plumber out to fix a tap amounts to N$ 100 which is unaffordable to most lower income families. In the case of wastewater systems the system is used for refuse disposal which leads to blockages that may pollute underground water or even surface reservoirs such as the Goreangab Dam.

A programme to train community based plumbers was developed but has not been implemented yet. The idea is to train unemployed residents in basic plumbing skills and proper maintenance of sewer systems. They will also receive training in basic business skills. Through the outsourcing of certain services rendered by the Municipality, like maintenance on main sewers, a basic income can be generated that can be augmented by rendering services directly to the residents in the area. Formal plumbing services are unaffordable to lower income residents and this leads to improper maintenance of water and sewer installations on private properties in lower income areas. A submission was made for approval by the City Council of Windhoek but it was shelved until the completion of the current restructuring process of the organisation of the Municipality of Windhoek.

Gardeners sometimes over-water gardens by applying more than five times the amount of water needed by the plants. A training programme for gardeners will help to prevent over-watering. Such a programme was not yet been developed nor implemented.

10.7 LEGISLATION

10.7.1 Undue Water Consumption

Enforcement of the regulations is difficult due to a lack of trained personnel and access to private properties. Various meetings were held with architects, designers, hardware shops and plumbers working in the City to specify supply and install suitable fittings and equipment.

The registration of plumbers in the City is also mandatory but it is a major task to create order in the trade. The registration of plumbers at present is not satisfactory because of a lack of co-operation from the plumbers as well as manpower shortages.

Windhoek is the only City in Southern Africa that employs a Water Control Officer to address wastage of water and give advice to the residents on water related issues.

10.7.2 Water Efficient Appliances

Except for the general stipulation in the Water Regulations on water efficient equipment there is no legislation at this stage to enforce the use of water efficient appliances. The legislation to cover the rating of water efficient devices such as dishwashers, washing machines and irrigation systems may be covered in National Water Regulations to be promulgated after completion of the new Water Act. The rating of water efficient equipment should perhaps be done on a regional basis in Southern Africa because the Namibian market is too small.

The example of Australia to rate water efficient appliances, domestic irrigation systems and plumbing fittings may be beneficial to the country to ensure that water efficient equipment is imported or manufactured in future. The Water Efficient Appliance and Plumbing (WEAP) Group in Australia and New Zealand has developed a system to label categories of water efficient appliances. The system is being implemented on a national basis and customers are advised to buy water efficient appliances. (Sydney Water 1994)

An investigation in Windhoek proved that replacing a washing machine, which uses water inefficiently, with one that uses water efficiently will yield more water annually than the collection of roof water through a tank and the cost will be much lower.

10.7.3 Groundwater Abstraction

In subterranean Groundwater Control Areas in Namibia the Department of Water Affairs can set limits on the drilling of new boreholes as well as the volume and rate of abstraction. Windhoek is located in one of the Subterranean Groundwater Control Areas of Namibia.

There are 71 boreholes on private properties in proclaimed townships in Windhoek. The Water Regulations of Windhoek allow the Council to install water meters on such boreholes and determine quotas for the abstraction of water. The Council may also measure rest water levels in these boreholes to get data for the modelling of the Windhoek aquifer.

10.7.4 Individual Metering of Accommodation Units

It is mandatory to install separate private water meters on premises with more than one accommodation unit. Research has shown that when water cannot be metered directly per unit the water consumption in such places may be 50% higher than in places where water is metered individually. The reason is that each consumer unit is accountable for its own use and water wasters have to pay for their own misuse of water.

10.7.5 Prevention of Water Pollution

Additional to the requirements in the Water Act the Water Regulations in Windhoek cover a whole spectrum of regulations to prevent the pollution of any water. Specific regulations are in place to prevent pollution of groundwater. It can be required for example that underground fuel tanks should be tested by an independent person to certify the integrity of any installation annually.

In sensitive areas where most of the natural groundwater recharge occurs, the municipality can specify that underground tanks e.g. fuel tanks for petrol stations should be installed in such a way that any leakage can be seen and contained without the risk of groundwater pollution. A groundwater vulnerability map to lower the risk of possible groundwater pollution with clear policy guidelines will be completed towards the end of 1999.

10.8 GOOD WATER SUPPLY OPERATIONAL PRACTICES BY AUTHORITIES

10.8.1 Operating for Maximum Efficiency

Drawings of the pipelines showing size, pipe materials, date of installation, fire hydrants, valves and air-valves are available on the CAD system and a Geographic Information System is implemented. Technical measures are in place to keep loss of water from the water reticulation system as low as possible. Due to financial constraints only 1% of the network is replaced per year.

10.8.2 Effective Water Meter Management

The bulk supply from NamWater is metered through three flow meters in series of which one belongs to the Municipality. All fire connections on private properties installed after 1968 are metered. There is a programme to identify and meter unmetered fire connections that were installed in older parts of the City before 1968. The costing programme produces a monthly list of meters that register below average consumption. Meter readers also report damaged and faulty water meters regularly. A meter management information system is used for proper meter management.

10.8.3 Metering and Briefing on Water Accounts

Most meters are read every month. For effective WDM practices water bills should be clear to customers. The present billing system, can be improved to an informative billing system like the one used in Hermanus (R.S.A.). The system used in Hermanus clearly indicates the water consumption pattern as well as the rising cost of water in figures and a graphical format. This is regarded as very important for customers, where block tariffs are applicable, to understand the incremental cost of water related to higher consumption.

10.8.4 Reduction of Municipal Water Use

The Windhoek Municipality was able to lower its potable water consumption by 50% since 1995. This reduction was mainly as a result of installing of proper irrigation systems in municipal parks and cemeteries as well as an improvement in maintenance of plumbing in buildings.

The dual pipe system that distributes purified effluent, is extended each year to link more parks and sportfields to the system. Through the extension of the system the use of potable water is substituted with treated wastewater provided through the dual pipe system.

10.8.5 Regular Water Audits

Water audits, where the total water production volumes from all sources are compared with the total volume sold, are done on a monthly basis. Unfortunately the audits are not done on a 'district basis' and the information in the case of Windhoek is not reliable because the water meters in certain parts of the City are read only every second month.

10.8.6 Reduction of Unaccounted-for-water

The yearly unaccounted-for-water as calculated per financial year is summarised in **Table 10.6**

Table 10.6 Unaccounted-for-water in Windhoek for the Past Three Years

1994/95	1995/96	1996/97
9.09%	12.09%	10.04%

(*Figures according to audited annual Financial Statements from 1 July to 30 June each year.)*

These figures compare favourably with cities/towns in other developing countries (Zambia, Mauritius) where unaccounted-for-water may be as high as 50%. According to literature a minimum figure of 7 % to 8% unaccounted-for-water can normally be maintained through good management of an urban reticulation system. According to the approved WDM Policy of Windhoek, the aim is to reduce unaccounted-for-water to 8 % by the year 2000.

10.8.7 Artificial Recharge of the Windhoek Aquifer

Conjunctive use of water has been practised in Namibia over many years. It is based on the premise that surface water be used during periods when ample supply is available and that the loss of surface water due to evaporation be reduced through accelerated use, while groundwater should be reserved for use during periods of drought. Further research is currently underway to recharge the Windhoek Aquifer with water that would otherwise evaporate from the existing surface sources. Due to the high evaporation rate in the surface reservoirs (Von Bach, Swakoppoort and Omatako) which supply water to the City, underground storage of water will be beneficial to the long term security of supply. During 1997 the production of water from the three-dam system was 15.7 Mm^3 while evaporation losses were 35.5 Mm^3. The natural recovery period for recharge of the Windhoek Aquifer, after high abstraction during periods of drought, is five years. If this period can be shortened to two or three years the security of water supply to the City will improve dramatically. The principle of “water banking” where access water is stored for consumption during periods of water shortage can be applied if the research proves successful.

Research, initiated in 1996, to inject water in the secondary fractured rock aquifer to the south of Windhoek, shows promising results. Since 12 August 1998 treated water, supplied by NamWater, is further treated through Granular Activated Carbon prior to direct deep well injection. Over a period of 6 months approximately 300 000 m^3 was injected in a production borehole situated in the centre of a draw-down cone (result of groundwater mining during the 1996 drought). At this stage no clogging, as a result of chemical/biological effects or air entrapment, can be detected. Some of the surrounding boreholes are recovering at a rate four times higher than the natural recovery rate. Further research and injection of water will continue until July 1999.

The larger scale application of this technique will contribute to the more efficient use of scarce water that would otherwise evaporate. Existing capital investment will be better utilised and a high cost benefit ratio is expected. If the safe yield is increased by only 2 Mm^3/ annum the estimated savings amount to N$ 3.8 million a year. It is estimated that the underground storage capacity is at least 15 to 25 Mm^3 and that a minimum annual recharge at a rate of 6 to 10 Mm^3 will be possible. The gain in evaporation losses over a period of three years starting with supply reservoir levels as on 1 April 1997 was calculated by the Hydrology division of the Department of Water Affairs and is summarised in **Table 10.7.**

The calculation was based on a one-off injection over one year starting on 1 April 1997. This gives some indication of possible savings to reduce evaporation losses in the reservoirs over three years (Personal communication Guido van Langenhove, 1998).

Table 10.7 Artificial Recharge and Total Saving in Evaporation Loss

Artificial Injection in First Year only (Mm^3)	Saving in Evaporation Loss over Three years (Mm^3)	Net Saving* in Water Evaporation over Three Years (Mm^3)
5.00	2.10	1.10
10.00	3.95	1.95
15.00	5.70	2.70

* *An allowance of 20% was made for losses in the aquifer during storage*

The water for artificial recharge is provided by NamWater at the actual production cost (i.e. the cost of chemicals and electricity to pump it to Windhoek) plus a 15%

mark up for overhead cost. The price of N$ 0.76/ m³ compares very favourable with the normal bulk supply price of N$ 2.40/m³. The underground storage of water will lead to a win-win situation for everybody, the Municipality, NamWater and the residents of the City, if it is implemented on a large enough scale.

The research is done in conjunction with the CSIR in Stellenbosh and the project was accepted as a pilot site for similar research in South Africa as part of a Water Research Commission project.

10.8.8 Rainwater Harvesting and Retention of Rainwater on Plots

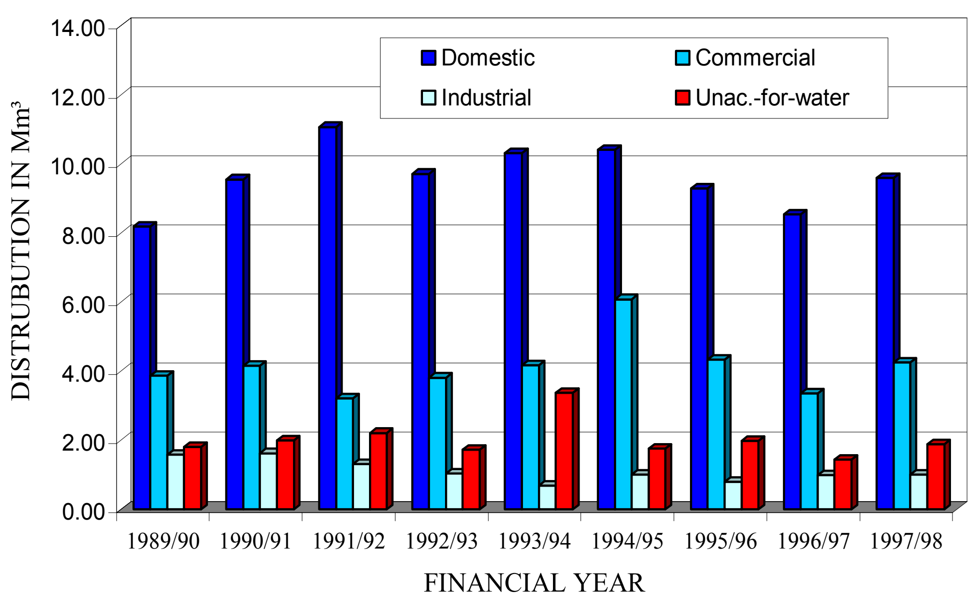
Storage of rainwater from roofs in water tanks is done by many Windhoek residents to supplement water supply to gardens but it is expensive and may create an environment for mosquitoes to breed if not properly controlled. Proper soil preparation and creation of underground storage in subsoil drains, filled with crushed stone may be a more viable alternative in Windhoek with its relatively shallow topsoil and steep slopes. The yield in the short term is low but it may contribute to more efficient use of rainwater. The stored water may also enhance the urban environment in the long term and reduce the storm-water run-off.

10.9 EFFICIENT USE OF WATER BY ALL CUSTOMERS

10.9.1 Existing Water Use Patterns and Potential for Saving

Figure 10.4 gives an indication on the change in water use patterns before and after the implementation of WDM. The effect of the drought which started in 1995 and stopped in 1997 can be clearly seen as well as the lowering in the water consumption by the commercial and industrial sectors. The relaxation in the punitive block from 30 m³ to 36 m³ increased the consumption for 1997/98 both residential and commercial consumption.

Figure 10.4 Water use Patterns of Different Consumer Groups Including Unaccounted-for-water

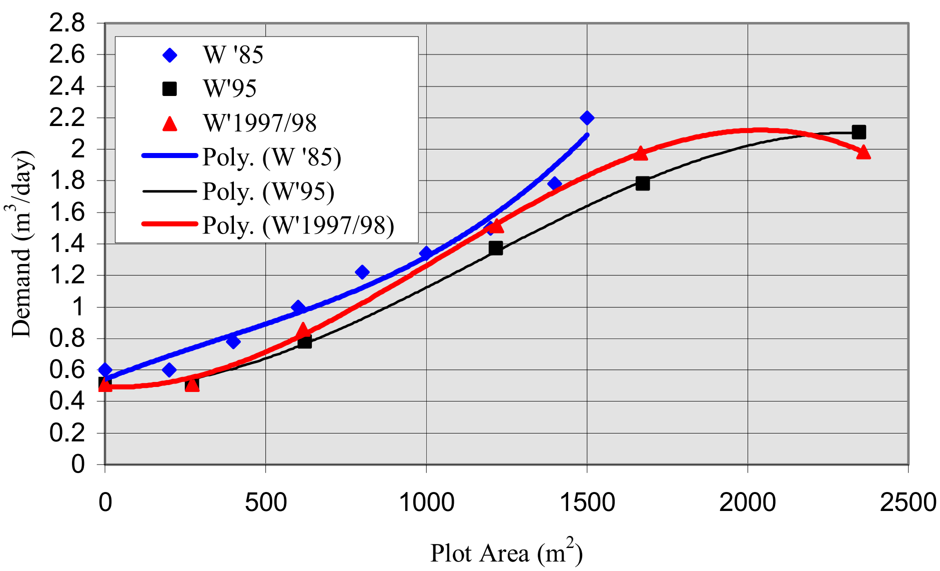


From **Figure 10.4** it is clear that the total residential consumption was the lowest in 1996/97 during the drought when the block tariffs were very strict.

10.9.2 Residential Consumption

There is a direct relationship between the size of a residential plot and the average daily water consumption. In **Figure 10.5** the change in the water consumption pattern in Windhoek is indicated for the calendar years 1985 and 1995 and the 1997/98 Municipal Financial Year.

Figure 10.5 Average Daily Water Demand for Residential Plots.

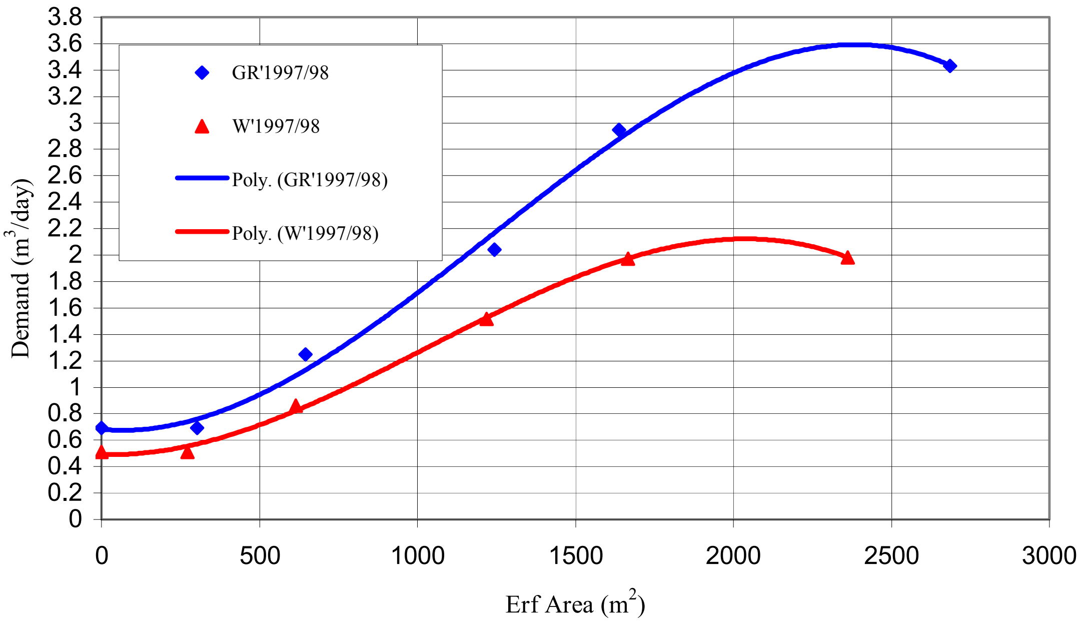


From the graph it is clear that the residential consumption has decreased in Windhoek since 1985. The biggest reduction was since the implementation of the WDM policy in 1994 including the introduction of tariffs linked to the full cost recovery in the higher block tariff to curb excessive demand. In the evaluation it should be kept in mind that the number of residents per plot also increased with 10 to 15% in most of the residential areas in the period 1985 to 1995 as result of higher densities being allowed in the city. The rainfall in 1995 was also less than 60% of the average annual rainfall. The consumption in 1996 decreased with another 15% below the 1995 consumption due to the stricter conservation measures promulgated to address expected shortfalls in the supply during 1996 as well as stricter implementation of the WDM policy.

Changing the punitive block in July 1997 increased the residential consumption, with an amount of 200 litres per day for plot sizes between 1 100m² and 1 700m² which correspond to the allowance of 200 litres per day which was allowed after the drought. This is a clear illustration that for high income groups there is a sensitivity for increased water tariffs if the price increase between N$ 4.75 and N$ 6.25. The increased consumption is needed to balance the Municipal Water Account and to pay for existing infrastructure. The high evaporation losses in the surface dams also played a role in the decision to increase the water allocation, at cost recovery price, from 30 m³/month to 36 m³/month i.e. 200 litres/day per residential plot.

In **Figure 10.6** the residential water consumption of Grootfontein relative to the plot size is compared with the consumption of Windhoek for 1995. In the case of Grootfontein (July 1995 to June 1996) the consumption for lower income families is more than 30 % higher while for high income families the consumption on a 1 000 m² plot is 46% higher than in Windhoek. The case of Grootfontein is a typical example of residential water consumption with unrestricted water demand.

Figure 10.6 Average Daily Residential Consumption:Windhoek & Grootfontein



In **Table 10.8** is a summary of the average daily residential consumption in relation to the plot size as well as the relevant climatic factors that influence water consumption in gardens according to the 1997/98 consumption figures for both Windhoek and Grootfontein. Variable soil conditions were not taken into account.

Table 10.8 Average Daily Residential Water Consumption in Relation to Plot Size and Climatic Conditions

Municipal Area	Cons. in m³ for a 300 m² Plot Size	Cons. In m³ for 450 m² Plot Size	Cons. in m³ for a 1200 m² Plot Size	Average Rainfall (mm/a)	Average Evapo-ration (mm/a)
Windhoek	0.56	0.70	1.50	366 (179-587)	3250
Grootfontein	0.75	0.95	2.30	553 (321-828)	2800

(The range of total annual rainfall that can be expected 90 % of the time is given in brackets) DRFN 1993
Evaporation DWA 1996

From the information in **Table 10.8** it is clear that the daily per capita residential consumption in Grootfontein is much higher than in Windhoek despite higher average rainfall and lower evaporation in Grootfontein.

