CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the University of Dar es Salaam a dissertation entitled: ***Assessment of water demand management practices for selected water authorities in Tanzania,*** in fulfillment of the requirements for the degree Masters in Integrated Water Resources Management of the University of Dar es salaam.

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Dr. R. Kimwaga

(Supervisor)

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Date

……

Prof D.A. Mashauri

(Supervisor)

……..

Date

DECLARATION

AND

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I, **Nasra Hussein,** declared that this dissertation is my original work and that it has not been presented and will not be presented to any other University for similar or any other degree award.

Signature……

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DEDICATION

I dedicate this research work to my lovely husband Hassan Ahmed and my parents for their prayers, special love and care they have shown during my studies, I love you all.

ABSTRACT

Water Demand Management (WDM) is a key focus area for most water utilities. Moshi and Mbeya authorities surveyed suffer to manage water demand; the reasons include limited physical coverage, dilapidated physical infrastructure, high levels of UFW, and low customer education among others. The objective of the study was to identify the current technical and socio economic aspect of WDM practices, community perception, gaps and constraints and then to propose WDM strategy. The study covered two authorities Mbeya and Moshi authorities. The methodology used was survey to water authorities, interviewing staffs and water consumers with the help of questionnaire, literature review. Data were analyzed by the use of Microsoft Excel. Moshi UWSA serves 95% of the population which is 150,000 with a 15,791 number of customers. Mbeya UWSA serves 93% of the population which is 330,000 with 18,791 numbers of customers.

Results indicate O&M problem where unaccounted for water is high which is 32.5% and 32% while meter usage is 100% and 70% for Moshi and Mbeya respectively. The time that water supply is available is 23hrs in Moshi with good water quality while in Mbeya is 21hrs with high turbidity value where sources have higher than the standard which is 15 NTU. More than 50% of consumers from both towns are not educated regarding to WDM. Major obstacles and constraints observed are poor tariff setting, public perception and lack of awareness, poor technology, and financial problems. Finally, WDM strategy was proposed and recommended to be adopted, the strategies is categorized into two parts, water demand reduction strategies; and supply rationalization strategies.

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ACRONYMS AND ABBREVIATIONS

CBA……Cost Benefit Analysis

DAWASA……..Dar es Salaam Water Supply and Sewerage Authority

DFID……..Department For International Development

IUCN……..International Union for Conservation of Nature

IWRM……Integrated Water Resources Management

KfW…… Kreditanstalt für Wiederaufbau

MUWSA……Moshi Urban Water Supply and Sewerage Authority

MCA……..Multi Criteria Analysis

MoU……. .Memorandum of Understanding

NAWAPO……..National Water Policy

NETWAS……..Network of Water and Sanitation

NPF……....National Provident Fund

O&M……..…Operational and Maintenance

TANESCO……Tanzania Electric Supply Company

UFW……..Unaccounted for Water

UWSA……..….Urban Water Supply and Sewerage Authority

WDM……Water Demand Management

CHAPTER ONE

INTRODUCTION

1.1 Background

Water demand management refers to actions that water authorities take in order to influence the demand for water, is an integral part of total management planning for water supply and sewerage (Thuringowa, 2006). It is an approach that aims to conserve water (quality and quantity) and optimize water use through various strategies which include: Technologies that increase the efficiency of water use; Behaviors change that ensures long-term sustainability of water resources; Pricing and setting of tariffs; and an enabling policy, institutional and legislative environment. (NETWAS, 2007).

For urban water supply utility demand management encompasses a range of possible measures. Some measures are: cost-reflective pricing; universal customer metering: reticulation leakage detection and repair; zone and customer pressure reduction; use of reclaimed water; temporary or permanent water use restrictions.

Demand management complements supply management because controlling the level and timing of demand can improve overall efficiency of system operations. This approach may help eliminate, reduce, or defer the need for an investment in new capacity by the water utility. Reductions in peak and off-peak demand affect the total capacity requirements of the utility system and thus the total cost of providing water service.

Management of water demand can also enable a water utility to improve the financial performance of its business, its level of customer service and its environmental outcomes. This is achieved by helping customers to use water efficiently, reducing wastage and losses by the water utility and providing opportunities for contact time with the customers and the community (Wise Water Management, 1998).

1.1.1 Utility in Tanzania

The Tanzania urban water supply and sanitation sector like many similar institutions is undergoing transformation. This process means a shift away from organizational structures where the district water engineer was responsible technically to the ministry but administratively to the local municipality, that in turn was responsible for managing cost recovery. Since 1994 a new scenario has emerged in Tanzania and now all main responsibility is devolved to the Urban Water and Sewerage Authorities (UWSA). With the support of legislation the UWSA have significant autonomy linked to the achievement of key performance indicators.

1.1.2 Water resources management in Tanzania

The current institutional framework for water resources management is inadequate in meeting the challenges of effective management of the resources and in providing an adequate mechanism for effective consultation and consensus building, and participation of stakeholders in the planning, design, operations, and management decision-making process (NWSDS 2005/2015).

A number of different Government departments or agencies deal with various aspects of water resources management according to their own mandates or needs, and also their own legislative provisions, with little integration towards holistic basin-wide planning and management.

In addition to this multiplicity of organizations, effective integrated water resources management is further constrained by limitations in the technical, human and financial capacities in these organizations.

1.1.3 Water demand management

According to URT 2002, the main objective of water demand management is to prevent wasteful water use and control water leakages. Water demand in urban areas is increasing at a rate which is not proportional to the rate of expansion of water supply and sewerage services. This is due to high rate of urbanization, increase of industrial activities and significant unaccounted for water that include leakage, wastage and illegal connections. Water demand management measures will be undertaken to conserve and use the available water efficiently and equitably, by instituting:

i) Measures on proper tariff setting (at an economic cost), metering, rationing, leakage control and mass education on frugal use of water and conservation

ii) Regulations on efficient use of water by using low capacity cisterns.

According to NWSDS 2005/2015, over the year's water has been considered a social good and the Government took the responsibility for providing access to services. Also, across all sectors, fees for using water have been very low and, thus, there has

been little incentive for using the resource efficiently or for conserving it, which has resulted in wasteful and inefficient use of water. Although the total water use picture country-wide is not well known, it is nonetheless clear that the emergence of conflicts over the resource provides an important indicator that existing supplies do not meet demands.

Present stresses and scarcity call for the adoption of measures to improve efficiencies in water use aimed at making more water available to meet demands. The situation will gradually lead to the need for measures, such as recycling and artificial recharge, which may provide a local drought-proof source of water.

Inefficient uses of water result from many factors including poor irrigation practices and technologies used in agriculture, and increasing leakage, illegal connections and theft due to unmonitored and unregistered uses, other unaccounted for losses in urban and rural water supplies, and poor billing and revenue collection.

The strategy for conservation and demand management will be to:

- Adopt water management approaches focusing on how water is best used, including efficiency, effectiveness, and conservation of the resource for each use;
- Enforce the use of demand management instruments such as water user fees and other charges, and restrictions;
- Promote the research and adoption of technologies that increase water conservation and demand management;
- Raise awareness on the best use and conservation of water; and

- Apply economic and administrative instruments.

1.1.4 Description of the utilities

Moshi and Mbeya Urban Water Supply and Sewerage Authorities are in the categories A water Authorities in Tanzania offering water and sewage services to the people of the respective Municipalities. The Authorities (MUWSA and Mbeya UWSA) were established under Act No. 8 of 1997 to provide water and sewerage services. The Authorities commenced operations on 1st July 1998 taking over the water services previously operated by Urban Water Department under the control of the Regional Water Engineer.

1.1.4.1 Moshi Urban Water Supply and Sewerage Authority

Moshi has an area of 58kms^2, it lies approximately 3^{o}18'S and 38^{o}20' E on the Southern slopes of Mt. Kilimanjaro. According to the 2002 Tanzania National Census, the population of the Moshi Urban District is 144,336. The population density is estimated at 3.275people per sq. km.

The Moshi Water Supply system takes water from two spring sources (Nsere and Shiri springs) and two boreholes (Kilimanjaro and Mawenzi). The original system was built in 1986, using Nsere and Shiri springs, and was subsequently expanded between 1986 and 1992, when the boreholes were developed. The whole system was upgraded between 1999 and 2002, when the sources were refurbished to increase production and the distribution works were rehabilitated and extended. The present system serves about 95% of the population of the service area.

1.1.4.2 Mbeya Urban Water Supply and Sewerage Authority

Mbeya is located between latitudes 8^0 51'– 8^0 57 South of Equator and Longitudes 33^0 30'–35^0 35' East of Greenwich with a population density of about 1542 people per square km and land area of about 214km^2. It has a mean annual rainfall of about 1000mm, mean temperature of about 18^0C with a population estimated at 330,000

The Authority obtains water from nine sources; treat it to conform to the required (W.H.O/Tanzania) standards and supply it to the consumers through its eleven administrative zones.

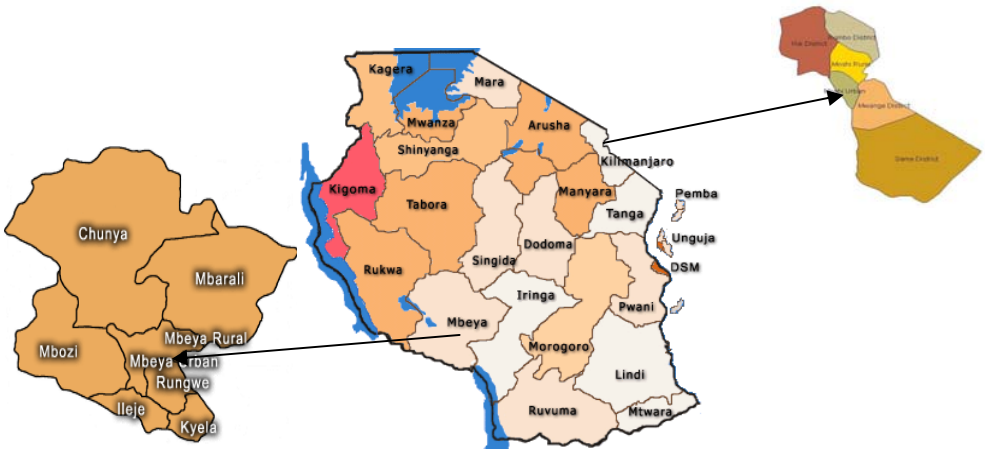

Fig 1.1: Showing study towns of Moshi and Mbeya(URT (a), 2002)

1.2 Problem Statement

Water demand in Tanzania has generally been increasing with the population growth and increasing human activities demanding water while the water sources both ground and surface water is decreasing day after day. The population of urban poor is increasing with the rate of 6% per year (URT (b), 2002)

Most utilities in Tanzania suffer to manage water demand, the main reason include limited physical coverage, dilapidated physical infrastructure, high levels of unaccounted for water, low customer education and in adequate skills, illegal connection, among others.