10.9.3 Other Consumption

The survey of the 30 highest consumers in Windhoek is summarised briefly. The survey gave a typical overview of clients with high water consumption and is not complete.

Of the 30 highest consumers 17 were Government departments and in most cases savings in excess of 50% can be realised. Inspections at the premises showed that lack of proper maintenance and the replacement of older water pipes are the main reason for the high water consumption. As from the 1998/99 financial year every Government Department is responsible for its own water account. This change in responsibility has already resulted in lowered water consumption at some schools.

The consumption at the hotels is very high despite the best efforts of the hotel management to convey the message to save water to their guests. The archaic legislation that compels three star hotels to have both a bath and a shower in a room should be addressed as soon as possible on a National basis. As part of the IUCN WDM advocacy programme a poster and sticker were produced aimed specifically at tourists.

Most of the wet industries use water efficiently relative to accepted industrial norms. However at the Meatco abattoir, savings of at least 15 % can be realised, bringing the water consumption closer to the norm for the meat processing industry. Additional savings are possible through partial reuse of properly treated purified effluent.

Major savings can be realised at the gardens of the Government Buildings as well as the Municipal Building in Independence Avenue. Saving in excess of 50% was realised on the water consumption of the garden at the Town House in 1996 as a result of the installation of a proper irrigation system and efficient control. Yet in 1997/98 consumption increased due to a lack of proper control, which produced no measurable savings on the gardens.

Namibia Breweries has installed a system to re-use some of the wash water from their carbon filters for irrigation on their gardens and washing of vehicles. The gardens are in a good shape and this form of direct re-use can perhaps be applied at some of the other high consumers of water such as Namibia Beverages.

10.9.4 Water Efficient Devices And Practices

10.9.4.1 Water Efficient Equipment

According to Water Supply Regulations promulgated for the City of Windhoek in December 1996, the use of low flush toilets, low flow rate showers and water efficient equipment will be mandatory in all new buildings to be completed after the date of promulgation. The lack of durable and reliable water efficient fittings and equipment manufactured in the Southern Africa region still presents a major obstacle with respect to the installation of water efficient equipment.

10.9.4.2 Irrigation Methods

The number of consumers that use efficient irrigation methods is still limited to a minority. The consumptive use in Windhoek is estimated at 40 to 50 % of the total residential water consumption. If the water used for gardens is used more efficiently, an estimated further saving of at least 10% to 20 % can be realised on the total residential water consumption. This will require commitment and even incentives from the Municipality of Windhoek as the competent supply authority.

10.9.4.3 Gardening Methods including Drought Resistant Gardens

The Municipality of Windhoek gets good support from local nurseries that advise their customers on suitable plants, use of mulch and proper soil preparation to retain water in the ground. This is related to the fact that the necessary expertise is available. A Garden Club was established recently by a local resident in conjunction with the WDM section. The Municipality plays an active role providing information on suitable scrubs and trees that adapt well to the local climate. Some local nurseries even specialise in the layout of 'xeriscape' gardens (gardens for dry conditions) or gardens using no additional water.

The 'xeriscape' garden principles and the use of mulch is a new concept in the Namibia. Xeriscaping combines creative landscaping and conservation principles with efficient irrigation practices in a manner whereby energy, time and money, and especially water, is conserved. (Van den Berg 1995) According to Van den Berg the water consumed by gardens can be reduced by 50 % through the application of these principles. The establishment of demonstration gardens by local authorities, nurseries and Non-Governmental Organisations (NGO`s) based on the xeriscape principles can help to propagate the concept in Namibia.

10.9.4.4 Evaporation Loss Reduction

In Windhoek, the covering of swimming pools is mandatory according to the Water Regulations. Large swimming pools at hotels and institutional swimming pools are exempted because of technical limitations. Covering of two private swimming pools for one month, can save enough water by reducing evaporation losses, to fill a new swimming pool or to provide water to two lower income families for a month. A recent survey in Windhoek indicated that more than 80 % of the residents do cover their swimming pools. Water meter readers are used to help control the covering of private pools. The block tariff system provides a financial incentive to customers to cover swimming pools. A survey showed that approximately 55 people are directly employed full-time in the swimming pool manufacturing industry in Windhoek.

Watering of gardens may not be done during periods of high evaporation i.e. between 10:00 and 16:00 daily except on Saturdays. Saturday is an exemption because it will cause hardship to the informal sector gardeners. Direct employment in the nurseries provides 350 full time job opportunities while an estimated 6 000 to 7 000 people are employed on a full time or temporary basis on the maintenance of private and public gardens in the city.

10.10 USE OF WATER FROM UNCONVENTIONAL SOURCES

10.10.1 On Site Reuse Including the Use of "Grey Water"

The local brewery in Windhoek was designed and planned at a time of a severe drought (1981). Through optimal design and the installation of a dual pipe system to utilise wash water from the sand filters for washing of vehicles and irrigation of gardens substantial savings on water consumption was realised. The system produces enough water for both these two functions at full production capacity. When the system was designed and installed there was no financial incentive to install it because water tariffs and the industrial effluent charges were very low. In 1987 industrial effluent charges were introduced and since 1992 the approved Government policy to start implementing full cost recovery for water, resulted in savings on industrial effluent tariffs and water cost which made this investment worthwhile. In 1997 the water consumption was only 4 litres for every litre of beer produced compared to 5-7 litres per litre of beer in Europe (Heyns et al, 1998). In Southern Africa the specific water intake for the Malt Brewing industry is between 5.5 to 8.8 litres of water per litre of beer brewed (Steffen et al, 1991).

The abattoir in Windhoek is investigating a reuse system to treat and reuse some of the effluent after treatment onsite for the daily washing of cattle pens to remove manure.

At this stage a few basic systems for reuse of grey water are installed in Windhoek. Water from showers, baths and rinse water from washing machines are allowed for onsite reuse of residential properties mainly for watering of gardens. In Windhoek most of the soil is alkaline and the use of grey water should be done with proper scientific back up to prevent permanent damage to plants and soil. Some of the nurseries provide information to consumers on grey water reuse.

10.10.2 Reuse of Treated Effluent for Irrigation and Industrial Use

In Windhoek 1,14 Mm^3 of water was used for the irrigation of sports fields, parks, cemetery gardens and nurseries in 1997. A total of 99 consumers, including municipal departmental consumption, are connected to the system. All connections are metered, meters are read and consumers are charged on a monthly basis. Quotas are calculated at 1 m^3/m^2 of irrigation area per annum under normal times and during periods of drought the quota is lowered to 0,7 m^3/m^2 of irrigation area per annum. Should the quota be exceeded, a block tariff of double the normal tariff is applied. Commercial and industrial properties are also linked to the system and pay a higher price than the departmental tariff and sporting bodies. A private farmer utilises the industrial effluent from the Ujams oxidation pond system for the irrigation of fodder. In Windhoek water quality guidelines issued by the Department of Health is used on the irrigation water system.

The incorporation of the existing Goreangab Water Reclamation plant and pipelines, after completion of the new water reclamation plant and new pipelines in September 2000, into the irrigation water system will provide high quality irrigation water. This water will be suitable for unrestricted irrigation. It will increase the capacity of the irrigation system fourfold and will be able to absorb the growth and extension of the dual pipe network for the next 10 years.

A cost comparison shows that the installation of a dual pipe system in existing townships will be at least three times more expensive than the reclamation of water to a potable standard. Longer retention times in the existing potable supply network will also lead to deterioration of potable water quality due to the high water temperatures in Windhoek. The high cost is mainly related to the higher capital cost.

Except for the "Dual Water Systems" manual of Water Supply Practice (AWWA 1994) there is no guideline for the design of dual systems adapted to the conditions in Southern Africa.

10.10.3 Reclamation of Wastewater for Direct Potable Reuse

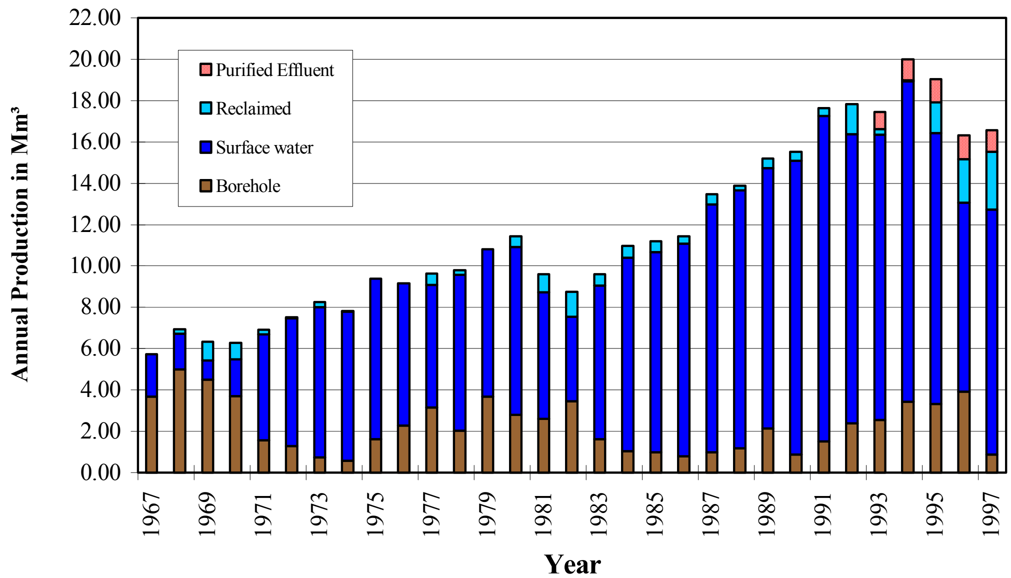
Water reclamation for potable reuse from domestic sewage effluent was pioneered in Windhoek in 1968. The system was upgraded several times over the past 30 years and the current plant can be described as the 5th generation.

The current capacity of the plant is 8 000 m^3/day which is 18,8% of the average daily potable water demand of 42 510m^3 in 1997. The production cost of N$2.40/$m^3$ of reclaimed water is the same as the cost of N$2.40/$m^3$ which is charged by NamWater for the bulk supply of water.

It is planned to build a new plant which will be able to produce 21 000 m^3/day. The planned extension will be completed by September 2000. The German Development Bank (Kreditanstalt für Wiederaufbau) finances part of the extension of the plant while the European Investment Bank indicated that they would finance the shortfall. The estimated cost of the project is N$92 million (1999). The loans are provided at subsidised rates and the estimated production cost inclusive of capital charges is calculated at N$2.80/$m^3$. This is only 33% of the estimated unit cost of water supplied through the planned extension of the Eastern National Water Carrier from Grootfontein to the Okavango River based on 1998 prices if 50% of the Okavango pipeline project can be financed through soft loans.

The reuse of water forms part of the integrated Water Demand Management policy, which was accepted for implementation in Windhoek. The graph in **Figure 10.7** shows the supply of water to Windhoek over the past 30 years from the different sources.

Figure 10.7 Water Production in Windhoek from Different Sources



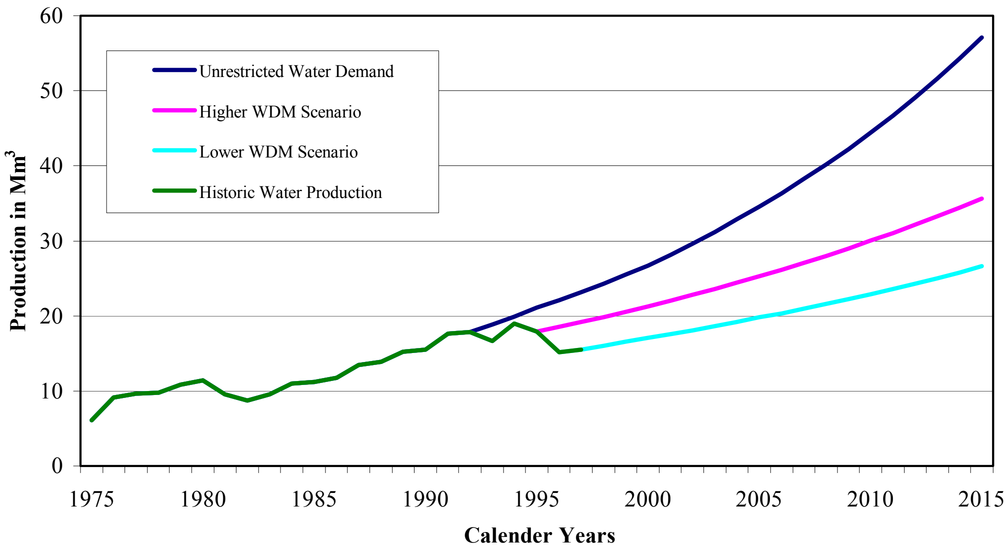
According to Van der Merwe (1998) the required volume from conventional surface and groundwater sources was lower in 1997 than in 1987 due to the reclamation of water and the installation of dual reticulation for irrigation water. Over the same period the population of Windhoek approximately doubled from 105 000 to 202 000. Approximately 45 000 residents are supplied with water from standpipes in 1998.

In Windhoek the possible health risk involved with the direct use of reclaimed water, is limited through the guideline that the maximum percentage reclaimed water is limited to 35% of the potable water supply. It is further the aim that reclaimed water should always be of the same or even better quality than water from other sources. Intensive bio-monitoring programmes are carried out on the reclaimed water. Over the past 30 years no negative health effects have been attributed to the use of reclaimed water.

10.11 SUMMARY OF EXPECTED SAVINGS AS A RESULT OF WATER DEMAND MANAGEMENT AND PRICE ELASTICITY

In 1995 savings of at least 15% were made on the unrestricted demand. Unrestricted demand forecasts were made in 1993 before the implementation of WDM In 1996 and 1997 savings of 31.5% and 33.3% were realised respectively compared to the unrestricted demand calculated in 1993 Joint Venture Consultants. The expected savings as a result of WDM only in water consumption for 2005 is estimated to be at least 30% if the current policies and strategies are adhered to.
The graph in **Figure 10.8** gives a clear indication of the unrestricted demand based on the low growth scenario as calculated by Joint Venture Consultants (1993) and the real water consumption until 1997, as well as the low and high Water Demand Management Scenarios.

Figure 10.8 Historic Water Production and Different Water Demand Scenarios



From the graph it is clear that, except for the short-term reduction in water demand a long-term benefit is the lowering in the annual growth rate in production. It is estimated that the saving on water production in 2015, will be 43.5% for the high WDM growth scenario and 53.4% on the low growth WDM scenario respectively.

10.12 FINANCIAL ASPECTS ON THE IMPLEMENTATION OF WATER DEMAND MANAGEMENT

10.12.1 Income and Expenditure on the Water Account

It is the policy of Windhoek City Council to operate the water account on a cost recovery basis. During the financial years 1990/91 until 1995/96 the water account made a surplus except for 1993/94 when a deficit of 0.92% occurred on the account.

With the drought of 1996 and the lowering in water consumption a deficit was made of N$11 072 259 in the 1996/97 financial year. This major deficit was partially financed from the Water Tariff Stabilisation Fund which had a positive balance of N$ 9 158 945. The expected deficit for the 1997/98 financial year amounts to N$5 680 955.

According to the Draft Budget for 1998/99 an estimated surplus of N$ 750 000.00 will be made on the water account.

The cost recovery tariff in Windhoek covers full capital charges, bulk water supply cost and full operation and maintenance cost as well as an administrative levy of approximately 9% to cover overhead cost of the Municipality. The water tariffs that have been charged since the 1993/94 financial year are summarised in **Table 10.9**.

Table 10.9 Summary of Water Tariffs for Meters up to 25mm in Size

1993/1994 (1 SEPT. 1993)		1994/95 (3 May 1994)		1995/96 (1 Aug. 1995)		1996/97 (1 Nov. 1996)		1997/98 (1 July 1997)		1998/99 (1 July 1998)	
Cons. M^3	Tar. N$	Cons m^3	Tar. N$	Cons. m^3	Tar. N$	Cons m^3	Tar. N$	Cons. m^3	Tar. N$	Cons. m^3	Tar. N$
0-60	1.85	0-10	1.85	0-10	1.85	0-10	2.10	0-8	2.20	0-6	2.65
61-90	2.6	11-50	2.15	11-30	2.65	11-30	3.10	9-15	3.10	7-15	3.70
90+	3.70	51-80	3.00	31-60	3.7	30+	6.20	16-36	3.80	16-36	4.75
		80+	4.30	60+	5.30			37-45	5.00	37-45	6.25
								45+	6.50	45+	8.15

***Cons.**- Monthly water consumption in m³.*
***Tar.**- Tariff per m³ applicable to the specific block of consumption.*
Dates in brackets give the implementation dates of the new tariffs.

A comparison with the historic water consumption as indicated in the graphs in **Figure 10.8** and the way in which block tariffs were structured, especially the cut off point for the punitive tariff in 1992/93 and 1996/97 shows a direct relationship. During the expected shortfall of water in 1992/93 drought as well as the 1996/97 drought the cut off point for the punitive tariff was 30 m³ per month.

10.12.2 Summary of Supply Cost from Different Sources.

The supply cost and estimated supply cost (capital charges, operation and maintenance cost), of water from the different sources is summarised in **Table 10.10.**

Table 10.10 Summary of Water Supply Cost from Different Sources to Windhoek.

Source	Price (N$/ m^3)	Base line year
Okavango water [a]	8.50	1998
NamWater cost recovery tariff[b]	3.17	1998
NamWater bulk tariff	2.40	1998
Goreangab (existing)	2.35	1997/98
Goreangab (new plant)	2.80	1999
Boreholes	1.15 [c]	1998
Artificial recharged borehole water	1.25	1998
Purified effluent	1.57	1998

(a) Based on 50% loan and 50% market related loan.
(b) Estimated cost recovery price subject to revision.
(c) Price with production rate of 2 300 000 m^2 per annum.

The estimated production cost of the new Goreangab Water Reclamation plant is indicated in the table as 'new plant'. The relatively low production cost is related to better utilisation of quality monitoring which will be recovered from higher production volumes as well as lower personnel cost per m³. The lower interest rates for financing of the scheme also contributed significantly to the lower estimated production cost.

10.12.3 Cost to Implement Water Demand Management and Potential Savings

WDM is financed by a levy on the income from water and the cost of the WDM programme is at present less than 1% of the income on the water account. The budgeted cost for the 1998/99 financial year amounts to 4.2 cents per m^3 sold. The estimated total cost for the implementation of WDM amounts to N$ 639 624 for the 1998/99 financial year while the total estimated expenditure on the operational account for water amounts to N$ 75.5 million for the same period.

The cost recovery price of water to Windhoek from the bulk supplier NamWater is estimated at N$3.17 per m^3, while the cost recovery price of the water from The Goreangab Water Reclamation Plant, after extensions to enlarge the capacity, will be N$2.80 per m^3 (present cost estimates). The cost recovery price of the semi-purified effluent used for irrigation amounts to N$1.57 per m^3. These costs reinforce the sound practise of water reuse. Calculated at 1998 cost structures and the cost recovery price of NamWater the annual saving on reclaimed water amounts to N$ 2.20 million and for irrigation water N$ 1.70 million respectively. After extension of the reclamation plant the savings as a result of using more reclaimed water will increase to N$ 5.1 million per annum.

The present cost of a good quality swimming pool cover for a pool with an area of $35m^2$ is N$2 000.00. If the evaporation rate of Windhoek is taken into account, savings in water of 90 m^3 per annum can be realised on an average swimming pool by covering the pool. If the cost of the water saved is calculated at the highest tariff applicable being N$8.15 per m^3, this saving would pay back the pool cover within three years if the pool cover is repaid over three years at a real interest rate of 5%. With the bulk water prices increasing by 20% per year buying a pool cover is a good investment.

If the same calculation is made on the cost recovery price of NamWater and Municipal cost recovery prices for 1998, a water tariff of N$ 5.52/m^3 is applicable, without taking future investment in bulk infrastructure into account. If the pool cover is repaid at 5% real interest rate over the expected lifetime of seven years the annual net saving on a water account of a consumer amounts to N$152.80. There are approximately 2 979 swimming pools in Windhoek of which 80% are covered. Calculated at Municipal and NamWater cost recovery price at an annual saving of N$ 152.80 per swimming pool, the total annual saving on all the swimming pools in the city amounts to N$ 364 152.