For the case of Moshi and Mbeya Urban utilities the current UFW is 32.6% and 32% respectively. Meter usage for MUWSA is 100% while for Mbeya is 70%, water re use is done to a very limited extent for agriculture just near the waste water treatment facilities. The tariff/billing system is divided in terms of categories that are institution, commercial, industrial and domestic. Illegal connection range from 2 to 7 per month. Water is supplied 24 hrs in Moshi except for one area is 18- 22 hrs using bore hole that result to be supplied 23hrs in average. In Mbeya UWSA rationing is done in more than 5 areas in town with average of 21 hrs supply. Consumers from both towns they are only concerned with the payment of the bills as long as is affordable not efficient use of water, the reason behind is community are not educated regarding WDM.

To manage and sustain the positive outcomes of the utilities, more focus is required in the improvement of the performance in terms of service delivery, operation and maintenance, with special emphasis on improvement of demand management, customer education and access by the poor. For that case there is need to asses the practices of WDM and community perception and then to propose the best WDM techniques.

1.3 Objective

1.3.1 Main objective

To assess water demand management practices in Moshi and Mbeya urban utilities

1.3.2 Specific Objective

- To asses the current technical aspect of water demand management practiced by the utilities.
- To asses the current socio economic aspect of water demand management practiced by the utilities.
- To asses community perception in water demand management in the respective towns.
- To identify the challenges and gaps in WDM in the utilities
- To identify the best water demand management strategies.

1.4 Significance of the study

The study help the Authorities to reduce wasteful use of the resource, which represents an opportunity lost as well as the use of water without an economic purpose. The research come out with the assessed water demand management practices in Moshi and Mbeya urban utilities and the best WDM practices in the utilities to achieve Integrated Water Resources Management. (IWRM).

1.5 Dissertation Layout

Chapter One describes the case study area, problem statement, objectives and significant of the study. Chapter Two describes the literature reviewed for the

purpose of this study. Methodologies regarding how the information were obtained and analyzed were explained in Chapter Three. Chapter Four included the result and discussion from the information obtained in chapter three. Chapter Five was reserved for conclusion summarizing the report and recommendation for future work.

CHAPTER TWO

LITERATURE REVIEW

2.1 Basic Concept

2.1.1 Water Demand

Water demand is defined as the quantity of water requested by users to satisfy their needs. In a simple way it is often considered equal to water consumption, although conceptually the two terms do not have the same meaning. This is because in some cases, the theoretical water demand considerably exceeds the actual consumptive water use (DFID, 2003).

2.1.2 Water Demand Management

WDM is a management approach that has conservation of both the quality and quantity of water as its primary aim. This conservation is achieved through the control of demand through the use of specific incentives that promote the following aspects of water:

- Efficient and equitable use
- Efficient and equitable allocation

2.1.3 Water Balance

The difference between the measured volume of water put into a water distribution system and the measured volume of water at any intermediate point in the distribution system (IUCN, 2002)

2.1.4 Water Auditing

A procedure to account for the water entering an area through a meter and the cumulative consumption and losses in the area (IUCN, 2002). Carrying out a water audit in an industrial establishment is one of the key activities that assist in improving the specific water consumption of the facility.

2.2 Status of water demand in Tanzania

Tanzania receives annual average rainfall of 937mm, which is very unevenly distributed. Half of the total area receives less than 750mm, which is under the 760mm threshold usually reckoned to signify potential for secure rain fed agriculture. The country has areas of fairly high population concentration: 64% of the population lives on just 20% of the land. Thus even in the high-precipitation areas, competition for water is intense.

Water is clearly a scarce resource, as less than 50% of the population of Tanzania has access to clean, safe water. Some sources put the figure as low as 38%. However, it is wrong to assume that these problems are altogether due to a low potential for water abstraction; additionally, the capacity to utilize existing water resources is limited. Tanzania, for instance, currently abstracts only 1% of the total renewable water resources in the country. Africa as a whole uses about 4% of its total flow of available water.20 in arid areas, particularly; there is great potential for tapping groundwater

In Tanzania, most of the domestic and industrial water supplies are from surface water. Groundwater sources, though potable in most cases, are not used because abstraction requires sophisticated and sometimes expensive technology.

The installed capacity for rural water-supply schemes, as of June 1992, served about 47% of the population. However, the reliability of the data is questionable because more than 35% of the schemes were not in operation. Many of the pumping units were worn out and non operational and needed replacement. Urban water supply, by June 1992, served about 67% of the population. This figure didn't take into account the quality of water supplied. Sometimes, because of the nonfunctioning of treatment plants and non availability of water-treatment chemicals, water is supplied either partially treated or untreated. The operational costs are normally higher than the revenue collected. This is because water tariffs do not meet running costs, and billing and revenue collection systems are insufficiently streamlined. In both the rural and the urban sectors, water demand far exceeds supply. Table 2.1 shows the low water-supply coverage.

Table 2.1: Status of Tanzania's domestic water-supply sector

	Population (million)	Population-coverage target		Actual coverage (%)
		(L/d per capita)	(%)	
Rural	15	25	90	47
Urban	1.7	50	10	67
[a]Reliability of the data is questionable because more than 35% of the schemes were not in operation.				

2.3 Utility Programs

Some demand management measures can be implemented by consumers on their own, while others can be implemented through utility-sponsored programs. High water and energy prices can induce customers to invest in water-efficient fixtures and appliances as well as to change water-use behavior. Utility programs can help consumers provide more informed choices as well as provide specific incentives for engaging in demand management. Some programs have helped utilities reduce operating costs (water, energy, and chemicals) and postpone or avoid capital costs (treatment plants and other facilities). Both water and wastewater systems can benefit from utility sponsored demand management programs (Beecher, 2003)

Utility demand management programs can range from very passive to very active. Passive approaches include the distribution of educational materials and low-cost conservation devices (such as leak detection tablets and faucet aerators). More active methods include water audits and rebates to households that purchase replace fixtures (such as toilets). An even more active approach is for the water utility to directly perform onsite retrofits. Program elements can be designed specifically for the needs of residential and nonresidential customers. Utilities can work directly with large-volume users in identifying methods for reducing or shifting loads.

2.3.1 Water Demand Management in utilities

For most local authorities the cost to supply water to consumers is continuously escalating as a result of one or a combination of the following factors:

- Relative to existing sources, new sources of supply are expensive to develop;
- Water quality guidelines and environmental standards are becoming more onerous with time, with resultant impacts on planning, design and construction costs;
- Existing assets are aging, with resultant increases in annual asset replacement costs; and
- Increasingly demanding consumer expectations calling for attainment of a consistently high standard of service, even in areas where water supply is difficult and expensive.

Hence, the introduction of effective demand management strategies is becoming increasingly important to local authorities. The essential elements of an effective water demand management system have been described as “the Five E’s of Demand Management” They include:

- Economics - establishment of an effective water pricing policy;
- Engineering - includes leak detection and maintenance, pressure control, and pipe work infrastructure;
- Education - raising public awareness of the need for water conservation;
- Encouragement - encouraging adoption of water-efficient practices including the installation of water efficient products; and
- Enforcement - introduction of local laws which forcibly promote efficient water use and minimize water wastage.

2.4 Water services and customers

Over recent years the emphasis in the water and sanitation sector, particularly in the rural context has been placed on issues of demand responsiveness and the participation of the community and household in the design, payment and management of water supply and sanitation services. Cited in government policies and donor implementation strategies these principles have led to the adoption of 'bottom-up' and 'demand driven' approaches, while 'top down' and 'supply driven' systems of operation are no longer supported. These new concepts are about putting the water consumer, *the customer*, first. Just as rural water and sanitation projects are designed with the role and needs of the community at the forefront, so too do customer orientated organizations place the customer at the top (Coates, *et al.*,2001).

However, for those working in the urban water and sanitation sector in developing countries the notion of 'customer' is only beginning to be recognized as important. The concept of the 'customer' has generally been perceived to be the interest and priority of the private sector, linked to profit motive. Customer orientation has attracted only the marginal interest of public sector management beyond the use of particular techniques, for example linked to marketing. Yet increasingly this narrow view is being challenged, as the benefits of 'thinking customer first' are being realized across service and product sectors alike. Empirical research carried out in service management has shown that customer orientation leads to customer satisfaction, which in turn leads to higher profitability and efficiency.

2.5 Water use

Water use can be distinguished into three different types. These are:

Withdraw or abstraction, this method water is taken from a surface or groundwater source, and after use returned to the natural water body, eg water used for cooling industrial processes is returned to a river (DFID, 2003). Such return flows are particularly important for downstream users in case of water taken from the river.

Consumptive water use or water consumption that starts with a withdrawal or an abstraction but in this case without any return flow. Water consumption is the water abstracted that is no longer available for use because it has evaporated, transpired, been incorporated into product and crops, consumed by man or livestock or otherwise removed from freshwater resources (DFID, 2003). Water losses during the transport of water between the points of abstractions and the point of use, (e.g. resulting from leakage from distribution pipes), are excluded from the consumptive water use figure. Example of consumptive water use include steam escaping into the atmosphere and water contained in final product i.e it is water that is no longer available directly for subsequent uses

Non- consumptive water use: That is in situ use of water body for navigation, in stream flow requirement for fish, recreation, effluent disposal and hydroelectric power generation (DFID, 2003).

2.6 Categories of water usage

Water is used domestically for household purposes, to maintain hygiene and keep the growth off plants and trees. Apart this purposes it is used for public uses like in hospitals and schools. It is used also for the manufacture of tools and equipment necessary for life.

2.6.1 Domestic consumption

Domestic water use includes water use for cooking, drinking, washing, sanitation and gardening. The water used in drinking helps for physiological processes such as blood formation and food assimilation. Prevalent diseases are far reduced by using water for sanitation and hygienic purposes.

The rate of water consumption depends on the level of service provided; it is at its lowest when water is distributed through public taps within certain walking distances from the houses. When water is brought to the house by piping the consumption increase considerably. It is necessary to note also that there is no incentive for consumer to save water when additional water consumption is free (Nteko, 1989).

2.6.2 Public institutions

Public institutions consumption is water consumption, which is non-domestic, or non-commercial such as schools, hospitals, administration office, police, mission and prisons. Water requirements for staff residing in the institution such as Tanzania Electrical supply Company (TANESCO), National Provident Fund (NPF) are

estimated separately in the same way as for other domestic water consumption (MAJI, 1988).

Table 2.2: Public institutions water consumption.

CONSUMER	URBAN AREA	REMARKS
Day school	10 l/student/day	With pit latrine
	25 l/student/day	With WC
Boarding school	70 l/student/day	With WC
Dispensaries	10 l/visitor/d	Out patients only
	50 l/bed/day	No modern facilities
Hospitals	100 l/bed/day	With WC and sewer
	200 l/bed/day	District hospital
	400 l/bed/day	Regional hospital with surgery
Administrative offices	10 l/worker/day	With pit latrine
	70 l/ worker/day	With WC

SOURCE: MAJI, 1988

2.6.3 Commercial water consumption.

With commercial water consumption it is understood consumption in hotels, restaurants, bars, shops, and small workshop and services stations. The actual water demand should be known from metered water consumption. Table 3 below gives some water consumption figures for commercial consumption.

Table 2.3: Commercial water consumption

CONSUMER	URBAN AREA	REMARKS
Hotels	70 l/bed/d 200 l/bed/d 400 l/bed/d	Low class Medium class High class
Bars	70 l/d 100 l/d 300 l/d	Low class Medium class High class
Shops	70 l/d 130 l/d	Low class Medium class

SOURCE: MAJI, 1988

2.6.4 Livestock

For the sake of water demands for livestock the following grading of domestic animals is being used in Tanzania. (MAJI, 1988).

Table 2.4: Livestock water consumption

CONSUMERS	RATE OF SUPPLY (L/animal/day)	REMARKS
Livestock	50 -90	High grade diary cattle
	25	Local breed cattle, donkey, ducks and goats.
		Five sheeps / goats
		Thirty poultry/ ducks
		Two donkeys

SOURCE: MAJI, 1988

2.6.5 Fire fighting

The fire fighting requirements are only to be adopted in urban areas. The pipe sizes in the distribution system should not be less than 100 mm in diameter. The flow in the fire hydrants should not be less than 10 l/s. The residual head in the pipe at a hydrant should not be less than 15 m. The distance between two adjacent fire hydrants should not exceed 300 m such that the distance of house from a hydrant is kept within 150 m (MAJI, 1988).

Table 2.5: Fire fighting water requirement

CATEGORY	FLOW (l/s)	FLOW PERIOD (hrs)	RESERVOUS (m3)
A	10	2	100
B	15-30	4	200-400
C	Water demand to be considered individually according to the activities, values of property and sensitivity to fire of the area		

SOURCE: MAJI, 1988

2.7 Tools for demand management

Tools and techniques to promote demand management can be classified in many ways but the following four categories are convenient (Rosegrant, 1997). None of the measures is as simple as will appear in the list below, even for surface water — and in almost all cases; they are even more complex for underground water.

2.7.1 Institutions and laws

Supply and demand systems for water always exist within a set of water rights, land rights, social and civil institutions, and legal regimes. Some are formal and others

informal; some modern and others traditional; some international and others local. They all play a role — more accurately, as great a role as granted to them — as do both modern and traditional institutions for conflict resolution. Few indeed are the societies that do not have some system for granting permanent or temporary rights to use water.

2.7.2 Market-based measures

This is the world of water prices and tariffs, and of water subsidies, both of which appear in a variety of forms. Although pricing is currently touted widely, careful analysts see it as a necessary *but insufficient* incentive for achieving efficiency, equity, and sustainability. Most would argue that subsidies should be explicitly justified; that water tariffs should be designed to encourage conservation, not just to recover costs (which implies that pricing should be high enough to move into the elastic portion of the demand curve); and that some form of lifeline pricing should be adopted to provide water for basic needs of even the poorest household. Of course, any of these measures depends on the existence of a more or less sophisticated system for metering.

2.7.3 Non-market measures

An enormous variety of no financial measures can be considered to promote WDM (Brooks and Peters 1988). Information and consulting services can be provided; social pressure can be applied; regulations can limit the time or quantity of use. Although regulations have a bad name, they are often both appropriate and efficient for managing water demand. Exhortation is also more effective than generally

believed, particularly in times of drought. The range of options is wide enough to preclude generalization, but one can say that they should be chosen to support, and if possible reinforce, the effects of market-based measures.

2.7.4 Direct intervention

Governments and water suppliers can, of course, intervene directly by providing services, installing consuming or conserving equipment, fixing leaks, adjusting pressure, providing sewerage, and so on. Publicly funded water and sanitation utilities typically undertake many of these functions. More fundamentally, they can also affect, if not control, land use by their decisions on the location and quality of water and sanitation services, which is of course why these decisions are so politically sensitive.

2.8 Economic aspect of WDM

Economic evaluation of demand management measures is important to ensure that cost-effective measures are implemented. Such evaluation needs to take account of the different perspectives – the customer, the water utility and the community. The most appropriate test for determining the economic benefits of a demand management measure is the total resource cost test, carried out from a community perspective (Winpenny, 1994).

The sequence in which measures are implemented is also important. For example, it is not possible to establish a fair and efficient pricing system for water unless all customers are metered. Similarly, community education will not be effective unless

the pricing system is such that customers can obtain a financial benefit from reducing their water usage. Although these three measures: metering; pricing and education are fundamental building blocks for developing a sound demand management strategy, other measures may also be warranted. For example, the price of water alone is not sufficient to guarantee the most appropriate level of investment in improved water efficiency, because of insufficient customer interest or inadequate access to capital. In many instances, therefore, there is an opportunity for the water utility to reap a financial benefit by investing in cost-effective means to improve its customers' water use efficiency. (Butler, and Memon, 2006, White, and Howe. 1998)

2.8.1 Wastewater reuse

While agriculture is the main water consumer in Africa, it cannot be compromised due to its role in domestic food security and export supplies (Chiuta, *et al.*, 2002). However, it is the largest consumer of freshwater resources, currently accounting for about 70% of global water diversions (Raschid, 2004). With increasing demand from municipal and industrial sectors, competition for water will increase and it is expected that water now used for agriculture will be diverted to the urban and industrial sectors. One response to this squeeze on agricultural water supply is to promote greater use of treated urban wastewater for irrigation (Gumbo, 1997).

2.8.2 Water audits

A procedure to account for the water entering an area through a meter and the cumulative consumption and losses in the area (IUCN, 2002). The analysis is

conducted starting with an accurate accounting of raw, treated and sold water. In a complete Water Audit, the accuracy of the raw water meters and their output is verified. The production is then compared to authorized consumption, both billed and unbilled, to determine water losing the system. Water loss is then divided in Apparent; unauthorized consumption and metering inaccuracies and Real; the loss through all type of leaks, bursts, service reservoirs and service connection up to the point of customer metering. The audit also analyzes the billing versus metered consumption, large meter sizing, pump efficiency, and economic leakage analysis.

2.9 System Water Losses

All water which goes into the distribution pipes does not reach the customers. Some portion of it is lost due to leakages in the mains, valves, fittings and illegal connections. In water supply system totally metered the Unaccounted for water is the different between the total metered input into the system and the total supplied as measured by meters of consumers (Nteko, 1989). The quantity of water loss due to the above reason is uncertain and can not be accurately estimated. In practice total losses may vary from 5% to 55% or more of the total supply and for large cities it is difficulty to keep total apparent losses below 16% of the total supply, whether this is measured by the MNF applying in the cover where domestic supplies are not metered or measured as the total UFW. However the main factors causing the variation in the amount of losses should be noted as outlined below.

2.9.1 Unaccounted for Water

Unaccounted-for Water (UFW) is the difference between the quantity of water supplied to a city's network and the metered quantity of water used by the customers. UFW has two components: (a) physical losses due to leakage from pipes, and (b) administrative losses due to illegal connections and under registration of water meters. While every case is different, often both components contribute roughly equally to UFW.

2.9.2 High Pressure

Pressure has an effect on the amount of losses, since the higher the pressure the greater the calking effect on the pipe joints. This cause rapid wear in the moving parts of water facilities that results to losses. The increment in water demand can lead to extension of new pipes from the existing network and this can cause rises of pressure in the existing pipes the increased pressure may bursts the pipes.

2.9.3 Illegal Connection

Unauthorized connection are sometimes made by individuals in the water supply system (MAJI, 1988) frequent inspection of distribution system and checking of large consumptions could help in rectifying illegal connection and defaulters should have legal action taken against them in order to minimize the misuse of water. Example Keko Mwanga B, DAWASA have connected a bulk water supply to the street, consequently a large number of household have made their own illegal connection. Water pressure is very low that most of those do not work those that do,

work sporadically. The street area has been laid with plastic pipes many leaking and located in open drains.

2.9.4 Excessive Load

Pipes are normally designed to sustain internal and external load. However in some cases they are subjected to loads beyond their designed capacities (Nteko, 1989). The forces that exceed the pipe strength can occur from excessive internal pressure which causes hoop stress failure resulting in the blow out of the weakest portion of the main wall, which leads to water losses.

2.9.5 Leakage

Leakage occurs in all distribution system only the degree of leakage changes and this varies widely from country to country and between regions to regions of each country. Leakage is one of the components of total water produced and the network and comprises the physical losses from pipes joints and fitting also from overflowing service reservoir. The losses can be severe and may go undetected for months or even years. The larger losses are usually from burst pipes or from the sudden rupture of the joint where as lower level losses are from leaking or “weeping” joints, service pipes and connections (Kasisi, 2000)

2.10 Cost and benefits of WDM

Any organization that is considering the implementation of WDM interventions needs to consider the available options in terms of the financial, environmental, and social costs and benefits. Generally, WDM should be implemented when the

benefits exceed the costs. This seems straightforward, but several questions arise. What are the costs and benefits? What time horizon should be adopted? Do organizations know about WDM opportunities? Which constraints need to be addressed before WDM is implemented?

2.10.1 Financial costs and benefits

Financial costs and benefits determine an economic performance and its degree of cost recovery, both of which are key concerns. One would expect that well-informed and organized Authorities would spontaneously implement WDM measures to improve its economic performance (cost recovery or profit). The reality is that Authority, in addition to positive internal leadership and awareness, usually require external support or pressure to implement WDM measures. Authority need to know the financial costs of these measures, categorized by source of supply and by type of WDM intervention. This is necessary to determine the net financial benefits (or costs) of individual WDM interventions compared to other interventions. This requires a financial Cost-Benefit Analysis (CBA) that could be part of a broader Multi-Criteria Analysis (MCA).

Table 2.6: outlines some of the financial costs and benefits that can accrue to Authorities as a result of WDM implementation.