As described earlier in the discussion on Total Least Cost Planning the total cost savings to a consumer by replacing an inefficient shower head amounts to N$341 per annum, after the cost of the new shower head is subtracted. If only 25% of the households in Windhoek make use of water saving showerheads the annual cost saving amounts to N$2.58 million.

Through artificial recharge it is estimated that the improvement of the safe yield of the Windhoek aquifer will be approximately 2 Mm^3 per annum. The cost of artificially recharged water amounts to N$1.25/ m^3. If the recharge is practised on a full scale the annual saving will amount to N$ 3.80 million based on the expected increase of the safe yield of the aquifer.

The estimated cost to build the pipeline from Grootfontein to the Okavango River amounts to N$ 726 million calculated at 1998 prices. If the real cost of capital is taken at 5% the delay of the capital investment amounts to N$ 36.30 million per annum. Theoretically the amount will then be available for other investment which may create more wealth for the country. However investments in water supply need to be considered in a dynamic sense. To say that investment in WDM is good because it allows the postponement of supply augmentation investments is not necessarily true since there are significant benefits postponed also. What can be said about WDM strategies; including economic pricing, moral persuasion and water conservation investments such as canal lining, evaporation reduction, retrofitting and reuse, is that they have various advantages over traditional supply augmentation strategies.

WDM sees water as an intermediary good, which provides certain end user services such as cooking and hygiene. As such WDM looks to provide the same services with smaller amounts of water. If this can be achieved through economic pricing, or moral persuasion, the costs of which are often low, this represents a very small investment by a water supply authority to gain a reduction in the necessary supply. Investments in conservation of water have been shown to be cheaper than supply augmentation in some cases, and their viability can easily be appraised. The water freed as a result of the reduced water demand for a given level of service, due to domestic WDM or reduction in distribution losses, is available for use elsewhere and economic benefits occur as this water is used productively rather than wastefully as before. Essentially a given water supply is used more efficiently. These economic benefits will in general accrue without the external economic costs, including environmental costs, associated with infrastructure development. This is because WDM is usually a change to the existing system of water management for higher efficiency rather than an additional water supply. Ultimately, in a static analysis comparing one investment with another, investments in WDM may be more suitable than investing in infrastructure supply augmentation, achieving the same level of benefits at a lower cost. Investment in WDM can also be made incrementally, as the need arises, instead as a huge capital investment, like in major water augmentation schemes. Thus, by investing in WDM more funds will be available to achieve other socially desirable ends.

In a more dynamic analysis, where we consider the long-term supply options, investment in WDM may also reduce the costs of other supply augmentation investments and hence the net benefits will be increased. For example, if as a result of implementing WDM the amount of water required to achieve a suitable service to a growing urban population is reduced, the size of the required infrastructure and hence the costs may also be reduced. If the benefits that accrue from the investment remain the same the project will yield higher economic returns. A typical example might be the Okavango River emergency supply. If as a result of WDM the required abstraction is reduced from $17Mm^3$ to $10Mm^3$, for example, this could have the effect of reducing the capacity of the infrastructure required and associated operations and maintenance costs may be reduced[1]. Furthermore, the environmental costs to downstream users will also be reduced. In cases where the demands for water are not growing continuously over time, WDM strategies may dispense with the need for further investment altogether, as in the case of Boston in the USA. These

[1] This will depend on the extent of economies of scale, there could be a minimum efficient scale for the extraction which will infer a delay in investment.

types of benefits can be attributable to WDM strategies, since they increase the efficiency of other investments.

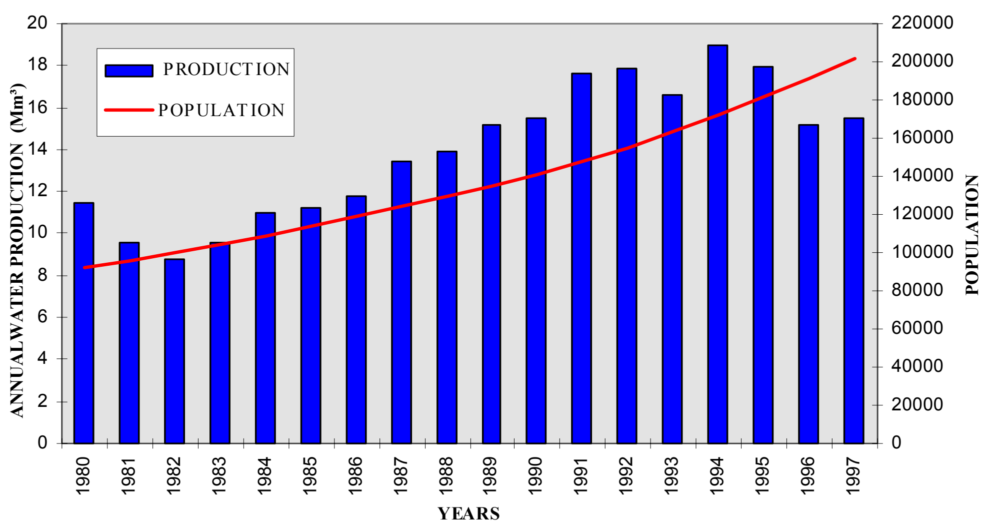
What is more likely in the dynamic analysis is that the investment option will be delayed rather than necessarily changed to reflect the reduced water requirements at a given point in time. As mentioned above there is nothing necessarily good about delaying the expenditure itself, since we also delay the benefits, but there may be certain dynamic benefits that may occur as a result. Significant delays in investment may mean that the cost of the investment as a proportion of GDP for example, may be reduced. This assumes that economic growth is greater than the rise in costs, which given the delay in investment may be aided by technological advancement. During the delay capital can be used for the promotion of economic growth.

In general there are great uncertainties surrounding the environmental costs of projects such as the Okavango pipeline. One of the benefits of delaying investments may be that these uncertainties; environmental linkages such as groundwater recharge, riparian effects, the reduced size of the Okavango Delta and its effect on floodplain productivity and tourism may be considerably reduced. This will lead to a better reflection of the full economic costs and a more informed investment decision[2].

10.13 TOTAL EFFECT OF WATER DEMAND MANAGEMENT ON WATER CONSUMPTION

The annual growth rate in water consumption was 6.6 % until 1980. From 1982 until 1991 an annual growth rate of 8.8% was experienced (Water Transfer Consultants, 1993). Through the implementation of an integrated WDM strategy in Windhoek a growth rate of not more than 3% per annum in water consumption can be realised despite a high population growth rate of 5.44% per annum. The relationship between total water production and population growth is indicated in **Figure 10 .9.**

Figure 10.9 Potable Water Production and Population in Windhoek



[2] Full economic costs means inclusive of the capital charges, operations and maintenance, opportunity cost and external economic costs such as environmental costs and effects on other economies.

The relationship between the total per capita daily water consumption and residential consumption is summarised in **Table 10.11.**

Table 10.11 Comparison of per Capita Daily Water Consumption in Windhoek

Financial Year	Total Water Consumption (Mm^3)	Daily per Capita Residential Consumption (l/p/d)	Total Daily per Capita Water Consumption (l/p/d)
1990/91	16.72	201	322
1991/92	15.59	201	283
1992/93	14.58	167	251
1994/95	17.50	161	271
1995/96	14.41	136	211
1996/97	12.36	117	179
1997/98[(a)]	15.24	130	201

Note: The figures include the total population including residents who use water from standpipes.
(a) Unaccounted-for-water estimated at average of the last three years because audited Financial Statements was not yet available for the 1997/98 financial year.

From **Table 10.11** it is clear that the daily per capita residential water consumption went down every year. This is partially related to the skewed growth pattern in the City with high influx from rural areas and a relatively low growth in the formal housing sector. It is clear that with the anticipated water shortage of 1992/93 and the drought of 1996/97 there was a substantial drop in the water consumption as a result of stricter conservation measures. Similar major decreases were experienced in the total daily per capita water consumption.

With the implementation of Water Demand Management, a saving of at least 30% (actual figure 33%) was realised in 1997. Due to the lower annual growth rate in water consumption a saving of at least 30% should be realised on the unrestricted water demand by the year 2005 as indicated in Table 13. A further saving of at least 5% can be realised through grey water reuse, retrofitting of showerheads and toilet cisterns. Due to the direct reclamation of water it will not make additional water available until the reclamation plant's full production can be utilised which will only be after 2005.

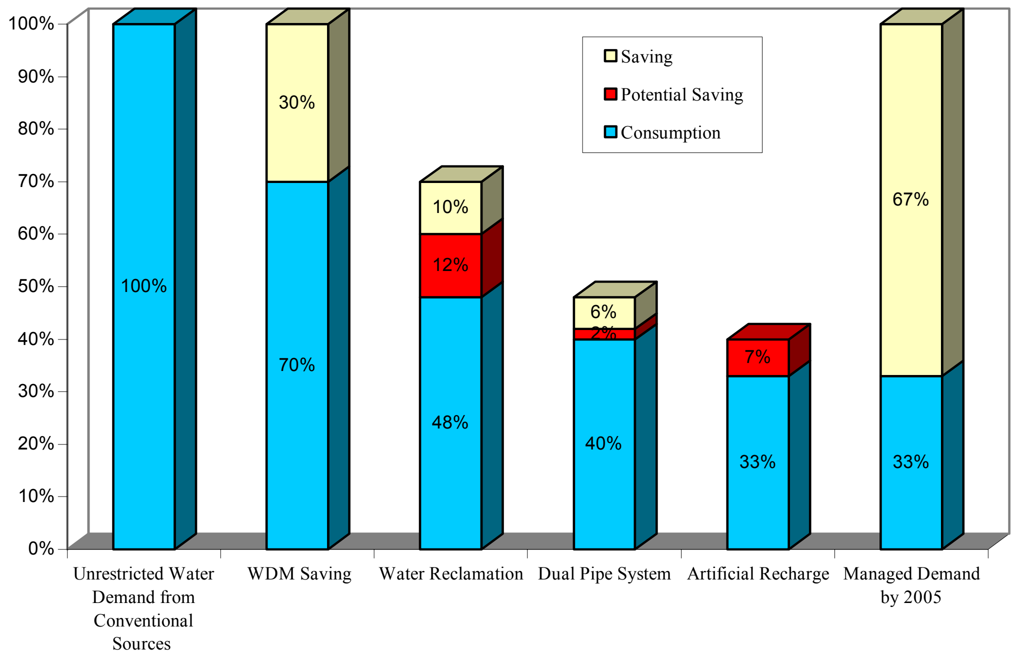
In 1997 a saving of 18% was realised through the reclamation of water. In the long term a saving of at least 22% on the unrestricted demand can be realised based on the capacity of existing water sources until the year 2005. This is based on the blending of reclaimed water to a maximum of 35% with water from conventional sources.

During 1997 a saving of 6.6% on potable water was realised through the use of the dual pipe irrigation system. It is estimated that in the long term savings of at least 8% can be realised depending on the development pattern of the City with respect to parks, sportsfields and gardens.

It is estimated that the potential savings through artificial recharge will be at least 7% through the anticipated increase of the safe yield of 2.0 Mm^3 of the Windhoek aquifer.

Figure 10.10 is an indication of what can be achieved over the medium term until 2005. At this stage a savings of 46% has been realised. An estimated total saving of 67% can be realised by the year 2005 on the unrestricted demand, from conventional sources, through the integrated approach within the next 3 to 6 years. The figure is conservative if it is taken into account that the long term expected saving through WDM alone is estimated to be between 30% and 42%.

Figure 10.10 Potential Saving Through Water Demand Management and Reuse of Water by 2005



10.14 DISCUSSION REGARDING CONSTRAINTS, OPPORTUNITIES, LESSONS AND EFFECTIVENESS

10.14.1 Constraints in the Implementation of Water Demand Management

Urbanisation is a politically sensitive issue in Namibia. This is related to pre-independence policies of influx control. The policy and strategy developed for implementation in Windhoek was accepted by the Central Government only as a guideline. At this stage very little money was made available by Central Government to assist in the provision of basic services to new settlers. The available sources of the Municipality of Windhoek are insufficient to address rapid urbanisation. Some of the requirements i.e. in respect of minimum plot sizes place the cost of a serviced plot out of reach of most of the residents in settlement areas. A project funded by donor money is currently being implemented in the City.

The implementation of the Water Regulations in Windhoek was not satisfactory due to a shortage of manpower and lack of co-operation by important stakeholders which support is needed for successful implementation. In spite of various meetings with the Building Inspectors of the Council as well as Plumbers in the City there is much scope for improvement. The registration of plumbers was not implemented at all.

It took 4 years to get a water meter management programme approved by the Information Services (IS) section. The liaison between the WDM section and IS can be improved to eliminate similar problems in future. There are large volumes of data available that needs to be changed into information for proper management of the water system. Training of meter mechanics and people installing new water connections on the principles how the Water Meter Management programme works will solve most of the inefficiencies currently experienced.

There is not sufficient information on pollution control available, except for the Sewer Regulations. A major threat to the long term supply of groundwater is the possible pollution of the Windhoek aquifer due to township development in the southern part of the City where most of the groundwater recharge occurs and where all the production boreholes are located. Approval was given by the City Council to appoint consultants for the compilation of a groundwater vulnerability map of the Greater Windhoek Area. It will also give guidelines for prevention of possible pollution in future.

The Goreangab Dam near the city is heavily polluted due to squatter settlements in the direct catchment area of the dam as well as the fact that most of the storm water run-off of the city flows into the dam. A committee consisting of members of the relevant community, concerned residents, Councillors and Municipal Officials was established to find a lasting solution to the problem of pollution of the Goreangab dam.

10.14.2 Opportunities in the Implementation of Water Demand Management

The customer advisory service is popular and it promotes the partnership idea in WDM. Community empowerment through the training of plumbers and in proper gardening methods shows great potential and presents a challenge for future implementation in Windhoek.

A major long-term threat is the insufficient replacement programme for water pipes. Proper investigations of aggressive soil conditions prior to installation of new pipes will be a major long-term benefit. The implementation of a programme to lower water pressure in the water network will also prolong the lifetime of existing pipes and curb excessive use of water due to higher water pressure. At this stage there is no preventative maintenance done on valves. This lack of maintenance will contribute to higher leakage and water losses in future.

Proper briefing on water accounts improved over the past year, but leaves room for improvement. The customers may develop a resistance against rising block tariffs that may put political pressure on the City Council to change the application of conservation tariffs.

Artificial recharge of the Windhoek aquifer shows major potential. Further research and implementation on a large scale will present a major opportunity to enhance the efficiency of the major supply sources including the Windhoek aquifer at relatively low cost. Water that evaporates in large quantities can be stored underground that will enhance the supply during periods of drought substantially.

The biggest constraint in the installation of water efficient showerheads and dual flush toilets are the lack of good quality products manufactured within the Southern African Region. This presents a major market and an opportunity for the manufacturing industry in the region.

For the survival of the provision of efficient water services to the City it is imperative that the water account should balance. The 1996 drought demonstrated the vulnerability of the City of Windhoek from a water supply and financial point of view. Application of rising block tariffs should be handled with great care as well as the sensitising of the public on water conservation to ensure financial viability of the water supply authority.

The change in gardening practices, proper soil preparation and move towards planting drought resistant plants are an important long term benefit which will lower the consumptive use relatively to total water consumption.

The tariffs levied for industrial effluent are low and at least 23 industries should be added to the list. The fact that these industries are not charged for industrial effluent yet, are related to insufficient laboratory capacity to test the effluent samples as well as a shortage of samplers. A report to address the problem was deferred for further investigation after the restructuring of the Municipality.

10.14.3 Lessons in the Implementation of Water Demand Management

The savings in water consumption in all the sectors: residential, commercial, industrial, Government and Municipal use was well above expectations. This may be a result of the approach by the Municipality to get customer involvement in the implementation of the project.

Management practices of the water supply system in Windhoek are good. The public of Windhoek is sensitive towards efficient use of water and curbing waste, contributes to efficient operation by reporting pipe bursts and water leaks in the City. The normal response time (15 to 20 minutes) by maintenance teams to prevent unnecessary loss of water is excellent.

Proper maintenance and regular water audits albeit not per pressure zone or in smaller 'district metering', contributes to the low unaccounted-for-water figure of 9 to 12%.

The use of durable swimming pool covers, in order to lower evaporation losses, create practical problems with fibreglass swimming pools. Due to the high heat generated below black pool covers the fibreglass in the pools is damaged if the pool pump is not kept in operation at least one hour during mid day. Shade netting provides an affordable alternative to solve the problem of water heating in swimming pools.

There is very good co-operation between the Town Planning Department and the WDM section with respect to the placing of wet industries as well as new industries with noxious effluent.

An evaluation of the public awareness campaign shows that the schools present the best vehicle to promote water awareness. The biggest benefit will be obtained if water awareness forms part of the normal curriculum in schools, and it should not be handled through additional handbooks or pamphlets.

In residential complexes with more than one accommodation unit, combined metering leads to wasteful practices as well as inequitable allocation of amounts payable by residents. The installation of water meters in batteries along the boundary of the plot presents a better option. Individual pipes to the accommodation units presents possibilities for cross connections and higher maintenance cost. Irresponsible contractors sometimes install inferior pipes to the different accommodation units.

10.14.4 Effectiveness in the Implementation of Water Demand Management

With respect to reuse of water, Windhoek can serve as an example to the rest of the region. Continued research is needed to get the maximum advantage from water reuse. The implementation of a pilot project for grey water reuse and urine separation may be worth further investigation for implementation.

The water pricing policy is comprehensive and is effective to lower water demand and enhance the efficient use of water. Further optimisation is needed as well as studies related to affordability, willingness to pay and price elasticity. The long term economic and social aspects with respect to the change in water use patterns needs further research and investigation.

With the reuse of water as well as the planned extension of the Goreangab Water Reclamation Works there is not major scope for short term implementation of a retrofitting programme except for low flow showers. The cost can be recovered within one year. This may only be feasible when the full capacity of the new Goreangab Water Reclamation plant can be utilised.

With an expected water demand of less than one third of the unrestricted water demand from conventional sources the WDM policy was very effective in reducing water demand. Expected saving on capital and operational cost outweighs the input in WDM by far.

10.15 CONCLUSIONS

The Windhoek experience with the implementation of an Integrated Water Demand Management Policy is a success that is of significance to arid regions in the world. The holistic approach on WDM including the reuse of water is environmentally sustainable and in line with the Dublin and Rio principles.

From a financial perspective WDM is also sustainable. Expected savings realised through 1998 amounts to N$ 6.84 million per annum excluding the savings of not building the Grootfontein-Okavango pipeline and the extended Goreangab Reclamation works. The cost for the implementation and control of the WDM policy amounts to N$ 0.64 million for the 1998/99 financial year. According to the unrestricted water demand scenario at least a water augmentation scheme should have been implemented in 1994 while another augmentation scheme should be in place by the year 2000. After extension of the Goreangab Water Reclamation plant further augmentation to the central area can possibly be delayed until 2010 provide that average inflow occur in the dams serving Windhoek. The estimated total annual saving as a result of the Integrated Water Demand Management policy when fully implemented amounts to N$ 13.54 Million (1998 base year) after full extension of the Goreangab Water Reclamation works and implementation of the artificial groundwater recharge project.

Under normal climatic conditions, further investment in bulk infrastructure, to augment water supply to Windhoek, can be postponed by at least 10 years. If the expected postponement of the Okavango River scheme are added the projected savings can be as high as N$ 84.84 million per annum depending the value of opportunities lost by not building the pipeline now and the value attached by postponing the investment. The calculation was made at a 5% rate of return on the capital investment. **Security of supply during periods of drought is, at present, the biggest challenge.** Depending on the success of artificial recharge it can make a major contribution to the security of water supply.

The daily per capita residential consumption decreased from 201 litres in 1990/91 to 117 litres in 1996/97. With the tariff changes from a drought tariff to a long-term WDM tariff in 1997/98 the consumption increased to 130 litres/person/day. A comparison of the total per capita consumption including commerce and industry shows a reduction from 322 litres/capita/day in 1990/91 to 201litres/capita/day in 1997/98.