Table 2.6: Financial costs and benefits of WDM to Authority

FINANCIAL COSTS	FINANCIAL BENEFITS
WDM capital costs	Savings from postponement of large-scale investment schemes
WDM operation and maintenance (O&M) costs	Lower energy and wastewater treatment costs
Lower revenues due to lower sales	Decrease in non-revenue-generating NRW
Lower revenues due to lower water price	Reduced value of purchases of water

Source (IUCN, 2004)

2.10.2 Social and environmental costs and benefits of WDM measures

It is the responsibility of government to consider all costs and benefits to the country, including social and environmental costs and benefits. The social costs and benefits are not necessarily the same as those for Authorities. For example, NRW is not a cost to an Authority, if the costs can be passed on to end-users through water tariffs. However, NRW is a social cost at all times. Water subsidies are a source of revenue to Authority, but do not appear as either an economic cost or benefit in a social CBA, as they constitute a transfer payment within society. (IUCN, 2004)

Examples of social and environmental costs and benefits are given in table 2.7

Table2.7: Social and environmental costs and benefits of WDM

SOCIAL AND ENVIRONMENTAL COSTS	SOCIAL AND ENVIRONMENTAL BENEFITS
Investments of end-users and water service providers	More affordable water
WDM O&M costs	Fairer distribution of water access
	Energy savings
	Decrease in waste flows and treatment costs
	Protection of the environment
	Budgetary savings
	Better resource-use understanding, and ethics
	More future options for water use

Source (IUCN WDM, 2004)

The comparison of the financial to the social and environmental costs and benefits shows the large differences that may occur between a financial and social analysis. The following situations may occur:

- The WDM measure is financially *and* socially beneficial. Such a measure should be implemented immediately by an Authority without government support.
- The WDM measure is only socially beneficial. Such a measure needs to be implemented but requires government support or regulation.
- The WDM measure is neither socially nor financially viable. Such a measure would normally not be implemented, unless there were unacceptable irreversible impacts or large risks and uncertainties attached to inaction.

In examining the social cost-benefit issues of equity, sustainability, and water use efficiency, a decision-maker must attempt to isolate objective solutions that provide optimal social benefits at least cost.

2.11 WDM Constraints

Constraints to WDM are those factors that defer or prevent the adoption or implementation of WDM measure. As WDM is not yet widely implemented, we must conclude that:

- WDM constraints are powerful and prohibitive, and/or
- WDM measures are not widely and properly understood.

What information do we have available to us about WDM constraints in southern Africa? What is really happening around us that blocks the implementation of WDM in the region? We have the following information:

- Various lists of constraints from different authors and studies
- Different ways of saying or expressing similar constraints

Quick-solution theories, whose empirical or practical value is not really tested, do not aim to add yet another list of constraints and vague solutions to those already available. Rather, will equip you to recognize the most important constraints that you face, organize your understanding of the constraints, and then develop and implement coping strategies.(IUCN WDM, 2004)

2.12 Overcoming WDM constraints

The IUCN-WDM Constraints study (Hazelton *et al,* 2002) identified the supply bias of water engineers and politicians and the lack of capacity and range of skills and finance as the key constraints of WDM implementation. The lack of a proper understanding of WDM, inadequacies in infrastructure and lack of appropriate incentives, in particular pricing mechanisms, are the other major constraints. In some areas, water scarcity is not widespread or felt, making it difficult to implement WDM initiatives.

Countries with funding constraints should prioritize WDM measures that generate revenues or are not costly to implement. With respect to attitudes and perceptions, end- users tend to associate WDM with 'drought regulations and life style restrictions' that bear a negative connotation. Water engineers often lack a proper understanding of WDM, and their minds are still set on solving water supply problems. A priori uncertainty about the exact impact on water consumption may be another reason for the slow implementation of WDM. If the impact of WDM on water consumption is not certain in advance or cannot easily be predicted, water planners will probably prefer conventional supply interventions whose supply impact can be predicted with a reasonable certainty.

The constraints can be overcome by a combination of the following measures: awareness raising, demonstrating the WDM-benefits, formal education, involvement of economic and social disciplines in water

management, improvements of technical infrastructure and the effectiveness of billing systems, greater costs recovery and better water pricing. (IUCN, 2004)

2.13 Motivation for WDM

Drought, water stress, and water scarcity are often the strongest incentives for Authorities and end-users alike to implement WDM. As water demand continues to grow, a choice must be made either to augment water supplies or to limit demand. At this stage, Authorities have strong incentives for implementing WDM measures prior to investing in new water augmentation schemes. Other more obscure but still important reasons for implementing WDM are related to efficient resource use, re- allocation of the resource among competing needs, and equity. The ultimate goal is the implementation of IWRM to ensure sustainability (IUCN, 2004).

Direct incentives for Authorities to adopt WDM measures include the following:

- The escalating costs of new water augmentation schemes financial viability of Authorities and economic incentives Increasing reliance on non-renewable water sources
- High water leakages
- Inefficient water use by end-users

Generally, we can group reasons for WDM into social, financial, and environmental reasons. These are discussed below.

2.13.1 Social reasons

The saved water can be used to allocate to people without access to water, and to attract new industries and services, hence creating more local employment. Better service can be delivered due to reduced water losses. Improvements in health can be effected. Authorities are seen to be acting responsibly and as setting a good example. Authorities are seen as providing good customer service, which may lead to a rise in levels of payment for services.

- WDM awareness is raised amongst consumers.
- Authorities contribute towards maintaining affordable water tariffs.
- Efficient water use through WDM safeguards water resources for current economic growth and for future generations.

2.13.2 Financial reasons

Greater flexibility and incremental implementation options allow costs to be spread over time. The charges to end-users can be kept down. WDM measures often have benefit/cost ratios in excess of 10:1 in urban settings. The need for an increased capacity for water and wastewater treatment may be delayed. WDM may lead to reduced operation and maintenance costs. More efficient water consumption can contribute to better and more effective expenditure planning of capital developments.

WDM may initially result in reduced water sales but it may also lead to a larger customer base through improved affordability, and better service delivery. WDM may lead to a reduction in unpaid-for water losses and unaccounted-for water

(UFW) through leak detection and repair in the water supply network, and on private premises. Financial ring-fencing of water supply and sanitation services retains revenue within the budget control of those departments. This revenue is then available for maintenance programs, improved service delivery and even expansion of services.(IUCN, 2004).

WDM can enable Authorities to deal with drought periods without resorting to expensive augmentation projects, or the application of restrictions or punitive tariff structures. Implementing WDM measures such as improved maintenance leads to more effective operation and efficiency in the delivery of water services, reducing the Authority own losses. Consumers benefit directly from their changed behavior by reducing their water bills.

2.13.3 Environmental reasons

More water is left for environmental use. WDM promotes sustainable use of water resources by introducing water-efficient practices. Pollution levels in water resources may drop as a result of Authorities applying punitive effluent-quality tariffs to industrial water users as part of an integrated management approach. Artificial recharge of underground aquifers with water from surface sources can lead to a saving in evaporation loss (IUCN, 2004)

2.14 On-going Initiatives and Way Forward Toward WDM

2.14.1 Environmental Protection

Since inappropriate water use practices and degradation threatens sustainability of the resource with potential negative effect to ecosystem integrity, future water management approaches will focus on efficiency, least detrimental effect on the natural environment and principles of sustainability. Public awareness campaigns will be carried out on good land-use practices in order to contain erosion problem.

2.14.2 Water Quality and Pollution Control

The various human activities taking place in the basins threaten the rivers with increasing pollution and degradation. Strategies will be developed to facilitate systematic monitoring and assessment of the status of water quality. In addition, the "polluter pays" principle in conjunction with other legal and administrative actions will be applied. Standards for in-stream flows, industrial effluents and other waste discharges for meeting environmental objectives will be developed and enforced.

2.14.3 Conservation and Demand Management

To avoid wasteful and inefficient use of water demand management in water supply and demand responsive the following approaches will be promoted.

2.14.4 Water Utilization and Allocation

In water allocation, water for basic human needs will receive highest priority. This will be followed by water for the environment, to protect the ecosystems that underpin water resources, which will be reserved. Other uses will be subjected to

social and economic criteria, which will be reviewed from time to time. Utilization of trans-boundary water resources will be based on the principle of equitable and reasonable use in accordance with agreements on trans-boundary water resources. All water abstractions and effluent discharges into water bodies shall be subject to a "water use permit" or "discharge permit" to be issued for determined beneficial use and for a specific duration. (IUCN, 2004)

2.14.5 Community Management

The Government will continue to empower communities to initiate, own, manage, operate and maintain their water schemes, including responsibility for coverage of operation and maintenance costs, so as to improve the sustainability of rural water supply systems. Eventually communities will be responsible for letting and supervising design and construction contracts for their water supply systems. This will expedite the rate of water service coverage for the rural population.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The study aimed at assessing the WDM practices in the utilities. The study mainly focuses on technical and socio economical aspect of WDM together with assessment of community perception on WDM. Due to limited time and funding the study focuses in two selected water authorities that are Moshi and Mbeya. Which include both large water users and small water user in the municipalities.

The rationale for the selection of the study was based mainly on determination and comparing water demand management practices in the utilities. Most of water utilities who are the service providers in the water sector face the water demand challenges in their respective Municipalities.

3.2 Research Methods

3.2.1 Objective # 1

To asses the current technical aspect of WDM, survey to the two utilities was conducted with assistance of personnel from the authorities on WDM practices that are conducted in the utilities. The study was achieved by interviewing engineers, technicians on technical matter like water loss (leakage and pressure control), % of UFW etc.

3.2.2 Objective # 2 and 3

In order to asses the current socio-economic aspect and customers perception on WDM from the utilities the survey was conducted to the utilities and customers.

Utility interview was conducted to personnel to obtain information on water pricing and tariffs, connection fee rate, illegal connection, metering and calibration. For consumers' house hold questionnaire were administered for assessing issues regarding willingness and affordability, and efficient use of water.

3.2.3 Objective # 4 and 5

In order to identify challenges and gaps the result obtained from the first, second and third objectives were compared to the recommended key indicators used to evaluate WDM. From there the gaps was identified and the appropriate best WDM developed by identifying the necessary information i.e reviewing literature, field data collection and data analysis.

3.3 Literature Review

Document from different sources were reviewed to obtain the broad perspective of WDM. The main method is through reading of both local and international documents through internet, text books, published journals, published research studies on WDM, proceeding and reports.

3.4 Field Data Collection

Field visits to the utilities under study were carried out using interview with utilities personnel by using questionnaire, for consumer/community questionnaire were distributed to the house hold level to gather information on their perception and practices toward WDM. Visual observation where the image of WDM practice was

obtained through observing what is happening in the field visit. Example; water loss can be observed through leaving the taps open.

3.5 Sample Population

The population size of customers interviewed in Moshi was 150 customers out of 15,791 in the seven zones around Moshi municipality. The sample sizes were taken depending on the number of customer size in the zone.

Mbeya UWSA the sample size was 225 customers out 18,791 in eleven zones available in Mbeya Municipality. The sample sizes also depend on the number of customers in each zone. The table 3.1 and 3.2 below shows number of customers and the number of questionnaire distributed in each zone in the respective municipalities

Table 3.1: Moshi Customers

Zone	I	II	III	IV	V	VI	VII	Total
Total	929	436	1,786	2,920	2,057	4,182	3,481	15,791
Number of Questionnaire	15	10	20	25	20	30	30	150

Table 3.2: Mbeya Customers

Zone	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	Total
Total	3135	1674	1399	1273	1364	1339	1898	2252	1613	1423	1421	18791
No of Qns	35	20	15	15	15	15	25	25	20	20	20	225

3.6 Data Analysis

The data from the two utilities were compared with the recommended performance indicators for WDM as per memorandum of understanding between Urban Water Supply and Sewerage Authority and Ministry of Water.

Microsoft excel was used to analyze the information on technical and socio economic aspect and customers' perception on WDM. Based on the findings of the literature review and field interviews, gaps in WDM were identified in:

- WDM awareness for consumers, this was observed in regard to WDM education in both water utility.
- Tariff setting according to the amount of water used in the authority surveyed.
- Customer satisfaction in terms of billing payment, hours of getting water services and quality of water.
- Capacity of utilities to implement WDM in terms of technology, financial and regulation

CHAPTER FOUR

RESULTS AND DISSCUSSION

4.1 Introduction

There is a broad range of technologies for managing water demand in the various sectors, it has been noted that technologies on their own do not bring about optimal water demand management. Technologies work optimally if they are supported by management tools and instruments such as regulations, policy, economic incentives and public education. It becomes imperative then to assess the technologies with reference to supportive management instruments.

The purpose of the study is to assess key technical, socio economic practices of WDM in water supply, customers perception on WDM, challenges and gaps in WDM and lastly to come with the strategy for WDM for the Authorities to use. This chapter covers the analysis of the data obtained from water Authority staffs and customers' questionnaires by the use of excel programme and the subsequent discussions.

4.2 Assessment of WDM

Water is used for various purposes according to the peoples need, either as raw material for industrial purposes, washing, and domestic uses. The utility and consumers surveyed practice WDM. But the extent of WDM varied between the two types of utility and consumers. The major WDM practices are:

4.2.1 Economic Measures:

Pricing policy is at the core of many attempts at WDM. In some instances, however, it is difficult to assess whether water pricing reforms have been instituted for WDM reasons or for reasons of financial sustainability. As mentioned, there is a growing focus on cost recovery in the water sector in all the municipal studied. This has led to the introduction of user charges where none existed and the re-evaluation of existing charges to reflect the operating and maintenance costs of supply systems and sometimes the projected costs of future supply schemes. The specific rationale for pricing reform makes little difference, however, as economically efficient pricing is an important step towards water use efficiency and hence an integral part of demand management whether motivated for financial or WDM reasons.

4.2.2 Technology improvements

The introduction of alternative technologies can have a large impact on water use efficiencies. These can range from fitting of low water use appliances in urban households to the improved leakage detection system. Technological or process changes can make an enormous difference to water efficiency for all water users.

However there has not been much success in encouraging technological change in the country, apart from fairly discrete examples of industries responding to water shortages or price increases. Certainly in the urban residential setting most water reduction appears to have come from behavioral change and there has not been a very widespread introduction of efficient household appliances.

4.2.2.1 Water loss control

At the water service provider level a key component of successful WDM programmes is the control of unaccounted-for water. Large efficiency gains can be made at this level. The programme includes leakage detection on a continuous basis; an ongoing repair programme; water audits; proper water meter management and a systematic pipe replacement programme.

As mentioned earlier approaches towards improving technologies at the level of the provision of water can also be highly effective. For example the use of leakage detection system can reduce percentage of UFW. In general the significant and cost effective opportunities that appear to be possible from water loss control have not yet been taken.

The two authority surveyed practices water loss control in leakage detection through physical observation, illegal connection control by involving community in information giving that result to the reduction of the UFW though not meeting the required target.

4.2.3 Education and awareness rising

In addition to the more direct measures of regulation and pricing policy the authority attempts an element of moral suasion and water conservation advice. These have included some substantial efforts. A comprehensive communication campaign to promote water conservation needed to be putted in place to encourage efficient use of water. In the two towns surveyed there has been little experience with awareness raising and water efficiency education amongst the consumers given the fact that these public awareness approaches are generally

undertaken in conjunction with other WDM measures it is difficult to quantify their impact on consumer demand. But both town studied suggested that awareness rising is an important component of WDM. Given the fact that demand behavior is being targeted by WDM strategies it is logical to use all means, including social persuasion and improved information, to induce a behavioral response.

4.3 Status of Water Demand Management in the selected Authorities

4.3.1 Moshi Urban Water Supply and Sewerage Authority

MUWSA is producing, treating and distributing an average of 24.5 million liters of clean and safe water per day (against an estimated total demand of 24.5 million per day) to 95 % of the population of Moshi Municipality which is presently (2008) estimated at 144,336 people basing on 2002 population census data. The main sources of water are two natural springs, located at Hai District, about 10km west of Moshi town.

From these two springs, water is conveyed, stored and distributed to consumers using Ductile Cast Iron (DCI) main pipes, PolyEthylene PolyVinylChloride (PE/PVC) pipes of diameter ranging from 32mm to 500mm, by gravity flow. Water storage is attained in huge reinforced concrete ground tanks located in the distribution network, with combined total storage capacity of 8.6 million litters.

The two springs are substantiated with two boreholes located in the northern part of Moshi town, for supplying water to the upper areas which can’t be served by the gravity flow system. One source, Njoro ya Dhobi spring, which was formerly

operated as a pumped system has been shut down but is still owned by the Authority as a standby sources. There are different storage tanks where by water from Nsere sources is stored in Petershoff Tank (of 1,350 m^3) and CCP Tank (4,540 m^3), Shiri in Kilimanjaro tank (2000 m^3), Mawenzi borehole in mawenzi sump tank (45 m^3) and Njoro ya Dhobi was supposed to be stored in Kiusa tank.

Figure 4.1 shows water sources capacity of MUWSA which is 52,600 m^3/day from the five sources, where the capacity of the sources is higher than the amount of water abstracted.

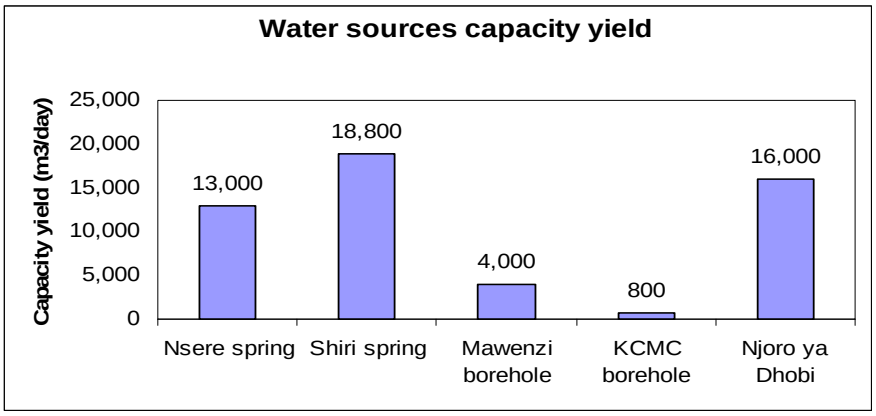

Fig 4.1 MUWSA water sources capacity yield

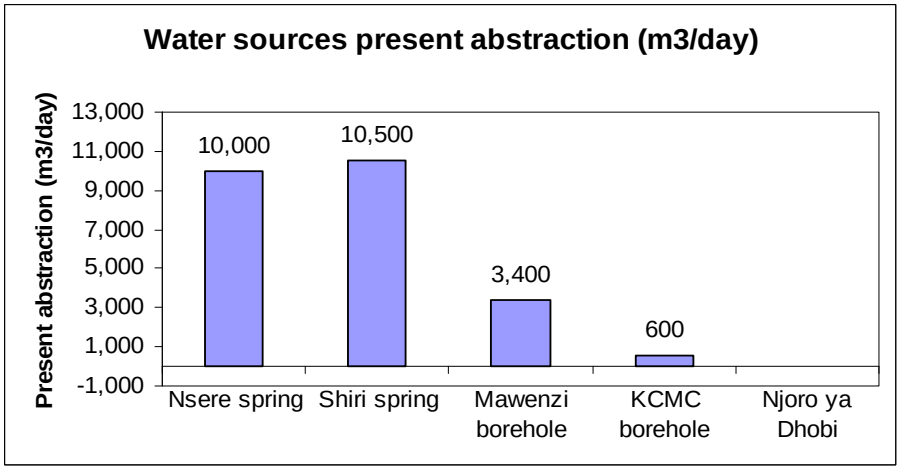

Fig 4.2 MUWSA Water sources present abstraction

According to figure 4.2 MUWSA is abstracting 24000 m^3/day amount of water from the sources but actual source capacity is 52,600 m^3/day, the reason being low capacity of water distribution system in some areas where only 95% of the population is supplied with water this shows failure in demand management and also community around the sources are having rights of using the water.

4.3.1.1 Water Users

Water is supplied to different categories of water users. The users range from small users to large users that are domestic, institutional, commercial, industrial, and kiosk; both are supplied with the same quality of water (treated water) but of different quantity and pricing. There are seven zones in terms of water supply and sewerage provision in Moshi Municipal, and the number of customers from each zone is as indicated in the figure 4.3 below:

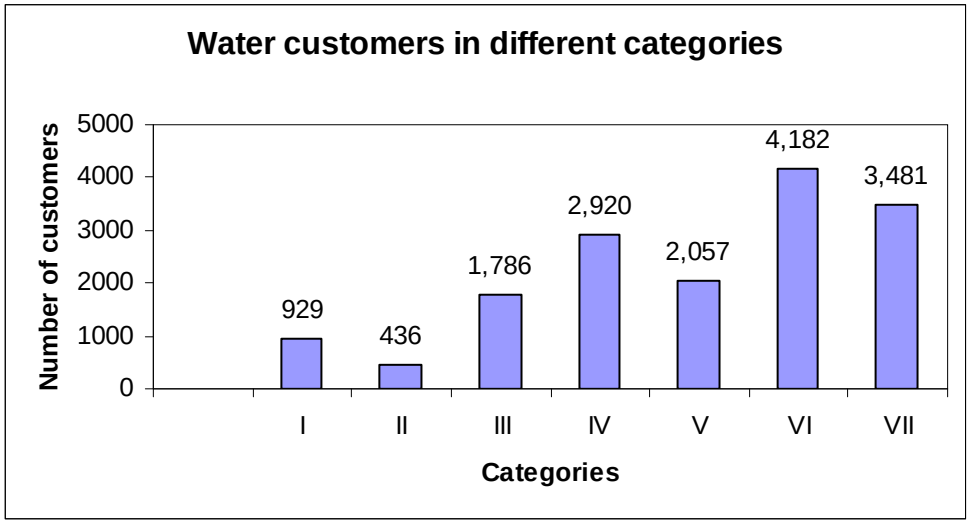

Fig 4.3: Water customers in different categories

4.3.1.2 Water Demand in MUWSA

The demand for water is projected to increase to 33,000m^3/day by 2020. To meet the pick demands, production capacity should be increased to around 38,000m^3/d, which compares with an existing production capacity of about 24,500 m^3 /d.