The total water consumption was lowered in all sectors, which is a major achievement because the reduction in water consumption in sectors like the Government is not easily achieved. In cases like schools, government buildings and municipal gardens, the water consumption was lowered by as much as 50%. In institutions like prisons and army bases, savings in excess of 50% are possible. This saving was not achieved mainly because of insufficient maintenance and replacement of old water-infrastructure**.**

Through the reclamation of water and the installation of dual reticulation for irrigation water, as well as grey water use, the required volume from conventional surface and groundwater sources was lower in 1997 than in 1987. Over the same period the population in Windhoek nearly doubled from 105 000 to 202 000.

Implementation of WDM principles will only spread rapidly through proper education, the adoption of economic incentives and regulations promoting conservation and efficiency instead of waste. In an arid country like Namibia, with low and erratic rainfall and fragile eco-systems, water must be treated as a scarce natural resource and a precious commodity. **An Integrated National Policy on WDM to develop a new water use ethic in the country is long overdue**. It is estimated that the water consumption in urban areas of Namibia can be lowered by approximately 30% (without reuse of water) through the implementation of WDM. This will ensure that the development of new water supply schemes will be delayed - with corresponding capital savings.

If WDM including reuse and artificial recharge are fully implemented towards the end of the year 2005, only 33% of the water needed for unrestricted water supply from conventional sources will be needed to supply water to the City of Windhoek. WDM requires commitment, comprehensive planning, clear policy guidelines, updated legislation, public participation and support for continued success.

The application of an efficient water tariff policy system is the most important instrument for the successful implementation of a WDM policy. All the evidence suggests that water is constantly overused when it is consistently under priced.

The famed words of the German poet Johann Wolfgang von Goethe are directly applicable to the integrated management and conservation of water resources within the Southern African region:

**"Knowing something is not enough, you have to apply it:
Wanting something is not enough, you have to do it".**

REFERENCES CHAPTER 10

Arimah B.C. and Ekeng, B.E. (1993*). Some factors explaining residential consumption in a third world city - the case of Calabar, Nigeria.* Aqua Vol.42 No.5 pp.289-294, 1993.

Du Toit, D., Korta A. and Sguazzen T. (1993).. *Sink or Swim Water and the Namibian environment.* Enviroteach production sponsored by SIDA.

Gleick, P.H., Loh, P., Gomez, S.V. and Morrison, J. (1995). *California Water 2020 - A sustainable Vision.* Pacific Institute for Studies in Development, Environment and Security

Heyns, P., Montgomery, S., Pallet,J and Seely, M., (1998) *Namibia's Water , a Decision Makers' Guide',* The Department of Water Affairs, Ministry of Agriculture, Water and Rural Development and the Desert Research Foundation of Namibia.

Joint Venture Consultants, (1993). *Central Area Water Master Plan: Phase 1*, Volume 3, Report no: Dir/1/93/3, Department of Water Affairs

Joint Venture Consultants, (1993). *Central Area Water Master Plan: Phase 1, Proceedings of the Second Workshop,* Department of Water Affairs.

The Namibian Economic Research Unit, (1996). *Projections and Opinions on Economic and Business Prospects in Windhoek.*

Rogerson, M.R. (1996). Willingness to pay for water: The International Debate. Water SA Vol.22, No.4, October 1996.

Steffen, Robertson and Kirsten Inc. (1991) *National Industrial Water and Waste-water Survey,* WRC Report No 145/1/91

Sydney Water, (1994). *Demand Management in the Water Board.* Policy document for Sydney Water on Water Demand Management.

TRP Associates, (1996). *1995 Residents Survey Report.* Prepared for the Municipality of Windhoek.

Van den Berg, C.H. (1995). *"Xeriscaping - Landscaping for Water Conservation.* Paper presented at a Conference on Water Conservation in the Horticultural Industry at Rosherville, Johannesburg, October 1995.

Van Langenhove, G. (1998) Chief Hydrology Division, Department of Water Affairs, Personal Communication.

Van der Merwe, B.F. (1998) *Strategies for Water Reuse*. Paper presented to Water' 98, The third Annual Regional Management Summit held in Sandton, South Africa on 10 and 11 March 1998.

Van der Merwe, B. F. (1994). *Water Demand Management in Windhoek, Namibia.* Internal Report Department of the City Engineer, Municipality of Windhoek.

White, S. (1994). *Wise Water Management. A Demand Manual for Water Authorities.* Draft Research Report No 93/64, Urban Research Association of Australia.

11. WATER DEMAND MANAGEMENT AT ETENDEKA MOUNTAIN CAMP, NAMIBIA

Shirley Bethune

11.1 INTRODUCTION

Tourism is the fastest growing sector of the Namibian economy. In Southern Africa tourism has grown at an average of 20% annually over the past five years. Namibia has experienced a steady increase, 21,85% between 1993 and 1996 and 9% per year since then, with more than half a million tourists visiting in 1997 (Stephen Brown, Directorate of Tourism personal communication).

Tourism is a labour-intensive industry providing employment in the tourism sector as well as in the supporting commercial sector. Half a million tourists also have an impact on water consumption in an arid country and for this reason the tourist sector was included in the Water Demand Management Country Study for Namibia.

Etendeka Mountain Camp was selected as a case study because of the fine example it sets. This case study shows that even up-market tourist facilities can be offered in arid areas and that by integrating appropriate technology and awareness, amongst both staff and clients, water consumption can be kept to a minimum in keeping with the environment.

11.2 CASE STUDY METHODOLOGY

A questionnaire was drafted and piloted in the Caprivi region in August, before being distributed to tourist facilities throughout the country. (Copy of the questionnaire in Annexure). To facilitate distribution two of the major tourist organisations, *The Hospitality Association of Namibia (HAN)* and *Namibia Resorts International (NRI)* were approached and agreed to send out the questionnaires to all their members. As can be seen in the section on the tourism sector (Chapter 8) very few of the tourist camps and hotels that responded are actively practising Water Demand Management. A significant exception is *Etendeka Mountain Camp.*

Following the questionnaire response from *Etendeka Mountain Camp,* the owner of the camp, Mr Denis Liebenberg, was interviewed on 5 November 1998. The water consumption figures for *Etendeka Mountain Camp* were compared with those given in questionnaire responses received from other tourist facilities and the relative value of the water compared with values calculated for other sectors of the economy.

11.3. DESCRIPTION OF THE CASE STUDY AND AREA

Etendeka Mountain Camp is situated on the Northern Namib escarpment in a semi-desert wilderness area. The camp is within the Kunene Region Concession Area No 2 and the *Etendeka* Tourist Concession covers an area of 45 000 ha. The concessionaire enjoys exclusive access, being the only tourist operation allowed to operate in the area and has an agreement with the communities living on neighbouring communal farms regarding nomadic use for stock-grazing and hunting rights. Strict eco-tourism principles are adhered to at *Etendeka Mountain Camp* and the local community is actively involved. There is a community fund related to bed-nights and money collected is handed to the community every two years

The area has a high tourism potential as unspoilt wilderness. Game species include gemsbok, zebra, springbuck, giraffe, rhino and elephant. The arid-adapted plants, rugged mountainous scenery and wildlife are the main attractions. The camp offers guided walks and scenic drives one of which is the hour and a half transfer drive from Veterinary gate on the main road, where guests can safely leave their vehicles.

The camp averages 1 300 bed nights a year, with most of these (950) during the peak season from July to October. Most tourists stay 2 nights. An inclusive rate (transfers, scenic drive, guided walk, tented accommodation and all meals) cost N$ 680.00 per night. There are 16 beds available in the 10 tents. There are 6 bucket showers and 7 low-flush toilets as well as staff accommodation with pit latrines.

11.4. MAIN ISSUES

The main issues are that the camp is situated in an area with little available water, with little economic potential other than tourism, that access to resources is a not easy and that water has to be brought in from wells away from the camp.

11.4.1 Water Scarcity

The camp is situated in a water scarce area, rainfall is between 100 and 120 mm per year and evaporation rates are high. Summer temperatures can reach 43^0C and in winter frost can occur. South Westerly winds predominate while damaging north easterly winds can occur with wind speeds as high as 130 km/h in the winter months. Water is supplied from three groundwater wells 6-8 km from the camp. There are a few natural springs that provide just enough water to maintain low densities of wildlife and in good years can provide water to small herds of nomadic livestock.

11.4.2 Low Productivity for Alternative Water Use

This arid and rugged area has little agricultural potential although after exceptional rains the normally rocky terrain can be transformed into lush grasslands. Nomadic farmers then move their cattle and goats into the area. In good years, the grass and temporary waterholes attract large concentrations of game too. These periods of plenty are short-lived. In the long-term farming is, at best, a marginal enterprise in the area. Yet with careful and environmentally sensitive planning eco-tourism can bring much needed revenue into the area. *Etendeka Mountain Camp* provides a good example of such planning and sustainable tourist development.

11.4.3 Access Restrictions

Given the aridity and harsh climate, no food is produced at the camp and everything has to be trucked in from Kamanjab 140 km away, Otjiwarongo, 358 km away and even Windhoek some 600 km away.

There is no water source at the camp and all water supplies ($120m^3/a$) are collected in drums from the groundwater wells and brought in by vehicle. The wells are dependent on the low and erratic rainfall for recharge and have a low storage volume. As a result the water resources are both low and unreliable. It would not be worth investing in a pipeline and pumps only to have the water source dry out. Further no permanent structures are allowed within the wilderness concession area.

11.4.4 Expensive Water Transport

The main expense at *Etendeka* is vehicles and transport. The purchase and maintenance of vehicles and fuel costs account for about 32% of the total costs the business incurs. Water provision amounts to 5% of the operational costs that include transport costs to bring the water to the camp. The cost of collection and transporting of water over the distance of 6 – 8 km is estimated to be about 15c/litre or N$ 150.00 per m^3. In comparison water supplied to households in Windhoek costs N$ 4.75 per m^3 calculated at the cost recovery price.

11.5 DRIVING FORCES FOR THE IMPLEMENTATION OF WATER DEMAND MANAGEMENT

The Water Demand Management practised at *Etendeka Mountain Camp* was initiated by the owner and manager Denis Liebenberg himself and is based on over 15 years of experience in eco-tourism in Southern Africa.

The driving force for the implementation of Water Demand Mangement has been the scarcity of available water in this arid area and the high costs to transport it to the camp.

11.6 INTERGRATED APPROACH TO WATER DEMAND MANAGEMENT (TOOLS AND METHODS)

Etendeka Mountain Camp relies on an integrated approach to implement effective Water Demand Management. This approach combines an appropriate management policy, technology and awareness. An efficient water management policy is followed and is an integral component of staff education. Appropriate water-saving technology is used to reduce water use by customers and staff and water conservation is actively promoted in the introductory lecture to all customers on arrival at the camp.

11.6.1 Management Policy

The management policy of the camp is in keeping with the aridity of the area. There are neither lawns nor exotic plants, the “garden” consists of natural rocks and plants indigenous to the arid area. There is no swimming pool. Shade is provided by shade-cloth. All staff members are trained to use water efficiently.

11.6.2 Water Saving Technology

The showers are restricted to 15 litres per person by using a bucket shower system. The water for the showers is heated in solar heaters and the shower buckets are filled only at the customer's request. Buckets are used in the kitchen, to bring in water for cooking and washing up and to remove wastewater. All rinsing water is poured onto indigenous plants at the camp. Direct flush toilets reduce water consumption to 2-3 litres per flush while the staff use pit latrines.

11.6.3 Water Awareness

Guests, mainly from overseas, are informed about the scarce water resources of Namibia and asked to help conserve these by curtailing their water use. They are educated regarding water conservation during an introductory lecture on arrival and through brochures and leaflets. Using the showers and low-flush toilets allows them to put this into practice. Linen is washed by hand and there is no laundry service for guests. Linen and towels are not changed daily but only when guests depart. These are washed at a nearby village. Clients' vehicles, parked at the Veterinary gate,are washed using buckets only.

11.6 RESULTS

Etendeka Mountain Camp is able to maintain 1 300 bed-nights on a water consumption of only 120m^3 per annum. A high standard of accommodation and services are maintained as expected by discerning overseas guests to the lodge. Unfortunately there has not been the opportunity during this study to compare these figures to similar camps in the same area. This would be worth doing as part of the Phase 2 study. Broad comparison with results obtained from questionnaire returns received from elsewhere in Namibia can however be made. *Camp Setengi* used twice this amount of water in 4 months but do not give figures on how many bed-nights this included. At the other end of the scale, *Mokuti Lodge,* next to the Etosha National Park, used almost a thousand times more water – 114 675 m^3 in a nine month period. Although they did not reply to the questions on tourist numbers they could not have hosted a thousand times more tourists than *Etendeka* did. The highest water use at *Etendeka* is that used by the tourists which comes to a mere 35 litres per person per day. Few other tourist resorts could match that.

The cost of installing and maintaining the appropriate water-efficient technology is estimated at being about the same as it would have cost to install more conventional showers, toilets and pipes. The bucket showers cost about N$1 000 each to build whilst the solar heaters pushed the cost up to N$4 000 for each of the six shower units. The special low water consumption design toilets cost about N$500 each and with the cisterns and pipes this could come to N$ 1000 for each of the seven toilets. The cost of the kitchen sinks and buckets was minimal and required no plumbing. When one takes into account the relatively high cost of transporting the water to the camp, given as 15c / litre i.e. N$ 150 /m^3, the operating cost is high. This cost, coupled with the scarcity and unreliability of water in the area, has driven water demand management. Despite this cost, the high returns from customers able to pay well for the product offered by *Etendeka Mountain Camp,* makes this an appropriate high value use of water. A calculation based on the annual water use and income for the average number of bed-nights shows that over N$ 7000.00 is generated per cubic metre of water used at the camp. Additional income is generated for the local community both in terms of employment and through the community fund.

11.8 DISCUSSION ON CONSTRAINTS, OPPORTUNITIES, LESSONS AND EFFECTIVENESS

The main constraint to implementing Water Demand Management at *Etendeka Mountain Camp* has been consumer resistance. *Etendeka Mountain Camp* is unique in its product and offers an experience that may not appeal to the majority of tourists.

The main benefit of implementing water demand management at *Etendeka Mountain Camp* has been the water savings, allowing sustainable use of a scarce resource in an arid area. By using water efficiently it has been possible to run a successful tourist business in an area where many would have thought it impossible, creating an opportunity to bring much needed revenue to the country and to local communities. It provides a lesson to other tourist facilities throughout the country, and particularly in arid areas, showing by example that it is possible to run a camp in a water scarce area and still attract tourists, create employment and bring in revenue. It provides an example to the rest of Southern Africa on the use of appropriate technology and the effectiveness of environmental education in tourism. Each visitor returns home with an enhanced understanding of the challenges faced when living in an arid environment and with the knowledge that they were actively able to contribute to conserving a valuable resource. Having experienced the benefits some tourists may be encouraged to practice Water Demand Management at home too. *Etendeka Mountain Camp* puts into practice the ethics of eco-tourism and actively promotes sustainable development. In this case tourism provides a higher value and more appropriate use of water in the area than alternative economic activities such as farming.

11.9 CONCLUSIONS

The camp has been run successfully since 1992 and, despite the limitations of water use imposed, many guests staying there consider the *Etendeka* experience as one of the highlights of their Namibian visit. Many return or recommend the camp to friends. Water Demand Management works at *Etendeka Mountain Camp* and is a good example of adapting to prevailing conditions.

Water Demand Management is driven through water scarcity and the high costs of collection and transport. This resource-sensitive approach to Water Demand Management is most relevant to arid areas. The example set by *Etendeka Mountain Camp* can be used to encourage Water Demand Management in tourist facilities elsewhere, even those not faced by the same scarcity of water resources. Tourist facilities in less dry areas also need to adopt Water Demand Management, but for different reasons e.g. due to growing demands on the water resources of the ephemeral or perennial rivers by competitive water users such as urban centres and/ or irrigation. The measures for Water Demand Management would be different, taking into account local conditions. In some cases, it may even be more appropriate to target the urban consumers and irrigation schemes that compared to tourist facilities, use a relative high volumes of water.

In the next phase of the Water Demand Management Country study for Namibia it would be interesting to investigate other tourism enterprises and compare effective water use and assign value added through the use of water for tourism. Pilot studies elsewhere in the Damaraland wilderness area and within the relatively dry Etosha National Park would be an interesting challenge. Direct measurement and payment for water used can have the same positive result in water savings as in the Kruger National Park in South Africa.

12. REGIONAL CONTEXT - IMPACT OF REGIONAL PROTOCOL AND TREATIES

Ben Groom

12.1 WATER TREATIES AND TECHNICAL CO-OPERATION.

Namibia is a basin state of several shared rivers. **Table 12.1** details the rivers, the countries with whom they are shared and the agreements associated with them.

Table 12. 1 Namibia's Shared Rivers and Agreements.

River Basin	Other Basin States Involved	Water Abstraction Agreements	Organization
Kunene	Angola, Namibia	Kunene Agreement of 1969.	Permanent Joint Technical Commission. (PJTC)
Okavango	Angola, Botswana, Zimbabwe, Namibia	None	Permanent Okavango River Water Commission (OKACOM)
Orange	Lesotho, Botswana, South Africa, Namibia.	Treaty on Joint Irrigation Scheme at Vioolsdrift	Permanent Water Commission between RSA and Namibia. (PWC)
Zambezi	Angola, Botswana, Malawi, Namibia Mozambique, Tanzania, Zambia, Zimbabwe.	None	Co-operation through the Zambezi Action Plan with Water Sector Co-ordinating Unit. (ZACPLAN)
Kwando-Linyanti-Chobe	Botswana, Namibia	None	Joint Permanent Technical Commission (JPTC)

Regionally Namibia ratified the SADC Protocol on Shared Watercourse Systems. The Helsinki Rules of 1966 serve as basis for cross-boundary negotiations of water use. Namibia voted for the adoption by the United Nations of the Convention of Non-navigational rivers.

12.2 THE REGIONAL CONTEXT OF WATER DEMAND MANAGEMENT AND SHARED RIVERS.

The 95% assured yield of Namibia's domestically available water resources amounts to some 500Mm^3/a. If water demands double in the next 10-20 years as a result of population growth and general economic development, the only further water resources available will be the perennial border rivers. This will require compliance from the other river basin states. At present there are two explicit abstraction agreements for the perennial rivers. The agreement with Angola on the Kunene, stipulates that 6 m^3/s or 190Mm^3/a can be abstracted and similarly the treaty on the Orange River makes provision for the abstraction of 9 Mm^3/a. Currently, 2 to3 m^3/s is diverted from the Kunene River at Calueque Dam across the watershed into the Cuvelai catchment and is required to supply most of the irrigation, domestic and stock-watering needs of people in Northern Namibia.

Some augmentation from the Okavango River during periods of drought to provide water to the central areas and Windhoek seems inevitable in the long-term. Although no agreement on the allowable abstraction has been signed the co-ordination of research and future integrated management of the Okavango River Basin is overseen by the tripartite Permanent Okavango River Basin Commission. In the case of the Okavango River, concerns have been widely aired about the downstream impacts of large-scale water withdrawal on the Okavango Delta, a Ramsar Site i.e. a Wetland of International Importance and source of huge tourism revenues for Botswana. When an emergency abstraction scheme from the Okavango River was proposed in 1994, the Government of Botswana urged that WDM be implemented in the Central Region of Namibia, before attempts were made to abstract water from the Okavango River. It is apparent that there could also be significant international and regional political consequences to abstraction of water by, either Angola or Namibia. At present Okacom is seeking international funding for an environmental assessment of the Okavango River Basin in all three countries and for the development of an integrated management plan for the basin.

In this context Water Demand Management is a highly relevant tool in the search for sustained services from given amounts of water. Indeed if water were extracted form the Okavango whilst it were still viable to achieve considerable water savings through Water Demand Management, the external costs would be unnecessarily borne by the third parties whilst the investment costs would be prematurely borne by Namibia. The volume needed by Namibia is less than 1% of the mean annual run-off.

However, as seen in the Windhoek case study, Water Demand Management has limitations. There is an absolute amount of water that is required to perform the various services required of it and as such Water Demand Management will only reduce and retard the annual growth in water demand in Windhoek. However, the implementation of rigorous Water Demand Management strategies will postpone the supply augmentation strategies allowing uncertainties associated with them to be reduced and more importantly allowing their effect on public finance to be reduced, assuming real economic growth. It is likely that future supply augmentation will be made more efficient by the presence of Water Demand Management since it may reduce the amount of water required for abstraction and, use more efficiently the water that is abstracted. Furthermore the regional and international community may look more favourably upon plans to abstract water from the border rivers if a regime of efficient and effective Water Demand Management measures are in place.