The total number of connection is expected to increase to about 20,000 of which some 18,500 will be for household consumers.

4.3.1.2.1 Assessment of Technical Aspect of WDM:

a) Water losses control

- **Unaccounted for water**

  High level of Unaccounted for Water (UFW) reflects poor water demand management in the sense that the water lost, especially through physical losses could have increased demand satisfaction level.

  For MUWSA although water production equals to water demand but the population served is only 95% and the level of UFW is high in comparison with the indicators from Ministry of Water. This is the combination of technical loses and commercial losses; the figure 4.4 below shows the UFW level as compared to the indicator that need to be attained by June 2008:

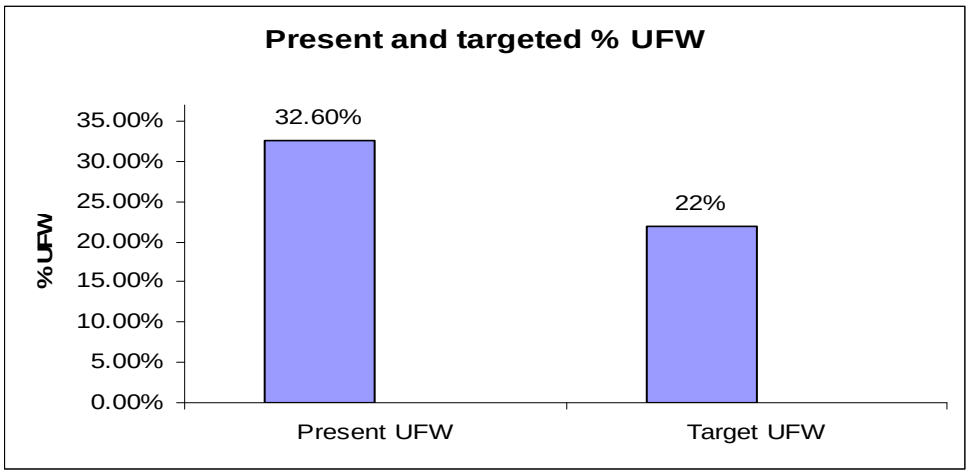

Fig 4.4 Present UFW and the targeted UFW

High UFW is mainly caused by the following factors:

- **Leakage**

Leakage is often a large source of unaccounted for water and is usually a result of either lack of maintenance or failure to replace ageing systems.

For MUWSA around 300 leakage is reported per month (43 leakage per day) mainly on Polyethylene pipes (Figure 4.5) the reason being pipe burst due to high pressure in the area of Majengo, Kiboroloni, Njoro, Pasua and Kaloleni, the other reason include old pipes and fittings, high pressure and vandalisms.

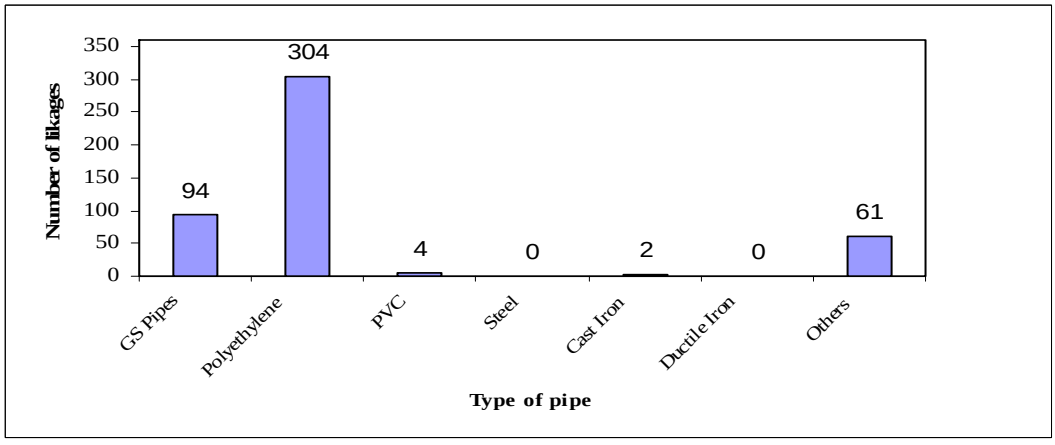

Fig 4.5: Number of leakage and pipe Materials.

- **Illegal Connection**

  Unlawful connection, illegal reconnection, injuring the water supply system, draws off or takes or diverts water illegally from any water supply system belonging to the Water Authority are offences. About 3-7 illegal connection occurs per month in Moshi and the person illegally connected is liable to a fine of Tsh 150,000 for domestic and 250, 000Tsh for commercial and industries plus the accumulation of less amount of the bill from the time of the correct bill paid.

  The reason for people connecting illegally is that they need to use water free for economic purposes like keeping cows and irrigating bananas especially in Moshi, delays in connection after paying and few are not affording to pay the bills.

b) Pressure management

The rate of discharge from water fittings is dependent upon the available pressure. Pressure reduction can be an effective way of reducing unwanted water consumption, while still maintaining a minimum level of pressure commensurate with public expectations. An example is leaving the garden tap running for 5 min at an acceptable low pressure, instead of at a high pressure. Additional benefits of pressure control include reduction leakage in the reticulation system as well as decreasing breaks in the system and extending the life of the water infrastructure. Pressure reducing valves can be applied to reduce pressure to a required level while still maintaining the peak demand levels.

Future planning of the water supply system has recognized the demand management potential of regulating pressures, particularly during low usage times,

to minimum levels commensurate with public expectations of an acceptable level of service.

Pressure management in MUWSA is done in a zoning method where there are seven zones as mention before. The pressure is regulated in the storage tanks, the tanks are used as storage tanks and pressure reducing devices. Eg Kiusa Tank instead of distributing water straight from the source to consumers' water is stored and pressure is reduced. Also MUWSA is on the preparation of constructing pressure break tank where high pressure zone is going to be reduced Eg Shiri area because shiri is were the source is located pressure is not controlled as water come straight from the sources.

c) Wastewater recycling and reuse

Recycling involves the re-use of treated wastewater to provide reliable source of water for irrigation and groundwater recharge. Recycling the waste product into a reliable water supply has huge benefits. It makes use of the nutrients in sewage to feed crops and keeps them from polluting waterways. It postpones the need to enlarge and update costly new sewage discharge systems, and eliminates the problems from discharging wastewater into rivers and oceans.

There are two type of waste water treatment in Moshi that is Waste stabilization ponds and constructed wetland, wastewater which comes from the two treatment is used for paddy cultivation and fish pond just within the pond fences and the other water join Rau river down stream. There is a project funded by UNDP (Compact

project) to improve irrigation of paddy to the villagers around the area for a proper use of the wastewater. The project is on the initial stages of its construction.

d) Water and Environmental conservation

Research and utilization of appropriate technology in meeting water related demand and water resources conservation is the key success in water supply and sanitation. MUWSA as from July 2007 established a unit in its technical department responsible with water resources management. The unit is charged with scientific and technical investigation and solution regarding:

- Water resource and environmental conservation (including water sources and production forecast)
- Water and sanitation demand projections and identification of infrastructural requirements to meet present and future demands.
- Technological innovations required for service improvement.

The unit is not yet in function is just on the process of starting.

4.3.1.2.2 Social Economic Aspect

a) Public education and Awareness

Public awareness and education programme need to stress the critical importance of water in daily life and the need for conservation even in non-crisis times. Awareness campaigns to reduce water use amongst all consumers can play an important role in demand management.

MUWSA involves the public in its water and sanitation plans and implementations through involvement of the public on location and operation of water sales kiosks

and in an effort to reduce NRW resulting from illegal connections and reconnections, water meter tempering and by passes, the Authority in collaboration with Moshi Municipality residents is implementing *'Tajirika na Mamlaka'* Programme, where by people volunteering to provide the Authority with information regarding water theft or other vandalism activities are rewarded.

According to figure 4.6 the customer survey conducted regarding awareness on WDM majority of customers more than 50% are not aware on the issue. The reason being there is no arrangement for seminars, workshops to consumers specifically on WDM, only few educated households are aware.

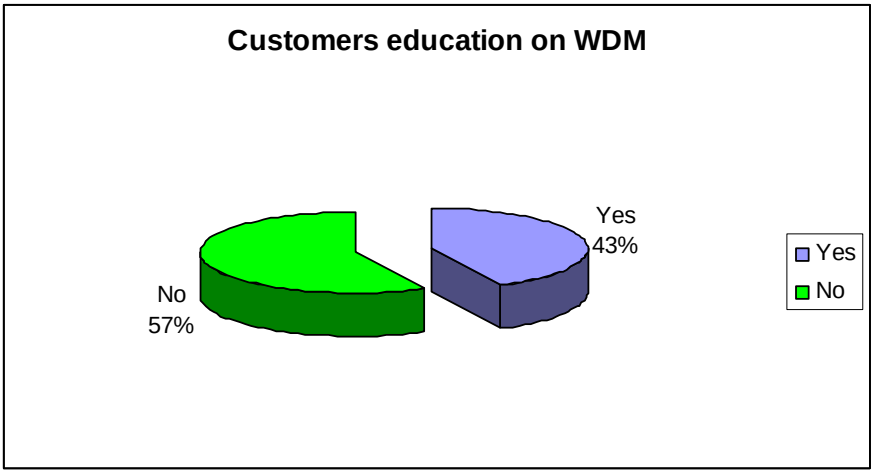

Fig 4.6: Customers education on WDM

b) Universal Customer Metering

MUWSA achieved universal water consumer metering as from year 2000 where up to now total number of 15,791 customers are metered (Figure 4.7). This was enabled through the Moshi Water Supply system rehabilitation Program, which was implemented (July 1998 – September 2003) through KfW funding. This help to reduce NRW as water wastage predominant in flat rate consumers is avoided. Meter

calibration is not done properly there are about 2188 out of 15,791 meters which is not calibrated as the result they are not giving out proper consumption.

Prepaid water meters are being used by MUWSA as an effective strategy for water saving and reduction of water wastage through water consumers self monitoring of consumption level and payment. Currently 50 meters have been installed to randomly selected consumers as a pilot study of the pre payment system; starting from December 2006. So far consumers installed with these meters are comfortable with their use and bills accumulation for these customers has been avoided. The number of total metered connection is illustrated in figure 4.7 below:

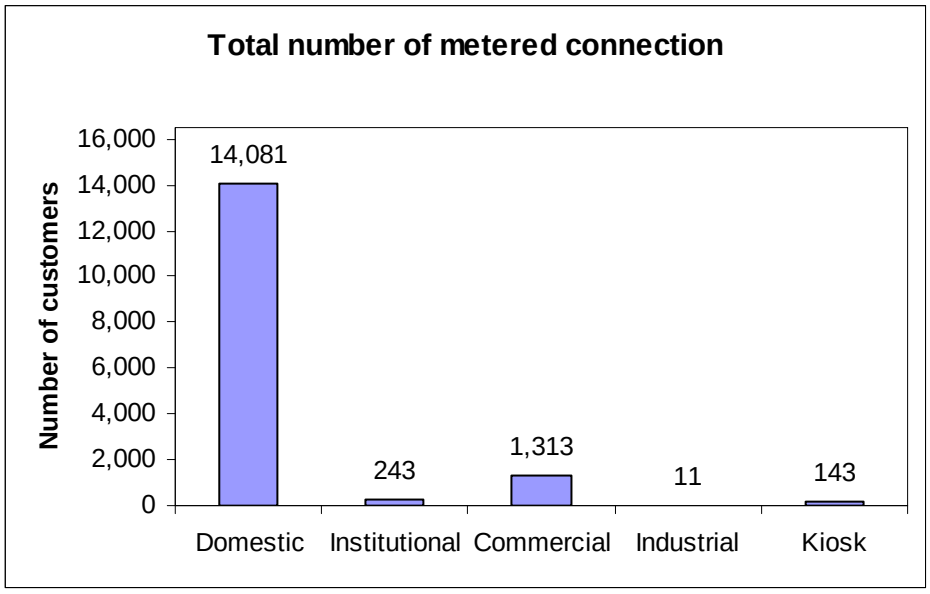

Fig 4.7: Total number of Metered connections.

c) Working hours

Working hours for the workers is only eight hours per day; leakage is reported by customers overnight through phones. That is probability if the customers saw the leakage; major burst after reported through the phone is attended by emergency team. According to customers questionnaire, 100% of customers who have

experienced leakage accept that their responsible to report to Authority. The main problem it is not possible for customers to see leakage overnight.

d) Water availability

Water is supplied for 24 hrs in Moshi Municipality covering about 90% of the Authority customers, rationing is only for 12hrs covering about 10% of the Authority customers who are served by the Mawenzi borehole. This happens due to power problem where the generator operates for 12 hrs per day.

4.3.1.2.3 Customer perception on water demand Management

a) Water quality

The quality of water in terms of chemical, physical and bacteriological parameters in Moshi is good. Customers are satisfied with the quality of water in terms of the physical parameters such as turbidity as the water can be taken straight from the tape. Table 4.1 shows the turbidity taste where water is totally clear.

Table 4.1: Moshi Turbidity Analysis

	Turbidity (NTU)
At source	-
At storage tanks	-
At selected points	-
Standard	15

b) Tariff/ Billing system and Willingness to pay

For Moshi the tariff system is in category form where there is no flat rate, customer pays according to the use no matter is very small. There is a different price for different

categories of water users (figure 4.8). Customers are not complaining much on the bill unless there is underground leakage without being noticed. For the poor there is a free service where identified poor people have coupons for fetching water in the nearby kiosk. For the time being 2 poor families are served with water as per table 4.2.

Table 4.2 Service for the poor

Poor Family Served	No. of Buckets	No. of Days	Total Litre consumed	Total Unit consumed	Total Cost
2	5	30	6,000	6	**1800**

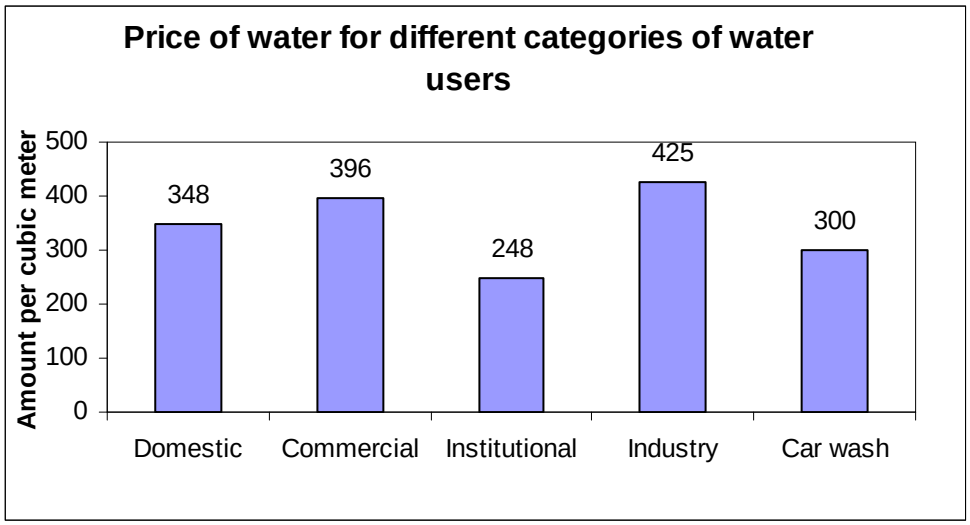

Fig 4.8: Water price for different categories

4.3.2 Mbeya Urban Water Supply and Sewerage Authority

Mbeya UWSA obtains raw water from eight different sources and treated before supplying it to the consumers. The average actual production is 21,136m^3/day while the demand stood at 28,000m^3/day.

The sources are shown in figure 4.9 where they consist of spring and surface, Ivumwe, Nzivwe I and II the two are spring sources and they use both pumping and

gravity, Mfwizimo/Lunji, Hanzya, Sisimba, Imeta and Nkwanana/Iwalanje they are surface water and supplied by gravity, and the last one is Nsalaga which is a spring but supplied by pumping.

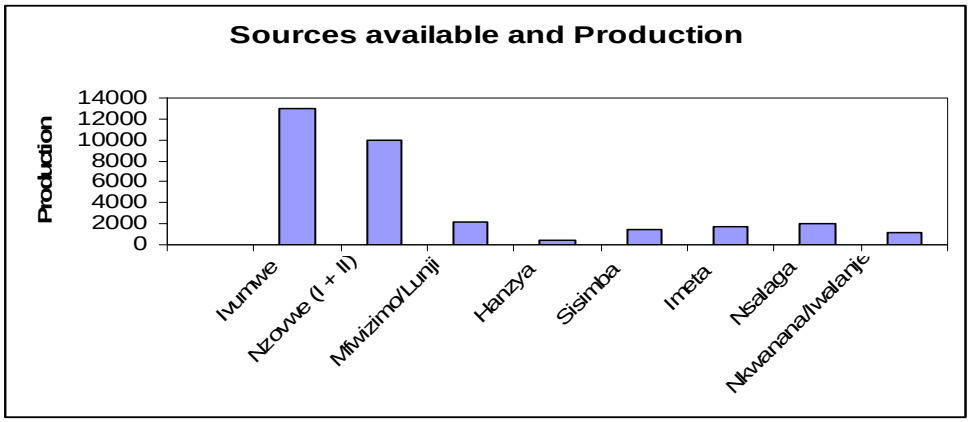

Fig 4.9: Sources available and the production

4.3.2.1 Water users

The water user of Mbeya town which receive water from the authority are categorized in five different groups within eleven different zones (division of the town in working areas) with the total active customers of 18,791, ranging from small user to large users. The figure 4.10 indicates number of water users' in different water zones:

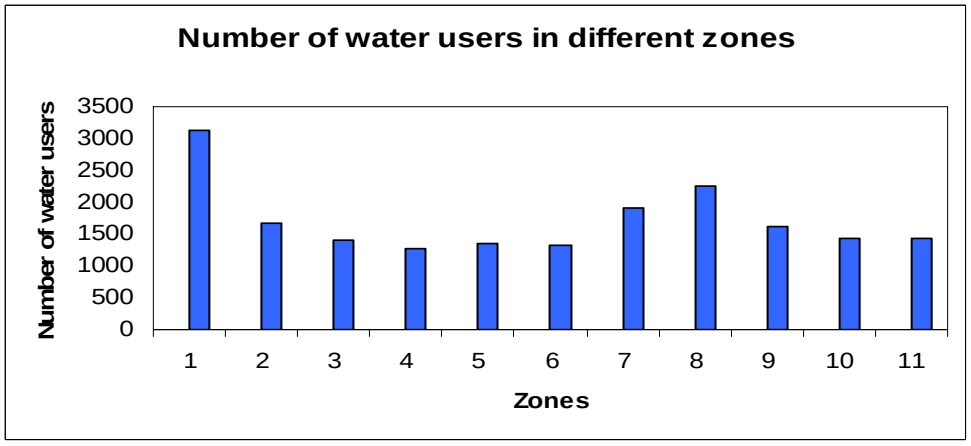

Fig 4.10: Number of water users in different zones

4.3.2.2 Water Demand in Mbeya UWSA

The demand for water in Mbeya is projected to increase up to 34,000 m^3/day by 2020. To meet peak demands, production capacity should be increased to around 39,000 m^3/day, which compares with an existing production capacity of about 21,136m^3/day. The total number of connection is expected to increase to about 25,500, of which some 25,000 will be for household customers.

Mbeya UWSA is performing WDM in the Authority the current practices is as follow:

4.3.2.2 Technical Aspect:

a) Water Losses Control

- **Unaccounted for Water**

  The unaccounted for water accounts for 32% on average of the monthly water produced as compared to the target which is 30% (figure 4.11), this is mainly attributed to water loss through leakage in the pipes distribution network within the system, lack of maintenance or failure to replace the aging of the pipes and commercial loss that is vandalism and meter tempering. Mbeya UWSA undertakes various measures in lowering down UFW where they have strategy to lower UFW below 20% by 2012. They expect to be achieved through the following interventions:

  - Attending urgently and effectively leak repairs once detected
  - Use of leak detectors instruments to detect invisible leaks
  - Having leak detection and repair technicians working in their respective zones.