One of the positive benefits of Water Demand Management is that a larger proportion of water remains available for the maintenance and functioning of important wetland environments. The perennial rivers of Namibia and their associated floodplains provide valuable natural resources and functions on which people living alongside and in downstream reaches of these rivers depend for their day-to-day needs. These rivers are also important foci for biodiversity and provide valuable functions in terms of natural water purification, flood attenuation, transport of sediment and nutrients as well as their recreational and aesthetic values.

Therefore, in a regional context Water Demand Management is very pertinent to maintaining relations with countries with whom rivers are shared for long-term environmental conservation. Indeed the argument extends beyond the Okavango scenario outlined above, to all of the shared rivers.

12.3 REGIONAL DISSEMINATION OF INFORMATION.

Namibia has already contributed to a greater awareness of Water Demand Management in the SADC region through the production of two recent publications on Water. These include *Sharing Water in Southern Africa* edited by John Pallett and *Namibia's Water-A Decision Makers' Guide* edited by Piet Heyns, Sharon Montgomery, John Pallett and Mary Seely. The current *State of the Environment Report on Water* will add a further contribution.

During 1998, two Government delegations, one from the Department of Water Affairs in Botswana and another from the Water Resources Management Strategy WRMS in Zimbabwe visited the Namibian Water Demand Management Team to share information on Water Demand Management and Water Awareness Activities. In 1996, a delegation led by Guy Preston of the South African *National Water Conservation Campaign* came to Namibia to consult the City of Windhoek, the Department of Water Affairs and the Desert Research Foundation of Namibia.

The documentation of the successes and failures of Water Demand Management in the countries currently being studied will provide a valuable source of information for other countries and cities striving for efficient water use. In particular the Windhoek case study can act as a template for other cities and towns facing similar water supply problems and climatic conditions. Indeed, knowledge of the strategies undertaken in Windhoek could benefit any town or city. This highlights the need for a proper evaluation of the costs and benefits of Water Demand Management in this case because some Water Demand Management strategies may not be economically viable outside of the water scarce context of Windhoek. However, the value of the information cannot be questioned in the SADC region where there are many cities in a similar situation to Windhoek.

12.4 FUTURE REGIONAL CO-OPERATION

12.4.1 Regional Water Demand Management Policy

This study has identified and articulated the need for a National Water Demand Management Policy for Namibia, yet equally there is a need that within the SADC region the national policies be linked through a common regional policy and protocol.

12.4.2 Regional Standing Committee

There is a need to form a regional standing committee for the implementation of Water Demand Management in Southern Africa. This needs to be done at high level to ensure that implementation of decisions and policy are not hampered. The standing committee should investigate forming and co-ordinating a task force in each country to ensure the integrated implementation of Water Demand Management measures in each country in all sectors – urban, rural, agricultural, mining and tourism and the introduction of Water Demand Management and water awareness in national school curriculum.

12.4.3 Regional Water Demand Management Guidelines per Sector

The shared experience of countries participating in this study should form the basis of a series of regional Water Demand Management Guidelines aimed at the different sectors.

12.5 CONCLUSIONS

There is a major opportunity for better co-operation between the countries within SADC in the field of WDM. Networking and exchange of ideas will be beneficial to all parties involved.

The benefits of WDM are clear especially in respect of shared rivers. As demonstrated in the Windhoek case study WDM can lower the demand on conventional sources as well as shared rivers. The implementation of similar policies in South Africa may improve the quality of water in the Orange river that will be beneficial to both countries.

The establishment of working groups and networking within the SADC region on WDM in a structured way can contribute to better security of supply in the whole region.

REFERENCES CHAPTER 12

Chenje.M., Johnson. P, (1996), *Water in Southern Africa.* SADC, Harare, Zimbabwe

Heyns. P, Montgomery. S, Pallet. J, Seely. M, (1998). *Namibia's Water, A Dicision Makers' Guide.* Department of Water Affairs, The Desert Research Foundation of Namibia.

Pallet. J, (1997) *Sharing Water in Southern Africa.* The Desert Research Foundation of Namibia.

13 OVERVIEW OF THE WATER DEMAND MANAGEMENT STRATEGY AND POLICY

Shirley Bethune, Ben Groom, Ben van der Merwe

13.1 APPLICATION OF WATER DEMAND MANAGEMENT

13.1.1 Definition and Approach:

Box 13.1 Definition of Water Demand Management

Water Demand Management involves the adoption of policy and investments by both the Water Authority and consumers to influence the demand for water.
Primarily "demand" is treated as an economic concept and water is treated as an economic good. As such the primary measures for Water Demand Management are economic/financial. These include economic pricing, fines and moral persuasion in the form of awareness and education. Water Demand Management attempts to reduce the consumption of water through directly influencing and removing inefficient consumer demand.

The consumer demand for water impacts on primary water sources, such as perennial rivers, impoundments on ephemeral rivers and groundwater. The demands of the water supply system also impact upon other primary resources. Reducing the pressure and reliance on primary water sources is one of the aims of Water Demand Management in Namibia. Water Demand Management attempts to supply a given service to water consumers whilst reducing overall demands on primary water sources.

In Namibia, the following measures have been identified as essential to the implementation of a successful integrated WDM strategy.

- Economic/Financial
- Public Awareness
- Legislation
- Good Water Supply Operational Practices by Water Authorities
- Efficient Use of Water by Consumers
- Use of Unconventional Water Sources

WDM is a complex, multi-faceted discipline aimed at controlling or managing water demand. It represents a major shift in thinking about how water resources are used. Previously the emphasis was on supply and all efforts in water resource management were aimed at satisfying an ever-increasing demand for water. With the realisation of finite resources came a paradigm shift from "water supply management" to "water demand management". The emphasis must now be on controlling the demand and using the available water as efficiently, and effectively as possible whilst taking into account, the natural limitations of the resource, environmental water requirements and the needs of other water users.

An integrated water demand management approach relies on a variety of methods to achieve successful demand management. These include an appropriate policy and the legislation to back it up, appropriate technology, innovative research to develop and test alternative water-efficient technologies, economic measures and financial incentives and education aimed at water users, water suppliers and water managers.

9.1.2 Economic Measures, Financial Incentives and Water Tariffs

Economic and financial instruments are attractive tools to reduce the pressure on water sources. The efficient use of water influences the size and implementation of major augmentation schemes lowering the demand for scarce capital resources. The fact that WDM is mainly driven by sound financial and economic policies make decision makers and consumers more aware of the value of water. The implementation of these strategies should be subjected to the same appraisal as any other investment in water supply to ensure that good economic practises prevail.

There are many agents affected by the application of Water Demand Management. They include:

- The Bulk Water Supply Agency.
- The Urban Water Supplier and Distributor.
- The Water Consumers.

Each agent affected by the WDM policy can be assessed and a measure of the net economic effect (costs or benefits) to each should be appraised. The results of these economic tests can be useful in explaining why Water Demand Management does or does not happen spontaneously and where intervention on behalf of the government may be necessary. The Urban Water Association of Australia (White 1994) gives a concise overview of the various economic tests that can be applied to ensure that Water Demand Management will be both economically desirable and politically acceptable.

Participant Test: This tests the economic effect on the consumers as a result of a water demand strategy. The test can be written as:

Box 13.1 Participant Test

Net Benefits = Reduced Bills – Customer Costs.

Where each term represents a present value discounted at a rate of interest relevant to the investment decisions of affected parties. In Windhoek the savings for a family through the installation of low flow showerheads is estimated to be N$ 341 during the first year. Over three years substantial monetary savings results.

The result of this test determines the suitability of a WDM practice to a consumer and is just as relevant to industrial as well as domestic users.

Water Authority Test: It is apparent that to make the above strategy economically attractive to water users, the water authority may have to give some financial incentives such as subsidies to promote water efficient technologies. Whether this is viable for the water authority can also be tested.

Box 13 .2 Net Benefits to the Water Authority

Net Benefits to Water Authority = Reduced Operating Costs + Savings from Deferred Capital Expenses – Program Costs.

In the case of Windhoek the unit cost for the water saved though WDM amounts only N$0.24/m^3. The average incremental cost of this strategy is N$ 0.11/m^3 calculated a 10% discount rate reflecting the opportunity cost of capital. Again the Internal Rate of Return (IRR) can be tested for this strategy against a suitable rate of return elsewhere; the opportunity cost of the investment funds.

Obviously a combination of the two tests would determine the overall benefits to the two parties of the Water Demand Management strategy provided the reduced revenue from the reduction in water consumption was included as a cost to the strategy. It is important for a water authority to know the revenue impact of Water Demand Management for this reason.

This is especially true of Windhoek where losses were made on the City water bill as a result of successful Water Demand Management during the 1996 drought. The calculation of expected income on the water account was based on estimated water sales, in turn, on the available water source. The loss occurred as a result of higher savings than anticipated. The savings occurred mainly in the higher consumption block that has a major effect on revenues.

The Revenue Impact Test: This is self-explanatory and is written as follows:

Revenue Impact = Reduction in Operating Costs + Reduction in Capital Costs – Programme Costs – Reduced Revenues.

The effect on revenues will depend very much on the type of Water Demand Management strategy used. If moral persuasion or subsidisation of retro-fitting is undertaken the revenue effect will be negative. The effect on revenues as a result of pricing hikes will depend upon the responsiveness of demand to price changes. With the high fixed cost element of a water supply authority the unit cost of water will increase with lower demand. Through higher water efficiency the total cost to the authority and the customers will be lower.

Box 13.3 Revenue Impact

The following calculation gives an indication of the situation during 1995 after the implementation of WDM started. In the case of capital cost the extension of the Goreangab Water Reclamation works are taken into account as a deferred investment at a nominal rate of 3% per annum. The saving in water consumption was 3.2 Mm^3 (15%) on the unrestricted demand.

The saving in bulk supply cost payable to the Department of Water Affairs (now NamWater) amounted to N$ 5.28 Million. Of this amount the net saving can only be taken as N$ 1.6 million because the actual saving for DWA on the production cost of water can only be taken as N$ 0.50/m^3 i.e. 30% of the bulk supply price. The estimated benefit due to deferred investment amounted to N$ 2.4 Million. The cost for the implementation of the WDM programme was N$ 0.60 million. No reduction in revenue was experienced in 1996.

The net **Revenue Impact** in 1996 was an estimated saving of N$ 3.38 million for the Municipality of Windhoek and DWA.

Whether or not the Water Demand Management investment is economically viable depends upon the appraisal of all these factors and any external factors such as environmental costs. Whether the policy is politically acceptable will depend upon whom the costs and benefits fall, the extent of compensation, and who ultimately foots the bill. A suitable blend of policies can be adopted in order to influence to whom the costs and benefits accrue.

In conclusion, tests such as these can be implemented to discover whether or not it is worthwhile for government to promote and invest in WDM strategies. If the benefits to private individuals are not sufficient for them to act unilaterally, be they residential consumers or industrial consumers, the savings made by the water authority or the government as a result of lower operational and investment costs in water supply may justify intervention. This could be in the form of subsidisation of WDM technologies.

The basis for water tariffs is covered in the WASP document. In practice there are problems with the implementation of the principles. Development of fair tariff systems seems to be lacking in smaller municipalities, towns and villages. The way that subsidies are paid in urban areas, rural areas and even irrigation, warrants proper guidelines and clear policy objectives.

The social aspect of water is not clearly defined to ensure equity in supply. In this respect ability to pay and willingness to pay for water needs further investigations and clear policies.

13.1.3 Advocacy:

Advocacy or the awareness and lobbying component of an integrated Water Demand Management Strategy is considered an essential component of successful implementation of any WDM activities. In Namibia, active awareness work was initiated after Independence with the formation of the *National Water Awareness Campaign* under the patronage of His Excellency, Dr Sam Nujoma, the President of the Republic of Namibia. The campaign was launched on World Water Day 1992 and is co-ordinated by the Ecological Research Section and the Liaison office for the Ministry of Agriculture, Water and Rural Development. Each year the campaign committee chooses an appropriate theme and targets World Water Day and the annual Industrial and Agricultural show as well as schools to create a better national awareness of water. Since 1992 a series of water-related environmental education publications have been developed, printed and distributed in co-operation with NGO's particularly the Desert Research Foundation of Namibia DRFN, the Windhoek City Municipality and donors.

In 1998 and early 1999 the campaign was linked to the IUCN Water Demand Management Country Study for Namibia to promote the study and the theme of *Let every drop count* was chosen. A variety of activities were successfully carried out jointly by the *National Water Awareness Committee*, the WDM study and the city of Windhoek. Advocacy was further promoted through four presentations on the WDM country study at national and regional conferences.

Box 13.4 Advocacy activities during 1998 and early 1999

1998 SHELL ENVIRONMENT AWARD SUBMISSION: The Water Demand Management project of the City of Windhoek won the prestigious *Shell Environment management Award* for 1998(Chapter 10)

WORLD WATER DAY – 22 MARCH
1998: The Water Demand Management team, the *National Water Awareness Campaign* and the Namibia Water Resources Management Review, NWRMR team joined forces to celebrate World Water Day 1998. A poster with the theme *Let every drop count* was designed and a play on *Water our Greatest Treasure* was commissioned and performed by the Environment Club of the *Holy Cross Convent Primary School.* A special stamp, with the slogan *Let every drop count* was issued by *NamPost.* President Sam Nujoma was the guest speaker.

1999: The Water Demand Management team, the *National Water Awareness Campaign, the Desert Research Foundation of Namibia, DRFN* and the NWRMR team jointly celebrated World Water Day and the President Dr Sam Nujoma, launched the book *Namibia's Water A Decision Makers'Guide* to mark the occasion. A poster *Please let every drop count* aimed at tourists was designed and distributed to all tourist facilities country wide.

WATER DEMAND MANAGEMENT PAMPHLET: A pamphlet "*Water Demand Management – Namibian Country Study"* was prepared and distributed during fieldtrips and sent out with the study questionnaires. The pamphlet introduces the country study, asks for co-operation from the public and gives tips on practising Water Demand Management.

SCHOOL ART COMPETITON – *Let every drop count:* In April, the WDM country study teamed up with the Rural Water Supply Directorate for a national art competition with the themes *Water in our community* and *Let every drop count*. Entries were received from over 60 schools with over 500 children participating. Forty WDM prizes were awarded and the art displayed at the the *Yebo Gallery-John Muafangejo Centre* in Windhoek during October. Each school with winners received a water resource package, and every school that entered an art resources package worth N$ 200.00. The prize-money was sponsored by the Namibian Chamber of Mines.

Box 13.4 Continue

WORLD ENVIRONMENT DAY – 5 JUNE 1998:The play *Water our Greatest Treasure* was performed by the *Holy Cross Convent* Environment Club as an open air public performance for children.

1998 WATER RESOURCE PACKAGES: The WDM pamphlet, the World Water Day poster and the Shell award winning City of Windhoek submission on integrated WDM were reproduced in colour for inclusion in the annual School's water resource packages prepared by the *National Water Awareness Campaign*. 250 water resource packages were distributed to Teacher's resource centres, libraries, youth centres, rural water supply offices, *NamWater* centres, environment clubs, Ministry of Environment and Tourism extension offices and Environmental education centres, regional Governors and Namibian Diplomatic Missions abroad.

PRESENTATIONS : Presentations on the Water Demand Management country study were given at the 49th Annual Congress of the Association of Local Authorities in Namibia (ALAN) in March, at the CSIR Workshop on Water Demand Management in Pretoria, South Africa in July, at the regional Globe Conference for southern African parliamentarians in Cape Town in September at the Agricultural Economic Association Congress in Swakopmund in October 1998.

PUBLICATIONS : Three articles were written to promote the country study and WDM in Namibia***:***
Bethune, S. (1997/98) World Water Day – 22 March 1998. . *Roan News. Wildlife Society of Namibia – summer edition*. :13
Buckle, J and Bethune, S (1997/98) Water Demand Management – City of Windhoek wins the Shell Environmental Award. *Roan News. Wildlife Society of Namibia :*31
Van der Merwe, B., Buckle, J. and Steynberg R (1998) *Integrated Water Resources Management – Water Demand Management –Windhoek, Namibia*. Based on the winning submission for the Shell Environmental Management Award of 1998. Printed by City of Windhoek.

WORKSHOPS: The workshop to develop a *Strategy for the implementation of Water Demand Management in South Africa* held in Pretoria in November 98 was attended as well as the CSIR workshop in July.

13.1.4 Legislation

The Namibian Constitution and the Water Supply and Sanitation Sector Policy embrace the principle of sound social and environmental principles for sustainable natural resource development. The issue of cost recovery and equity is also addressed.

It was recognised that that Namibia is prone to drought with a very erratic rainfall pattern. A strategy was developed by the National Drought Task Force in 1997 to minimise the severe effects of drought on the people and the economy of the country. The measures include reduction of livestock during periods of drought, food aid for vulnerable groups as well as advice to farmers in advance on possible negative climatic conditions that may effect their production.

A wetland policy is being developed by the cross-sectoral Wetlands Working Group of Namibia to protect vulnerable wetlands in the country.

Model Water Regulations were developed with special emphasis on efficient use of and the prevention of water pollution. However very few Municipalities promulgated these regulations within their areas of jurisdiction.

13.1.5 Good Operational Practices by Water Authorities

There are cases in Namibia with exceptionally good practices. Yet in the country as a whole, the number of operators with inadequate expertise, the lack of proper maintenance and high unaccounted-for-water losses outweigh the good performers.

The institutional arrangements in respect to some local authorities contributes to a great extend to this sad state of affairs. The decentralisation of responsibilities will help to solve the problem in respect of integrated management of water resources. A clear WDM strategy with clear implementation plans is lacking at this stage.

Artificial recharge of aquifers shows promising results. If practical the goal of banking water to provide for periods of scarcity can become a major strategy to augment existing supplies, to increase efficiency of existing supplies through the lowering of evaporation losses and for better utilisation of existing infrastructure. This will contribute a great deal towards solving problems related to security of supply during extended periods of low inflow in surface reservoirs.

13.1.6 Efficient use of Water by Consumers

Efficient use of water is not national priority at this stage. In very few places like Windhoek, Swakopmund, Okahandja and Gobabis, water efficiency has a high priority. In the case of some mines, and industries and tourist camps good practices occur as a result of cost factors and a commitment by management. Initiatives are driven by individuals and there is little commitment to higher water efficiency on a National level.

The residential water consumption in many towns is very high. This includes places like Otjiwarongo and Khorixas with water supply problems. Water efficiency in the commercial and industrial sector can be improved. The Central Government departments with their soft budgets are major culprits as water wasters. With the present budget system and the lack of accountability it will be difficult to address the challenge to conserve water.

The new initiative in Rural Water Supply through Community Based Management will make water supply in rural areas more sustainable. Equity in rural water supply needs to be addressed in a proper way.

The irrigation sector that consumes approximately 43% of the total production makes use mainly of flood irrigation. In some case more water efficient irrigation systems have been installed. The planting of higher value crops in the country should be encouraged. The value added by this sector amounts only to N$ 0.50/m^3. The earlier policy of food self-sufficiency has now been adjusted to the more realistic one of food security in the new National Agricultural Policy.

Mines pay the full cost of their water supply. At least three of the mines in the country manage water efficiently. Reuse of water is practised at two mines while sea-water is used instead of freshwater at the diamond mines along the coast

The rapidly expanding tourism sector needs clear guidelines for higher water efficiency. The case study of Etendeka shows what can be achieved in a water scarce environment through proper management strategies.

13.1.7 Use of Unconventional Water Sources

Dual pipe systems to allow use of the purified effluent as irrigation water for sportsfields and parks are widely used in the country. In Windhoek, domestic effluent has been reclaimed to a potable standard since 1968. This source is regarded as a strategic resource during periods of drought and makes a major contribution to lower the reliance on water from unreliable conventional sources.

Desalination is under investigation at the coast while fog harvesting is also under investigation at Gobabeb (Desert Research station in the Namib). Rainwater harvesting is done on a very small scale by individuals.

13.2 WHAT DRIVES WATER DEMAND MANAGEMENT

In Namibia, scarce water resources and protection of the environment are the major driving forces for WDM. Often in developing countries, human pressure and the need for rapic social development takes precedence over care for the environment. Many of the major water schemes in the past did not take negative environmental effects properly into account.

At present the large local authorities in Namibia are driving Water Demand Management. Windhoek, being the capital and having the expertise and resources has been at the forefront in this regard. In Windhoek, the City Council has given their approval and backing to the Water Demand Management programme. Without this it would not have been successful. The re-use of treated sewage water on city gardens and the water reclaimation plant have substantially lowered the pressure on conventional water sources. Individual companies within the city, such as *Namibia Breweries,* have initiated sound Water Demand Management practises

For the mines the incentives are a combination of the limits of the water resource, (five of the mines surveyed are in the Namib Desert) environmental concerns and economic considerations.

The reasons for the Water Demand Management programme in Windhoek City and at *Namibia Breweries* is due to the conventional water sources being exploited fully and Water Demand Management being seen as the next source of water before the extension of the Eastern National Water Carrier to the Okavango River. In the case of *Etendeka* was scarcity an arid part of Namibia and the expense of transporting water from wells made Water Demand Management necessary.

The Department of Water Affairs has also promoted Water Demand Management on a national scale. Two recent publications by the Department of Water Affairs and the *Desert Research Foundation of Namibia,* DRFN, highlight the importance of Water Demand Management in Namibia. These are *Sharing Water in Southern Africa* where Chapter 6 on *Managing the situation* deals with, Water Demand Management and includes a table to show the relative value for water in each sector in Namibia. **Table 13.1** below is adapted from the table used. Industry and commerce provide the highest value whilst agriculture proves to be the least economic use of water in an arid country. The second publication is *Namibia's Water – A Decision Makers' Guide* that devotes several pages to Water Demand Management, explaining the need, the incentives and the benefits.

Table 13.1 Summary of Value Added per Cubic Metre of Water by Sector 1996

Economic Sector	Value added 1996 (millions of N$)	Water use 1996 (Mm^3)	Value added per cubic metre of water 1996 (N$)
Agriculture	1,029	142,9	7,20
Mining	1,654	25,2	65,60
Manufacturing	1,552	5,3	292,80
Services	3,215	5,5	574,50
Whole economy (GDP)	11,796	231,2[1]	51,00

In Namibia where water is such a scarce resource, WDM is a must and it is essential that policies and structures must be put in place to implement integrated WDM nationally.

13.3 FUNDING FOR WATER DEMAND MANAGEMENT ACTIVITIES

The Department of Water Affairs has no specific budget allocation for Water Demand Management. Funds to run the *National Water Awareness Campaign* and develop publications are provided by donors and to a limited extent from the budget allocation for Water Resources Management.

Water Demand Management is funded in Windhoek city by a levy of less than 1% on the water account. This includes the total cost of the permanent appointed officials and media campaigns.

Individual organisations fund their own strategies and find that in the long-term sound integrated Water Demand Management can save money.

13.4 RESPONSIVENESS OF SECTORS TO WATER DEMAND MANAGEMENT MEASURES

13.4.1 Urban Sector – Residential, Commercial and Industrial

Water Demand Management measures have been practised in an integrated manner only in Windhoek. The Windhoek case study shows the response of the different sectors in an urban environment to Water Demand Management. The results achieved show that through an integrated approach WDM in Windhoek has been a major success. The water demand decreased by more than 30% and the long-term growth in water demand has been restricted to less than 3% per annum (in spite of a 5.5% annual population growth rate). Through the reuse of water and artificial

[1] This total is different to the estimate given by Day 1997. Water production in 1996 was at least 30% lower as result of the drought.

groundwater recharge the reliance of Windhoek on conventional sources can be reduced to 33% of the unrestricted water demand from conventional sources.

The response to public campaigns and the co-operation of the public and private companies was excellent. Response from Government Departments was also ver good but needs improvement.

The case study of the Namibia Breweries shows the success of an industry that has been planned and built with the reuse of water in mind.

13.4.2 Rural Sector – Communal

The implementation of Community based Management, the progress with the establishment of Water Point Committees and the gradual introduction of a policy of payment for water shows that rural communities are willing and able to take on the responsibility of maintaining their own water supply and that it is in their own interest to use the water supplied efficiently.

13.4.3 Agricultural Sector – Stock and Irrigation

Most farmers are aware of the limitations of the water resource in Namibia and farm accordingly. In recent years many commercial farmers have incorporated game farming and tourism as more suitable land use practises in an arid environment. The exception remains the irrigation farmers. Here cheaper, water consumptive irrigation techniques such as flood irrigation are often still favoured and higher water efficiency is needed. A project to look at this at the Hardap Dam Irrigation Scheme is proposed for phase 2 of this study.

13.4.4 Mining Sector

In general, the mining sector has been responsive to Water Demand Management and the mines surveyed all practice some elements of the strategy. Yet, each still had room for improvement, particularly in terms of offering 'free' subsidised water to mine employees in very arid settings. An integrated approach should be further developed and guidelines produced for this sector on how to implement Water Demand Management.

13.4.5 Tourism Sector

Some tourist facilities, particularly those promoting eco-tourism do put into practice elements of Water Demand Management but as a sector there is as yet little response and a need to demonstrate, through pilot studies, that Water Demand Management has a role to play in this sector.

13.5 INFRASTRUCTURAL AND INSTITUTIONAL SUPPORT FOR THE IMPLEMENTATION OF WATER DEMAND MANAGEMENT

Infrastructural and Institutional support for the implementation of WDM in Namibia is weak and needs improvement.

Water Demand Management measures can only be successfully implemented if water consumption is metered and water audits are done. This is the case for most of the towns/municipalities in Namibia. Many towns in Namibia have poor reticulation systems, little maintenance and as a result high unaccounted-for-water losses. Leak detection and repairs need to be urgently addressed as part of Water Demand Management in Namibia.

Water metering is a new concept in communal areas and in the agricultural sector. Many irrigation farmers have no idea what their water consumption figures are and they tend to irrigate according to water needs assessed for particular crops in South Africa. The mines monitor their water use but not necessarily that used for gardens and individual households. Tourist facilities are often unmetered. The potential and technology for re-use and recycling exists and would require high investments in infrastructure needed for dual pipelines and reclamation plants.

13.6REGIONAL PROTOCOL AND TREATIES

The following five technical co-operation regional committees exist:

Kunene River	Permanent Joint Technical Commission (PJTC)
Okavango River	Permanent Okavango River Water Commision. (OKACOM)
Orange River	Permanent Water Commission (PWC)
Zambezi River	Zambezi Action Plan (ZACPLAN)
Kwando/Linyanti- Chobe River	Joint Permanent Technical Commision (JPTC)

Agreements for abstraction of water exist only for the Kunene and Orange rivers.

13.7 IMPACT OF THE WATER DEMAND MANAGEMENT COUNTRY STUDY

The WDM country study has made the entire water sector and users of water more aware on the need for more efficient use of water. In the past very few places actively pursued integrated WDM practices. The information collected gives very good cross-sectoral information for clear policy guidelines in the future.

The cross-sectoral membership of the WDM Country study Steering Committee team has further insured that the main players in water supply and use in Namibia are aware of the project and have had the opportunity to contribute to and learn from the studies undertaken.

The principle of water as an economic and social has been emphasised and will influence decisions in future. The benefits achieved through water saving and the potential monetary savings have been quantified for the first time. The principles as set out in the country study can form an important input in the development of national integrated policies in respect of WDM.

The issue of gender equality and the importance of the role of woman in the water sector came to the forefront. It was recognised that very little information is available on this important topic.

Benefits of WDM as management tool against the negative effects of drought was recognised. The long-term positive effects on the lowering of the annual growth rate in water production, especially in urban areas with high population growth rates (rural/urban migration) were quantified.

The document will be circulated and discussed with policy and decision makers to ensure that WDM will play a more prominent role in future development and the decision making process.

13.8 CONSTRAINTS AND OPPORTUNITIES FOR WATER DEMAND MANAGEMENT

The fact that Namibia does not have a clear policy and implementation strategy can be regarded as a major problem. This leads to a piecemeal approach to the implementation of WDM. Development of a national cross-sectoral policy and implementation strategy will help to address this challenge. Planning of new water infrastructure should also take different sectors and consumers into account as well as possible negative/positive social and environmental factors.

Financial accountability by the different authorities will provide a major opportunity for effective implementation of WDM by the different levels of water authorities. There are major opportunities to improve the development of proper water tariff systems based on long-term financial and environmental sustainability concepts. The calculation of opportunity cost in different sectors as well as environmental costs needs to be assessed for possible inclusion in future tariff systems.

In former communal towns the training and development of human resources for proper maintenance and operation of water related infrastructure is overdue and needs urgent attention. Development of proper preventative maintenance programmme will lower unaccounted-for-water and enhance income generated from water sales.

As a result of the fairly wide range of Advocacy activities during this year, and by coupling the efforts to those of the existing *National Water Awareness Campaign* the IUCN Water Demand Management Study has become well known throughout Namibia. The art competition has focussed learners attention on efficient water use through the slogan *Let every drop count* and it is hoped that the special stamp edition has done the same for the general public. The presentations at conferences served to inform specific audiences of the work, e.g. the ALAN Conference was attended by all the newly elected members of the 42 local authorities in Namibia as well as 2 Ministers and several regional Governors.

The Questionnaires sent to the main water users in the Urban, Commercial (Industrial and mining), Irrigation and Tourist sectors served to create a country-wide awareness of the project and its aims. This was further enhanced by the numerous interviews conducted with water users and suppliers throughout Namibia during the field trips. Posters and the WDM pamphlets were handed to all those interviewed and sent out with all the questionnaires. This initial introduction to the project will serve us well in implementing the pilot projects identified for the second phase. All the pilot projects proposed for phase two will contain an strong awareness component, which include staff and public training as well as the development of appropriate posters, pamphlets and guideline booklets.

The work to date has shown the importance of an integrated approach for Water Demand Management to be successful, and one vital component is well-targeted advocacy. A need for clear guidelines, appropriate to each water use sector has been identified and should form the focus of advocacy work in the second phase of the IUCN Water Demand Management Country Study for Namibia. These guidelines could later be expanded for regional use.

13.9 CONCLUSIONS

The country study was worth all the effort. The document will be useful for policy and decision makers to improve water efficiency through the development of sound policies and strategies for implementation.

The issue of sustainable use of resources as set out in the Constitution of Namibia and the WASP document came to the forefront again.

14. GENERAL LESSONS LEARNT, CONCLUSIONS AND RECOMMENDATIONS.

There are many lessons and recommendations that can be drawn from the case studies and the general findings of the report. The findings can be considered under the following sub-headings.

Policy

The current national water sector policies, under which all water related activities must fall, include:
The Water Act 54 of 1956 and regulations promulgated in term of the Act

The Water and Sanitation Policy of 1993

The Namibia Water Corporation Act 12 of 1997

The Local Authorities Act 23 of 1992

The Model Water Supply Regulations, notice 72 of 1996.

The Model Sewerage and Drainage Regulations, notice 99 of 1996

All of these pieces of legislation allude to the more efficient and equitable provision of water resources under the premise of sustainability. None refer to Water Demand Management specifically although the principles of Water Demand Management are contained therein e.g. the economic pricing of water resources, utilisation of water resources on a long-term sustainable basis, and provision for equitable distribution of water resources.

The best results of WDM have been noted in Windhoek. These include:

- Highly water efficient industries
- A high level of public awareness and co-operation
- Low per capita residential consumption

WDM has been effective in Windhoek as a result of the municipality's proclaimed WDM policy. It seems clear from the successes that have been illustrated in the Windhoek case study that a distinct Water Demand Management policy focuses the managers of water supply on the combined facets of existing policy relating to reduction of wastage and efficient allocation of water. In this way an integrated approach to water management is achieved with the emphasis on finding the most effective way to provide the same services that people obtain from water (and hence the economic benefits) yet using smaller amounts of water. This suggests that countrywide water efficiency could be improved by the implementation of a **National Water Demand Management Policy**.

Economics and Pricing

Economic analysis of WDM, water policy and the water sector leads us to the following broad conclusions:

- The Optimal use of water resources requires an economic price. Investigations and evidence from the recent past has shown that the price of water offers the main incentive to use water efficiently in residential areas, industry and commerce.

- It is possible to both under and over-price water. It is important that a keen eye is kept on the price setting behaviour of water supply institutions such as NamWater and the Local Authorities, in order for the true costs of water to be reflected in the price and therefore WDM to be effected in the most beneficial way.

- The price setting process in NamWater and Local Authorities is currently not subject to a broad pricing policy. It has been shown that the water tariffs in municipalities, towns and villages often do not reflect the financial cost of supply. Both Local Authorities' and NamWater's tariffs do not reflect all the components of an optimal economic price.

- Irrigation levees do not coincide with the principles of WDM. The per hectare tariff used along the border rivers does not comply with the principles of WDM. Only volumetric tariffs will encourage efficient use of water. This will require metering of water and a reasonable tariff to be set.

Planning

- WDM and the associated tools should be a key component of the planning process for the Water Sector. WDM options are competitive in terms of the financial costs and largely avoid the external costs associated with supply augmentation. The efficiency of current water systems will be improved by WDM. In this sense the narrowing gap between demand and supply should be addressed from the demand side as well as the supply side.

- National planning and the policies of different government sectors should consider their effect on the water sector.

Social

The social goals of the water sector have been clearly stated. Emphasis has been placed on access to water in rural areas and affordability in both urban and rural areas. Several points can be made with respect to these social goals.

- Economic efficiency does not necessarily evoke equitable outcomes. The emphasis of WDM upon economic pricing neglects the issue of affordability. However, the use of block tariffs which supply “life-line” levels of water at a cost lower than the actual cost of supply can help to alleviate the access problems that occur due to economic constraints in poorer households. At present this system is only used in a handful of towns.

- Care is needed in developing block tariff systems. In Tsumeb for example the implementation of block tariff increased the overall consumption of the town. Properly implemented, block tariffs can address both social issues and the issues of WDM.

- The use of WDM in rural areas should take heed of the low levels of per capita consumption that currently prevail. The results of the SIAPAC study suggest that the level of per capita daily consumption in rural areas is below the minimum required for health as recommended by WHO.

Urban Water Supply Sector

The main issues that have arisen from this analysis of the institutions and institutional arrangements that exist for urban water supply in Namibia are as follows:

- Soft budget constraints.
  The responsibility for payment of water bills is often with the central Ministry rather than the Local Authorities. There is no incentive for these Local Authorities to collect revenues or monitor costs. NamWater supplies, the Ministry pays (or not), and the consumers consume.

- Water Accounting**.**
  Revenues received from water consumers do not pay directly for the costs of water supply. Often the revenues go into the state fund. Revenues are divorced from the costs of supply making it impossible to tell whether water supply is breaking even.

- Tariff Setting.
  The divorce of cost and revenues leads in part to several tariff-setting problems:
  - Non-volumetric tariffs
  - Tariffs incommensurate with reticulation costs
  - The true costs of groundwater mining may not be reflected
  - Tariffs do not keep pace with inflation
  - Environmental costs are not reflected

  The institutional responsibility for ensuring that each of these factors is considered is not clear.

- Reuse of wastewater as a substitute of water from conventional sources are practised in many urban areas. This is based on sound economics and sustainable development principles.

- Unaccounted for water and Expertise:
  The Local Authorities must pay for all water that is supplied by NamWater, much of which, often over 30%, is unaccounted for. Often local authorities lack the expertise and incentive to reduce wastage. The development of a training module in WDM principles and practises for us by Local Authorities is proposed in **Annexure 3**. Anecdotal evidence suggests that it is often unclear as to the institution responsible for maintenance.

- Non-payment:
  Non-payment of water bills is a common feature in all urban centres. Institutions lack teeth and incentive to take action on non-payers.

- Government Institutions.
  Government institutions tend to be some of the highest users of water in the urban centres. Those who use water in these institutions do not have to pay for water. Government institutions tend to see water as just another recurrent expenditure.

In summary, the way in which water is paid for, accounted for, monitored and managed in urban areas is not efficient and the institutional arrangements and responsibilities are ineffectual and unclear.

Rural Water Supply Sector

The low per capita water consumption is of concern. The idea of cost recovery at all costs should perhaps be weighed against equality and basic human needs. The principle to impose a levy on livestock watering needs may be a good way to get better equity amongst the rural consumers.

- Lower wastage will be possible through more efficient livestock watering.
- Community Based Management will enhance efficiency and will create ownership of the water points amongst the users of the resource. This will lower the dependency on Central Government for the maintenance of supplies.

Agricultural Sector

Irrigation
In irrigation the following uncertainties arose:

- Irrigation payments
  The payment for water use at Hardap dam, the Etunda scheme and Naute dam seems not to have occurred with regularity. It is often unclear who is responsible for the payment.

- Value added through irrigation
  The value added through irrigation is the lowest in the country. Due the aridity of Namibia proper evaluations needs to be done to ensure that irrigation farming is the best option. Growing of high value crops may present an opportunity. A study proposal is added in **Annexure 3.**

- The involvement of the Government in irrigation schemes should as far as possible be restricted to a facilitating role. Development of schemes should be left to the private sector provided that proper feasibility studies are done.

Livestock Farming

- Limited information is available on Water Demand Management in livestock farming. Livestock farming uses approximately 20% of the total water supply. The value added amounts to N$ 20.00/m^3 water consumed. More information on this sector needs to be collected to better assess of WDM practices.

The Industrial Sector

Namibia has relatively few water consumptive industries. Some industries, such as the breweries practise WDM, whilst others such as the meat and fish processing industries can do more to implement effective Water Demand Management. A project to work with these industries to improve the efficiency of water use is proposed in **Annexure 3.**

The Mining Sector

The mining sector seems to be sensitive to water consumption in mining operations. All the mines pay the full financial cost of water.

- Use of sea-water and water reclamation is practised at many of the mines.
- The wastage of “free water” at mining townships needs urgent attention.

Tourism Sector

Tourism is a growing sector in the economy of Namibia. The following needs to be implemented within the sector:

- Advocacy to make the sector more aware of water as a precious resource.

- Evaluation of the value added in the different tourist facilities for future planning purposes. A project proposal to evaluate this as well the efficiency of water use is attached in **Annexure 3.**

RECOMMENDATIONS

Policy

The creation of a distinct **National or even Regional Water Demand Management Policy,** to raise awareness of the scarcity of water and to focus the players in the water sector on the issues of water conservation and efficiency of supply, will yield net benefits comparable to those seen in Windhoek. Evidence from around the country suggests that there is considerable potential to be exploited.

Regulation

- From a WDM point of view it is important that NamWater be monitored/regulated in order that the financial pricing technique reflects the long-run cost of water supply and that environmental costs are taken into consideration and managed. If this is not the case consumers will be given the wrong signal with respect to the scarcity of water and although NamWater may achieve financial cost recovery the social costs of water may not be reflected.

Local Authorities share the responsibility for providing water. Tariff setting in Local Authorities has been shown to be inadequate for WDM. It is important that Local Authorities pass on the true costs of water supply to the consumers. Training to improve competency in this area is urgently required and is included in the proposal to develop a suitable training module is included in **Annexure 3.**

Decentralization

The decentralization policy, as indicated in the WASP and the Constitution itself, offers potential improvements for water management and the implementation of WDM policies such as pricing. However it is imperative that the process of decentralization is given the full backing of Central Government in terms of training, finance and power.

- The movement towards decentralization needs to be monitored. The extent to which decentralised responsibilities are being successfully undertaken will require some centralized involvement.

- Tariff setting behaviour in all institutions must be addressed with respect to the problems mentioned above. NEPRU 1997 suggests that guidelines for good practice should be developed for the variety of different tasks that local authorities undertake. Tariff setting is one of those tasks.

- The extent of non-payment and unaccounted for water should be addressed in order to establish the sustainability of supply in certain areas. Unaccounted for water, non-payment and tariff setting should be monitored over time to indicate the effectiveness of the new management regimes.

- The extent to which savings in water could be cost effectively achieved in the government institutions should be investigated.

- The accountability of different water users needs to be established at each supply node, e.g. Namwater, Local Government/municipality, and consumers (residents, businesses and government institutions). It seems evident that a firm grip on water accounts in each of the institutions is required for water to be effectively managed.

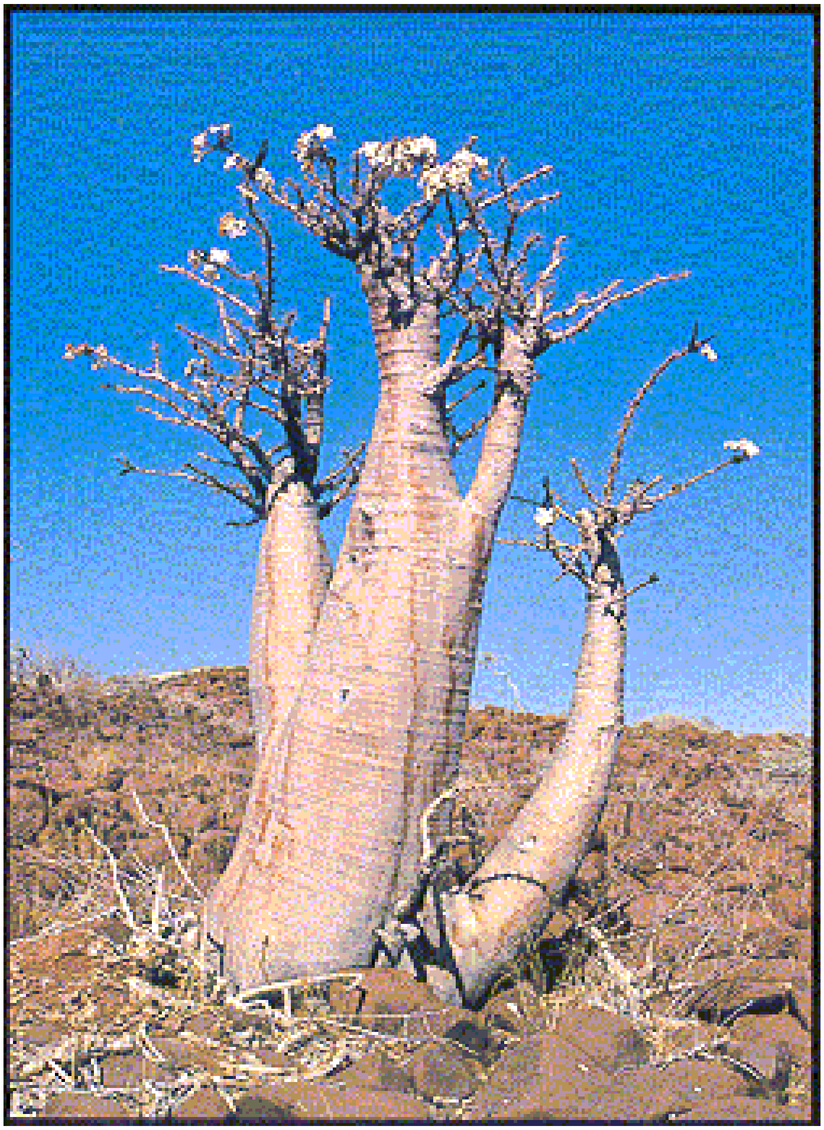
Regional Co-operation

- The establishment of a regional network and website on Water Demand Management practises will be a worthwhile way to promote the exchange of information.
- An interest group in the region to further the objectives of integrated Water Demand Management policies and practises should be created.
- Establishment of specific water intakes for the different types of mining and industrial operations in the region.
- A series of guideline booklets specific to each sector should be developed for the region

'When the well's dry, We know the worth of Water
-*Benjamin Franklin*

WATER DEMAND MANAGEMENT AT ETENDEKA MOUNTAIN CAMP

SHIRLEY BETHUNE



REPORT TO IUCN

(THE WORLD CONSERVATION UNION)

WATER DEMAND MANAGEMENT AT ETENDEKA MOUNTAIN CAMP

TABLE OF CONTENTS

DRAFT
WATER DEMAND MANAGEMENT
AT ETENDEKA MOUNTAIN CAMP, NAMIBIA

Shirley Bethune
Ecological Research Section
Department of Water Affairs
Private Bag 13193
Windhoek, Namibia
Email: bethunes@mawrd.gov.na

1. INTRODUCTION

Tourism is the fastest growing sector of the Namibian economy. In southern Africa tourism has grown at an average of 20% annually over the past five years. Namibia has experienced a steady increase, 21,85% between 1993 and 1996 and 9% per year since then, with more than half a million tourists visiting in 1997 (Stephen Brown, Directorate of Tourism pers.comm).

Tourism is a labour-intensive industry providing employment in the tourism sector as well as in the supporting commercial sector. Half a million tourists also have an impact on water consumption in an arid country and for this reason the tourist sector was included in the Water Demand Management Country Study for Namibia.

Etendeka Mountain Camp was selected as a case study because of the fine example it sets. This case study shows that even up-market tourist facilities can be offered in arid areas and that by integrating appropriate technology and awareness, amongst both staff and clients, water consumption can be kept to a minimum in keeping with the environment.

2. CASE STUDY METHODOLOGY

A questionnaire was drafted and piloted in the Caprivi region in August, before being distributed to tourist facilities throughout the country. (See attached copy of the questionnaire). To facilitate distribution two of the major tourist organisations, *The Hospitality Association of Namibia (HAN)* and *Namibia Resorts International (NRI)* were approached and agreed to send out the questionnaires to all their members. As can be seen in the section of the tourism sector very few of the tourist camps and hotels that responded are actively practising Water Demand Management. A significant exception is *Etendeka Mountain Camp.*

Following the questionnaire response from *Etendeka Mountain Camp,* the owner of the camp, Mr Denis Liebenberg, was interviewed on 5 November. The author has been a guest at the camp on three previous occasions and can vouch for the water demand practices employed.

The water consumption figures for *Etendeka Mountain Camp* were compared with those given in questionnaire reponses received from other tourist facilities and the relative value of the water compared with values calculated for other sectors of the economy.

3. DESCRIPTION OF THE CASE STUDY AND AREA

Etendeka Mountain Camp is situated on the Northern Namib escarpment in a semi-desert wilderness area. The camp is within the Kunene Region Concession Area no 2 and the *Etendeka* Tourist Concession covers an area of 45 000 ha. The concessionaire enjoys exclusive access, being the only tourist operation allowed operate in the area and has an agreement with the communities living on neighbouring communal farms regarding nomadic use for stock-grazing and hunting rights. Strict ecotourism principles are adhered too at *Etendeka Mountain Camp* and the local community is actively involved. There is a community fund related to bed-nights and money collected is handed to the community every two years

The area has a high tourism potential as unspoilt wilderness. Game species include gemsbok, zebra, springbuck, giraffe, rhino and elephant. The arid-adapted plants, rugged mountainous scenery and wildlife are the main attractions. The camp offers guided walks and scenic drives one of which is the hour and a half transfer drive from Veterinary gate on the main road, where guests can safely leave their vehicles.

The camp averages 1 300 bed nights a year, with most of these (950) during the peak season from July to October. Most tourists stay 2 nights. An inclusive rate (transfers, scenic drive, guided walk, tented accommodation and all meals) cost N$ 680.00 per night. There are 16 beds available in the 10 tents. There are 6 bucket showers and 7 low-flush toilets as well as staff accommodation and pit latrines.

4. MAIN ISSUES

The main issues are that the camp is situated in an area with little available water, with little economic potential other than tourism, that access to resources is a not easy and that water has to be brought in from wells 6 – 8 kms away.

4.1 WATER SCARCITY

The camp is situated in a water scarce area, rainfall is between 100 and 120 mm per year and evaporation rates are high. Summer temperatures can reach 43^0C and in winter frost can occur. South westerly winds predominate and in the winter months damaging north easterly winds occur, wind speeds of up to 130 km/h have been measured. Water is supplied from 3 groundwater wells, 6 – 8 km from the camp. There are a few natural springs which provide just enough water to maintain low densities of wildlife and in good years can provide water to small herds of nomadic livestock.

4.2 LOW PRODUCTIVITY

This arid and rugged area has little agricultural potential although after exceptional rains the normally rocky terrain can be transformed into lush grasslands. Nomadic farmers then move their cattle and goat herds into the area. In good years, the grass and temporary waterholes attract large concentrations of game too. These periods of plenty are short-lived and in the long-term farming is at best a marginal enterprise in the area. Yet with careful and environmentally sensitive planning eco-tourism can bring much needed revenue into the area. *Etendeka Mountain Camp* provides a good example of such planning and sustainable tourist development.

4.3 ACCESS RESTRICTIONS

Given the aridity and harsh climate, no food is produced at the camp and everything has to be trucked in from Kamanjab 140 km away, Otjiwarongo, 358 km away and even Windhoek some 600 km away.

There is no water source at the camp and all water supplies ($120m^3/a$) is collected in drums from boreholes 6 – 8 km from the camp and brought in by vehicle. The wells are dependent on the low and erratic rainfall for recharge and have a low storage volume. As a result the water resources are both low and unreliable. It would not be worth investing in a pipeline and pumps only to have the water source dry out and further, permanent structures are not allowed within the wilderness concession area.

4.4 EXPENSIVE WATER TRANSPORT

The main expense at *Etendeka* is vehicles and transport. The purchase and maintenance of vehicles and fuel costs account for about 32% of the total costs the business incurs. Water provision costs about 5% most of which is incorporated in vehicle use to bring the water to the camp. The cost of collecting the water and transporting it 6 – 8 km is estimated to be about 15c/litre or N$ 150.00 per m^3. In comparison water supplied to households in Windhoek costs N$ 2.65c.

5. DRIVING FORCES FOR THE IMPLEMENTATION OF WATER DEMAND MANAGEMENT

The water demand management practiced at *Etendeka Mountain Camp* was initiated by the owner and manager Denis Liebenberg himself and is based on over 15 years of experience in eco-tourism in southern Africa.

The driving force for the implementation of Water Demand Mangement has been the scarcity of available water in this arid area and the expense of transferring the water by vehicle from the distant and unreliable wells to the where the camp is located.

6. INTERGRATED APPROACH TO WATER DEMAND MANAGEMENT (TOOLS AND METHODS)

Etendeka Mountain Camp relies on an integrated approach to implement effective Water Demand Management. This approach combines an appropriate management policy, technology and awareness. An efficient water management policy is followed and is an integral component of staff education, appropriate water-saving technology is used to reduce water use by customers and staff and water conservation is actively promoted in the introductory lecture to all customers on arrival at the camp.

6.1 MANAGEMENT POLICY

The management policy of the camp is in keeping with the aridity of the area. There are neither lawns nor exotic plants, the “garden” consists of natural rocks and plants indigenous to the arid area. There is no swimming pool. Shade is provided by shade-cloth. All staff members are trained to use water economically.

6.2 WATER SAVING TECHNOLOGY

The showers are restricted to 15 litres per person by using a bucket shower system. The water for the showers is heated in solar heaters and the shower buckets are filled by the staff at the customer's request. Buckets are used in the kitchen, to bring in water for cooking and washing up and to remove waste-water. All rinsing water is poured onto indigenous plants at the camp. Direct flush toilets reduce water consumption to 2-3 litres per flush, the staff use pit latrines.

6.3 WATER AWARENESS

Guests, mainly from overseas, are informed about the scarce water resources of Namibia and asked to help conserve these by curtailing their water use. They are educated regarding water conservation during an introductory lecture on arrival and through brochures and leaflets. Using the showers and low-flush toilets allows them to put this into practice. Linen is washed by hand and there is no laundry service for guests. Linen and towels are not changed daily but only when guests depart. These are washed at a nearby village. Clients' vehicles, parked at the Veterinary gate, are washed using buckets and not hose-pipes.

7. RESULTS

Etendeka Mountain Camp is able to maintain 1 300 bed-nights a year on a water consumption of only 120m^3 per year and maintain a standard of accommodation and service expected by discerning overseas guests, for a tented lodge. Unfortunately there has not been the opportunity during this study to compare these figures to similar camps in the same area. This would be worth doing as part of the Phase 2 study. Broad comparison with results obtained from questionnaire returns received from elsewhere in Namibia can however be made. *Camp Setengi* used twice this amount of water in 4 months but do not give figures on how many bed-nights this included. At the other end of the scale, *Mokuti Lodge,* next to the Etosha National Park, used almost a thousand times more water – 114 675 m^3 in a nine month period. Although they did not reply to the questions on tourist numbers they could not have hosted a thousand times more tourists than *Etendeka* did. The highest water use at *Etendeka* is that used by the tourists which comes to a mere 35 litres per person per day. Few other tourist resorts could match that.

The cost of installing and maintaining the appropriate water-efficient technology is estimated at being about the same as it would have cost to install more conventional showers, toilets and pipes. The bucket showers cost about N$1 000 each to build whilst the solar heaters pushed the cost up to N$4 000 for each of the six shower units. The special low water consumption design toilets cost about N$500 each and with the cisterns and pipes this could come to N$ 1000 for each of the seven toilets. The cost of the kitchen sinks and buckets was minimal and required no plumbing. When one takes into account the relatively high cost of transporting the water to the camp, given as 15c / litre i.e. N$ 150 /m^3, the operating cost is high. This cost, coupled with the scarcity and unreliability of water in the area, has driven water demand mangement. Despite this cost, the high returns from customers able to pay well for the product offered by *Etendeka Mountain Camp,* makes this an appropriate high value use of water. A calculation based on the annual water use and income for the average number of bed-nights shows that over N$ 7000.00 is generated per cubic metre of water used at the camp. Additional income is generated for the local community both in terms of employment and through the community fund.

8. DISCUSSION ON CONSTRAINTS, OPPORTUNITIES, LESSONS AND EFFECTIVENESS

The main constraint to implementing Water Demand Management at *Etendeka Mountain Camp* has been consumer resistance. *Etendeka Mountain Camp* is unique in its product and offers and experience that may not appeal to the majority of tourists.

The main benefit of implementing water demand management at *Etendeka Mountain Camp* has been the water savings, allowing sustainable use of a scarce resource in an arid area. By using water efficiently it has been possible to run a successful tourist business in an area where many would have thought it impossible, creating an opportunity to bring much needed revenue to the country and to local communities. It provides a lesson to other tourist facilities throughout the country, and particularly in arid areas, showing by example that it is possible to run a camp in a water scarce area and still attract tourists, create employment and bring in revenue. It provides an example to the rest of Southern Africa on the use of appropriate technology and the effectiveness of environmental education in tourism. Each visitor returns home with an enhanced understanding of the challenges faced when living in an arid environment and with the knowledge that they were actively able to contribute to conserving a valuable resource. Having experienced the benefits on holiday some tourists may be encouraged to practice Water Demand Management at home too. *Etendeka Mountain Camp* puts into practice the ethics of eco-tourism and actively promotes sustainable development. In this case tourism provides a higher value and more appropriate use of water in the area than alternative economic activities such as farming would.

9. CONCLUSION

The camp has been run successfully since 1992 and, despite the limitations of water use imposed, many guests staying there consider the *Etendeka* experience as one of the highlights of their Namibian visit. Many return or recommend the camp to friends. Water Demand Management works at *Etendeka Mountain Camp* and is a good example of adapting to prevailing conditions.

Water Demand Management here is strictly necessary because of water scarcity and the high costs of collection and transport. This resource-sensitive approach to Water Demand Management is most relevant to arid areas. The example set by *Etendeka Mountain Camp* can be used to encourage Water Demand Management in tourist facilities elsewhere, even those not faced by the same scarcity of water resources e.g. camps on the banks of the Okavango River. Tourist facilities in less dry areas also need to adopt Water Demand Management, but for different reasons e.g. due to growing demands on the water resources of the perennial rivers by competitive water users such as irrigation and urban centres. Here the style of Water Demand Management would need to be different, taking into account local conditions. In some cases, it may even be more appropriate to target the municipalities and irrigation schemes that compared to tourist facilities, use a relatively small amount of water.

In the next phase of the Water Demand Management Country study for Namibia it would be interesting to investigate other tourism enterprises and compare effective water use and assign relative water values. Pilot studies elsewhere in the Damaraland wilderness area and within the relatively dry Etosha National Park would provide interesting information.

10. ACKNOWLEDGEMENTS:

I would like to thank Denis Liebenberg and Barbara Curtis for information on *Etendeka Mountain Camp* and Ben Groom, Piet Heyns and Mary Seely for reviewing drafts of this report.

GLOSSARY

Bed-nights: A measure of occupation, number of nights tourists occupy accommodation.

Eco-tourism: Purposeful travel to natural areas to understand the culture and natural history of the environment, taking care not to alter the integrity of the ecosystem, while producing economic opportunities that make the conservation of natural resources beneficial to local people.

Integrated approach: An approach that takes into account all the different viewpoints or a variety of methods, to cover all the relevant aspects.

Resource sensitive approach: An approach that takes into account the natural resources, and tries not to degrade or damage them

Tourist: Person away from home, on short term, temporary visits, of at least one night, mainly for leisure but including business purposes.

Water Demand Management: A holistic and integrated approach towards sustainable development and use of water resources, involving the implementation of policies for the efficient use of water, for equity, economic efficiency and environmental sustainability.

CASE STUDY ON WATER DEMAND MANAGEMENT IN NAMIBIA BREWERIES

Manfred Redecker*

*P O Box 22325
Windhoek
Namibia
e-mail: manfred@ iafrica.com.na

1. BACKGROUND INFORMATION

1.1 History of Namibia Breweries*

*(extract from the Namibia Breweries Ltd Prospectus issued 13 March 1996)

Namibia Breweries traces its origins to the beginning of this century when four local breweries were established, one in Swakopmund, one in Omaruru and two in Windhoek. These breweries supplied beer more suited to the local conditions than the beers that had previously been imported from Germany. During the 1914 -1918 War in Europe, Germany withdrew the troops stationed in this country and the demand for beer fell, ultimately resulting in the amalgamation of the Windhoek and Omaruru breweries in 1920. The amalgamated company was called The South West Breweries Limited, the former name of the present Namibia Breweries.

In 1968 the majority shareholding in Hansa Brauerei, Swakopmund was acquired. The brewery had operated with outdated equipment of limited capacity. Following the acquisition, the brewery was re-equipped and has since continued to produce beer for both the local and the export market.

During 1970 the Company acquired Tropicana Bottling Company (Pty) Limited, which was the franchise holder for Pepsi Cola in the country. Following this acquisition the Company invested in new plant to update the existing equipment and to increase capacity.

When Angola gained its independence in 1975 and then plunged into civil war, the Company was given the first real opportunity to gain market prominence in the north of the country. Until then this market had been supplied by South African producers, whose products were available in the Caprivi region, and by Angolan producers whose products had entered the Ovambo and Kavango regions of the country without incurring excise or other duties, due to virtually non-existent border controls. With the advent of civil war, Angolan produced beer no longer reached the northern Namibian regions.

In 1977 the Company was granted a road transportation permit. This was very important to the Company's growth since it freed it from the severely restrictive state rail transportation services and enabled it to cut delivery times substantially. As a result the Company experienced significant growth in its domestic market.

Absolute capacity limits were reached in 1980. A new bottling plant and a dispatch and warehousing facility went into operation at the end of 1982 and in 1985 the new brewery in Windhoek was commissioned, employing technology which even today ranks amongst the most advanced in the world.

When the country gained its independence in 1990, the Company changed its name to Namibia Breweries Limited and began to exploit a number of export markets which hitherto had been closed to it. This has further strengthened the Company's position as the largest manufacturer within Namibia.

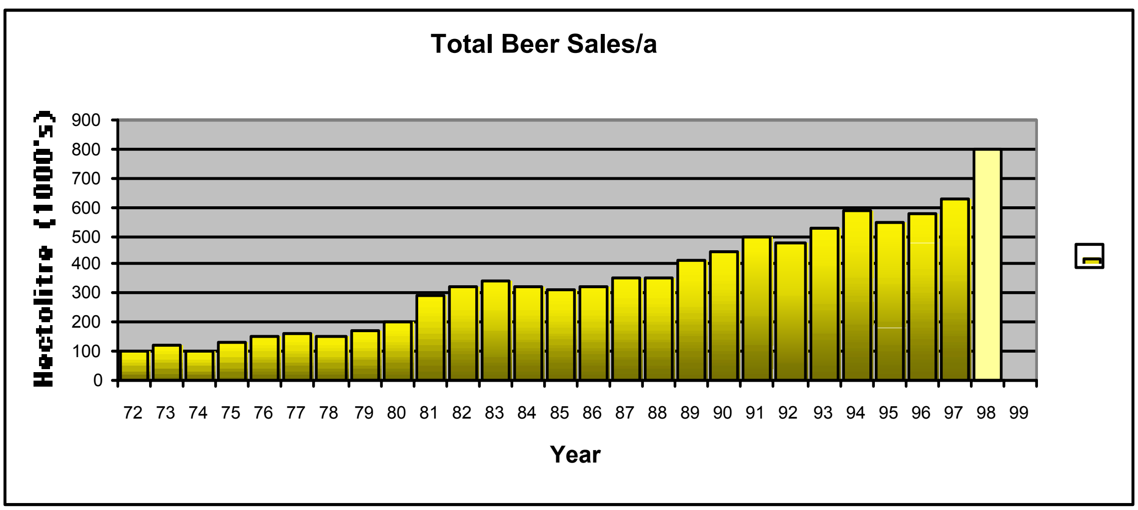
In 1995 the Company celebrated its 75th anniversary and the Company is now the only licensed producer of beer in the country and by far the market leader.

1.2 Ownership of Namibia Breweries Ltd

Since 1996 Namibia Breweries Ltd is listed on the Namibian Stock Exchange. The majority shareholder is Ohlthaver & List Finance and Trading Corporation Limited.

1.3 Development of the new brewery in Windhoek

The increasing demand for Windhoek beer called for the construction of an entirely new brewery.



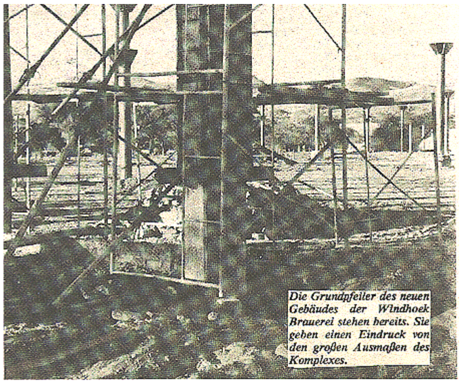
The old brewery was situated in Garten Street from its establishment in 1920 till 1986, when the plant was finally decommissioned and beer production activities were relocated to the new brewery in Iscor/Dortmund Street. Bottling operations commenced earlier in 1982 at the new brewery.

From the old bottling plant:

….to the new bottling plant:

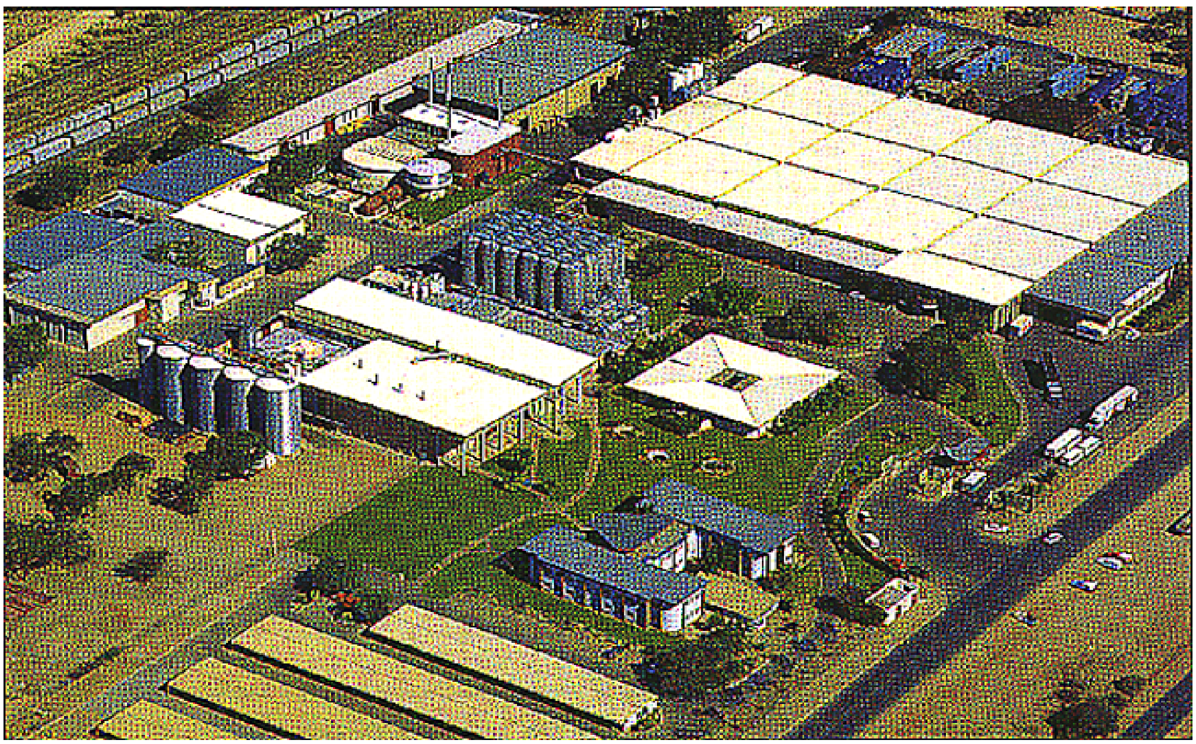
Key dates in the development history of the new Windhoek Brewery:
On 13-3-1981 the site was handed over to the building contractor. On 26-1-1982 the first run of the bottling plant was witnessed and six months later the bottling plant was finally completed. Beer brewing continued at Garten Street and on 4-12-1985 the new brew house was commissioned. All operations at the old brewery were discontinued late in 1986.

The new Windhoek Brewery from first column to final completion:



The first column 1981

Construction of the Brew house 1985



Aerial view of the Namibia Breweries in Iscor Street

2. WATER DEMAND MANAGEMENT IN THE NAMIBIA BREWERIES

2.1 Design approach

The concept design of the new Windhoek Brewery was executed in 1980/81. During this period Windhoek experienced a severe water shortage and water consumption restrictions were implemented.

A report in a local newspaper quoted the City Clerk as threatening to close the brewery if the water supply to Windhoek City would deteriorate any further. This threat emphasised necessary and extraordinary attention to water consumption during the design stage. A holistic and integrated approach to water savings and management followed.

2.2 Quality approach

The adoption of the total quality concept by management of the Brewery is an additional and fundamentally important step towards the responsible utilization of raw materials including power and water usage. Quality in every sphere reduces the waste of products and therefore requires less input of raw materials including water.

Above departures are considered to have contributed to the fact that the Windhoek Brewery is today a world leader in the optimal use of water and that the water utilization concept of the Brewery lends itself to serve as an example for studying water demand management in many facets.

The low specific water consumption in comparison with sister industries world wide is a result of a number of smaller individual measures which in combination provide a substantial reduction of water consumption. *There is no single patent or solution to achieve water demand management*. A holistic approach to water utilisation is considered a fundamental requirement for sound water demand management.

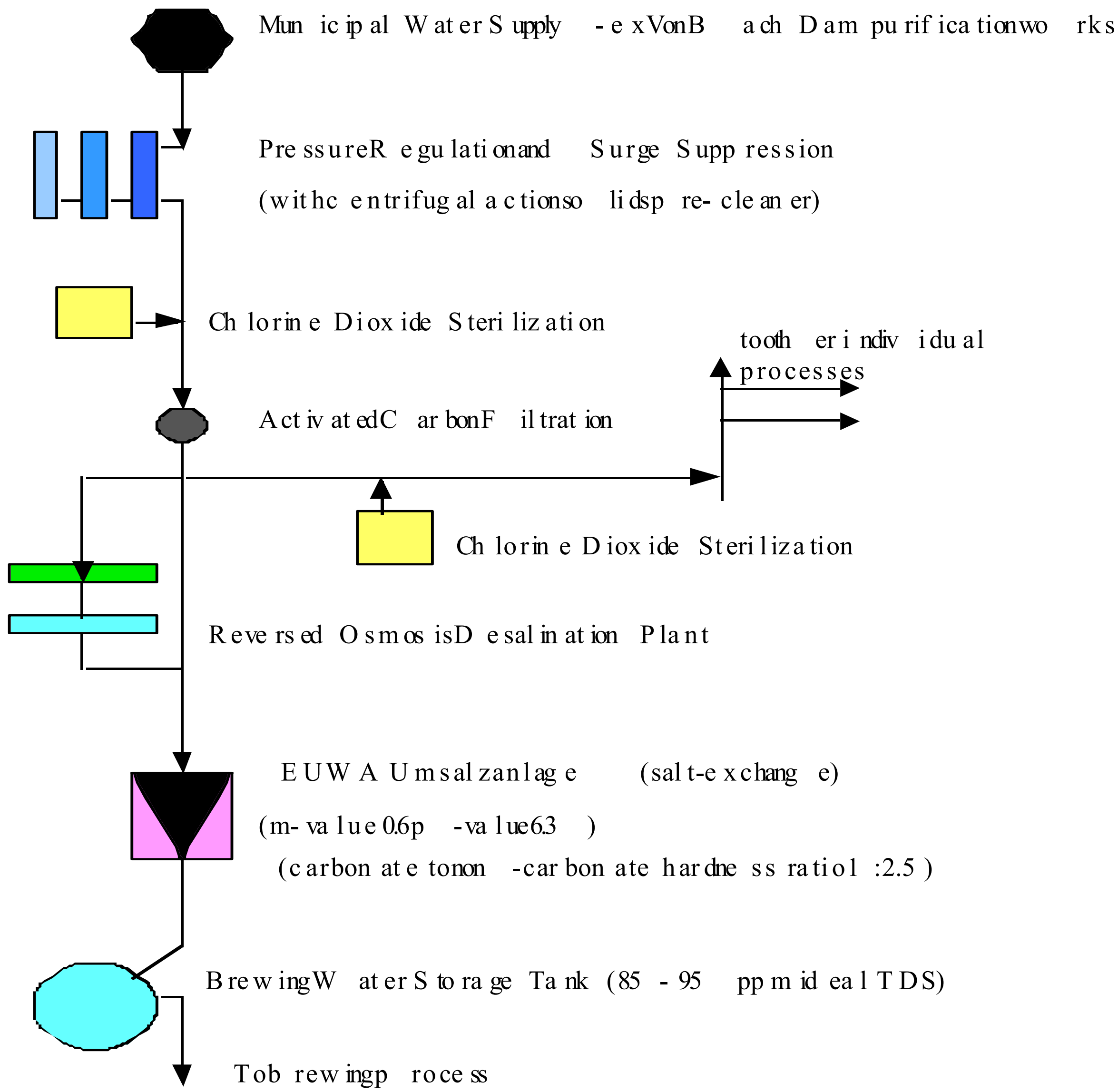
2.3 Individual water demand management and saving aspects

1. A Master plan was compiled providing for optimised building and equipment layouts such to give short product and service lines. In an industry like a brewery producing beverages it is necessary to clean product lines frequently and regularly to avoid bacterial growth. This cleaning process requires to flush pipelines with cold and/ or warm water and other mediums like solutions of caustic soda. Short lines reduce the quantity of the wash medium to be abandoned. The water demand is hereby reduced by approximately 10%.
   (Pipelines, product lines and other service lines are predominantly on one level ie.. ± 2.5 m above floor level such to avoid unnecessary multiple vertical lengths to link equipment with each other.)

2. Introduction of a water supply distribution system, at the design stage to divide the in coming municipal supply into various separate individual circuits. This allows for specific treatment of the individual volume only as may be required later. Hereby unnecessary water treatment and water losses caused by the system back wash for example are eliminated.

Example of brewing water pre-treatment:

Brewing Water Treatment Diagrammatic Layout



2. Computerised energy, water and raw materials consumption management system to continuously monitor figures for early detection of abnormalities on a weekly basis. Results are distributed monthly to all management staff. Unnecessary water losses are greatly reduced.

4. An enclosed high pressure hot water boiler system was introduced right from the start in favour of a steam type boiler plant which is ± 20% less capital cost intensive. The high pressure hot water boiler system inherently has a heat energy “flywheel effect” to absorb extra heat from the coal combustion. This extra heat is generated during sudden heat load shedding while the fire on the coal grating cannot be regulated down immediately. The large volume of the water in the entire boiler and piping system absorbs the heat during load shedding by increasing its temperature only a few degrees. In a steam type boiler plant the surplus energy must be released by steam blow-off into the atmosphere. Make-up water is reduced. The water saving brought about by the enclosed boiler system is low but adds to the total saving.

5. Enclosed brewing, fermentation and storage vessels as well as other liquid systems were introduced, where feasible to facilitate the installation of numerous energy, water and heat recovery components. The CIP (cleaning in place) system referred to elsewhere in this study is the major example and contributes substantially to the water savings.

6. Utilising ammonia medium as refrigerant for the main refrigeration system as well as for certain office air conditioning results in reduced energy and condenser water cooling requirements. The heat pump ratio of an ammonia plant of ± 4:1 exceeds the figure of ± 2.5:1 for common refrigerant air conditioners. To save guard the inhabitants of the offices from accidental exposure to toxic ammonia gas a special heavy duty high pressure rating ammonia evaporator was introduced. The factory inspector granted special approval for this unusual installation.

7. Approximately 16000 m^2 of Brown Built roof cladding were positioned such that the vertical webs of the sheeting follows the north / south direction. The vertical webs of the roof sheeting cast shadows on to the roof sheeting itself during the morning and afternoon hours. The shadow areas in combination with the hot web triggers small air cooling vortices on top of the roof sheeting which substantially reduces the heat load on to the building below. Water in the bottling hall is saved by this design due to the reduced load on the 400 000 m^3/h adiabatic air coolers.

8. The bottling hall layout with integrated product storage area and loading bay are designed such that the cooled air is only supplied to the bottling plant and the passes to the storage area and eventually the loading bay. The stepwise re-use of ventilation air reduces the total load on the high capacity adiabatic air conditioners thereby reducing the amount of make-up water.

9. The computer controlled CIP (cleaning in place) systems introduced in the brew house and bottling optimise the consumption of cleaning consumables and reduction of product losses.

Yeast Propagation Plant. CIP Plant in background

10. Clean building and equipment design reduces cleaning and washing effort of floors and equipment exteriors.

11. The incoming water filter backwash recovery system for re-use of water for gardening.

12. An innovative “In-line” pasteurisation of beer for can filling operations was introduced. A standard pasteuriser of the water shower and walking beam type consumes large volumes of cold water (±100 m3/h or more) from time to time to cool down the beer containers (filled bottles) inside the unit to prevent over pasteurisation. This happens during power failures or other unscheduled stoppages. The large quantity of cooling water is wasted because it cannot be absorbed by the system. The inline pasteuriser pre-pasteurises the beer prior to be filled in to the cans and can be interrupted without requiring cooling water.

13. A caustic soda effluent recovery system for the beer bottle washer was introduced to re-use caustic soda solution discharged from the washing machine after loss of required concentration. The re-use was made possible by automatic increase of caustic soda concentration (above 2.5%) near the bottom of the effluent storage tank. This recycling of caustic soda solutions reduces the water demand by the washing machine substantially.

14. A Reverse Osmosis plant was introduced in 1995 to improve or blend brewing water should the water quality supplied by Namwater to the municipality deteriorate because of country wide drought conditions. The consistent quality of brewing water reduces loss of product which in case of unsuitable water needs to be discarded.

15.Utilisation of stainless steel product handling vessels and pipe work to provide a self-sterilisation effect as far as feasible. Alternatives were fibre resin materials and other chemical coatings. The self-sterilising effect requires less water for cleaning. The water saving is high.

16. A separate effluent discharge system was introduced in the brew house to allow separate treatment of waste waters. The separation allows for optimisation of recovery.

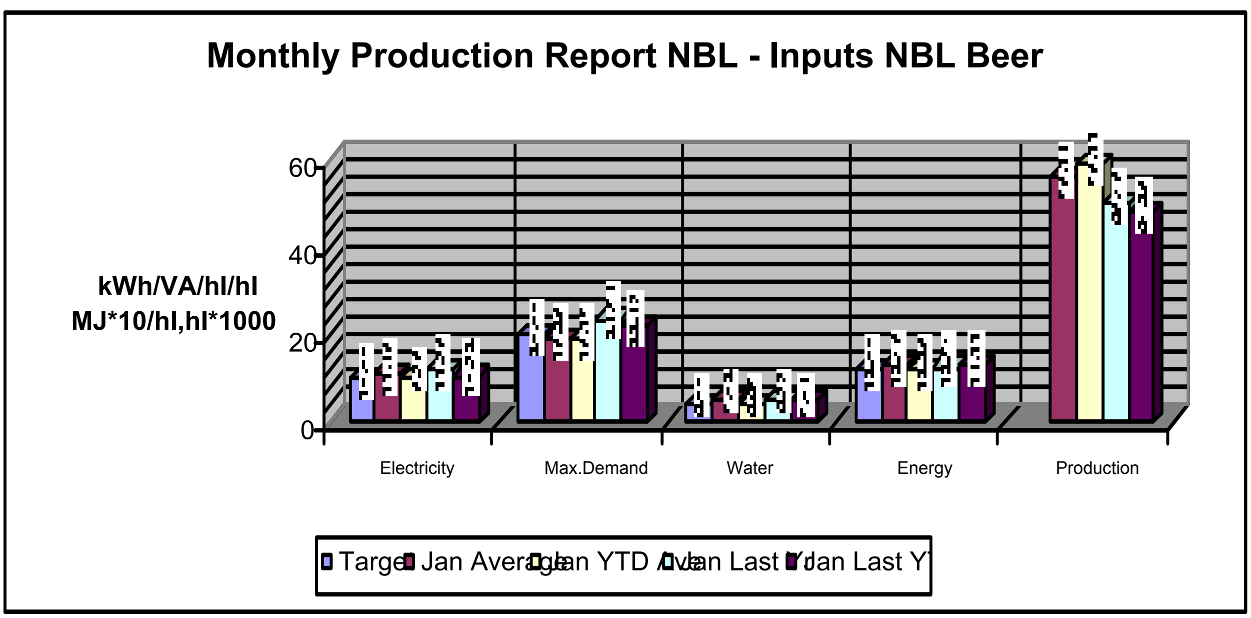
17. A central social facilities complex was constructed for staff to enhance personal hygiene and cleanliness as well as work force motivation. An efficient team behaves not waste full.

2.4 Results of approach

The low specific water consumption in comparison with sister industries world wide is a result of a number of smaller individual measures which in combination provide a substantial reduction of water consumption. *There is no single patent or solution to achieve water demand management*. A holistic approach to water utilisation is considered a fundamental requirement for sound water demand management.

Windhoek Brewery's specific water consumption is currently between 4.0 and 5.0 litres of water per litre beer produced (record month 3.7 litres) compared to a present industry standard of 6 to 8 litres. Some smaller breweries are still consuming up to 22 litres of water per litre of beer sold.

The particularly low water consumption:



3. CONCLUSION

There is no single patent or solution to achieve water demand management. An overall approach to water utilisation is considered a fundamental requirement for sound water demand management.

The initial specific water consumption in 1986 of ± 7 litres of water per litre of beer produced could be gradually reduced to a record low of 3.7 litres. (4.05 average for the year) A holistic and integrated approach to water conservation at the design stage followed by regular improvements and disciplined management is necessary to achieve such low figure of water consumption per unit of product.

Unfortunately many saving measures for example the type of boiler plant and roof cladding are costly or not viable to be introduced later.

Do things right from the start!

Future additional saving measures are in the pipeline. Water prices and the capital cost of additional measures will determine the timing of implementation.

Attachments: Diagrammatic layouts of:
1. Water Treatment for Brewhouse
2. Brewing Water Treatment Flow Diagram
3. Bottling Water Treatment and Distribution

References: 1. Namibia Breweries Limited Prospectus issued 13-3-96
2. Designs documents of group engineer of Namibia Breweries (M.Redecker 1980 till 1988)