- Use the community in informing the Authority once they come across the leaking pipes in their premises/areas.
- Rehabilitations/replacement of worn-out pipe network through internal financing and phase I and II donor projects.
- Use of good class pipe materials and fittings in pipe laying and new connections.
- Installation of bulk water flow meters as well as universal metering to all connections.

The plans are well documented the important thing is to act on them where follow up is need at the end of phase I and II.

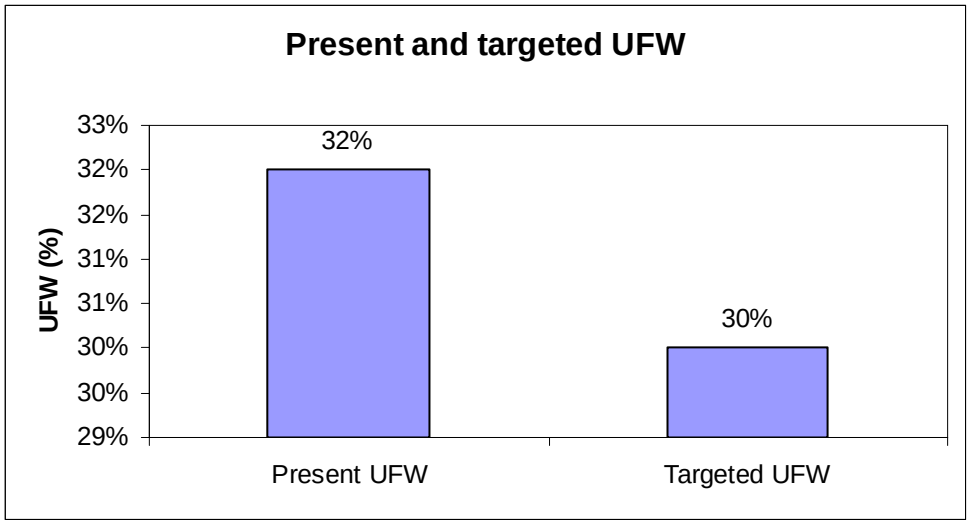

Fig 4.11 Present and targeted UFW

The main causes of high UFW include high leakage rate and illegal connection

- **Leakage control**

About 390 leakages is reported in average per month on Polythene and PVC pipes, the main reason being worn out pipes and the use of low standard pipes. Amount of water which is lost is estimated to have a monthly average of 178600m^3 which is obtained from the amount produced which is 886501 $m^3$and the Billable water which is 707,901 m^3 in the relation of

Billable water = Water produced–leakages

The Authority is undertaking the project of upgrading the system funded by KfW, it is expecting to reduce the physical leakage rate to 20% after completion of phase 1 and 2 of the project that is the year 2012 and 2017 when UWSA operation will be improved. The table 4.3 shows physical leakage to be reduced by 2017

Table 4.3: Physical Leakage rate

Year	**2007**	**2008**	**2012**	**2017**
Leakage in %	35	32	20	20
Period		Completion of Phase I & II		Improved UWSA Operation

- **Illegal Connection**

Due to high cost of water bills other customers decide to connect themselves to the system. From the information obtained about 3-4 illegal connection occurred per month. Illegal connections can cause unattended leakages, high UFW and water becomes unhygienic due to pipe busts, resulting in high level of water borne

diseases. Communities are also involved in reporting the illegal connection, and the reporters are awarded 50,000Tsh for each report. These help to identify number of illegal connection.

b) Pressure control

Mbeya UWSA carries out pressure regulation by using dedicated service reservoirs serving areas lying over a particular range of elevation which is approximately +/- 30 meters. Interconnections to either lower or higher locations exceeding the above range are isolated by means of service valves. In so doing all connections within a particular pressure zone receive water at adequate pressure and reliable continuity. Figure 4.12 shows there a total of twelve (12) pressure zones designated by alphabets from A,B,C,D,E,F,G,H,I,J ,Uyole A and Uyole B where each pressure zone has a demand and supply to consumers from a particular dedicated tank. The demands are:

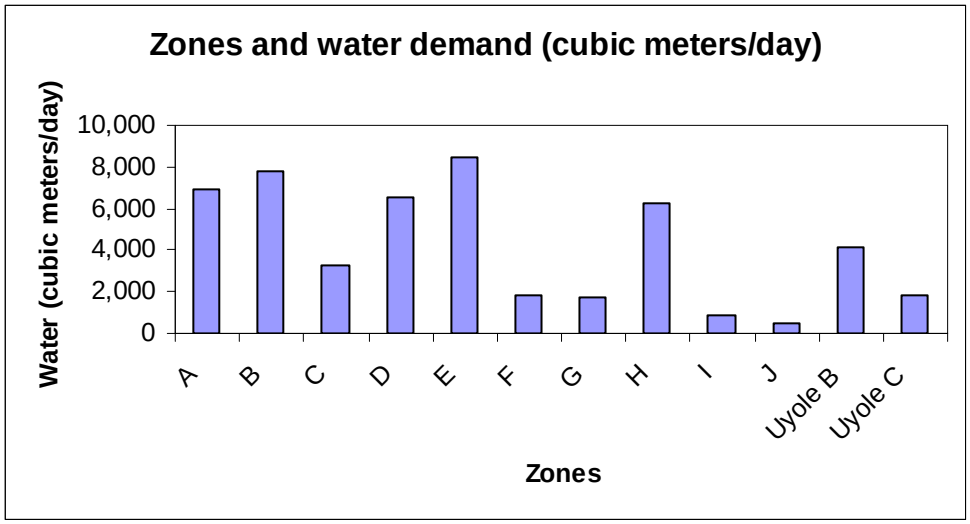

Fig 4.12: Zones water demand

c) Waste water reuse

Currently waste water is not reused is just disposed to the Meta River and is used by the people down stream. This may result to high concentration of nutrient going to the river which is not favouring human life and aquatic organism at the same time there is a loss of nutrient which may be used for agricultural activities.

d) Conservation and Protection of water sources:

Mbeya UWSA undertakes various water sources conservation measures to ensure a sustainable water resources management. The measures is well documented but the action on the ground is not well performed as up to now the are household near the required source diameter of 250m. These measures include:-

- To protect existing surface and spring water sources catchments by involving the communities living in the encroaching villages as the key stakeholders in safeguarding the water sources which includes planting of trees in water sources catchments

- To provide education and sensitizing the community living in the nearby villages. This exercise to be conducted by the UWSA' staff in association with Regional, District and City authorities as well as NGO's, Ward Councilors, Ward Executive Officers and village cell leaders.

- Prevent the hazardous land use activities which cause environmental degradation. These include farming activities and grazing cattle in the water shed catchments, deforestation and bush fire.
- Undertaking stern measures to the defaulters by using existing bylaws which include penalties and use of courts.

- The Basin Offices takes a great role in ensuring the existing regulations regarding water resources conservation and are strictly observed.

4.3.2.3 Social economic Aspect

a) Consumer Metering:

Consumer metering is important tool in water demand management as it discourages excessive use of water and wastage. It reduces commercial losses and hence an increase of potential revenue. One element to eliminate commercial losses is to ensure all consumers connected to the distribution network are metered. Mbeya UWSA has been undertaking such exercise of metering its customers and so it has about 13,000 customers who are metered out of 18,772 registered customers; equivalent to 70%. So far the Authority has metered most of Commercial, Institutional and Industrial consumers.

b) Water rationing:

Proper water rationing is an important tool for ensuring effective water distribution to consumers as well as water demand management if water availability does not meet the need. Mbeya UWSA applies this method to areas with limited supply due to lower production against demand, inadequate water supply distribution network, and higher

elevated areas as compared to low lying areas. Areas which are served through rationing in Mbeya City include New forest, Block Q, Block X and Uyole. According to the interview with Authority staff rationing exercise is expected to be reduced and possibly eliminated soon as phase II water supply project comes into operation in 2009. Mbeya City distribution network has now been split up into hydraulic zones in order to ensure water rationing exercise is more effective.

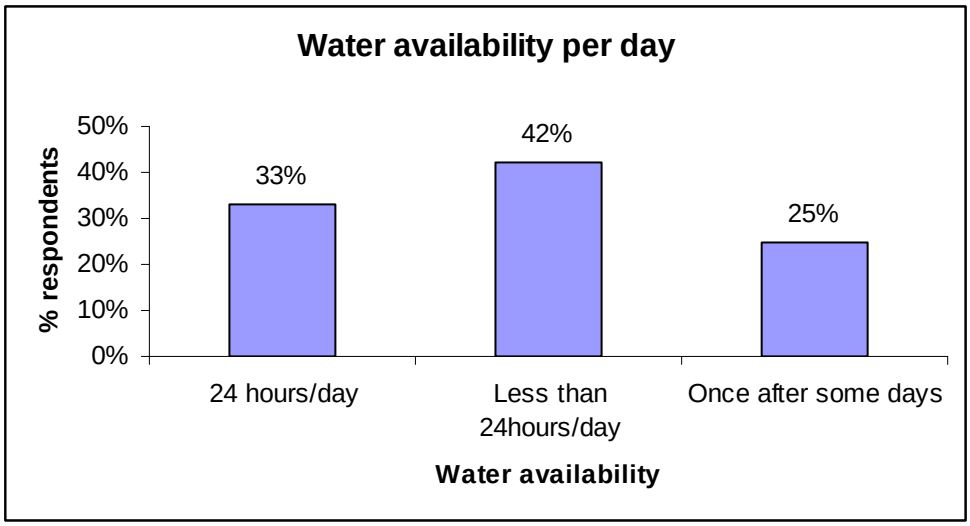

Fig 4.13: Water availability per day

Figure 4.13 above explains water availability per day where only 33% obtains water for 24 hours, 42% for less than 24 hours a day and 25% they may get water even once a week is unpredictable.

c) Public awareness and Education on WDM

Mbeya Authority is starting to realize the need of putting more efforts on public awareness and education to the Population of Mbeya City in order for the people to know

its functions, objectives and day to day activities. To start with, the Mbeya UWSA has employed a Public Relation Officer who will be responsible for all activities concerning Public awareness and education. To achieve this target, UWSA is planning to conduct more seminars and provide magazines, client service charter and fliers. So far the Authority is in the preparation of the first magazine which will be distributed to the public. It is planned that the magazine will be released before the end of this financial year. For the time being customers are not fully aware of WDM, metered customers are using water efficiently for reason of reducing the bills and unmetered customers they are just using water freely. The figure 4.14 below shows only 38% of customers accept that they are aware of WDM issues

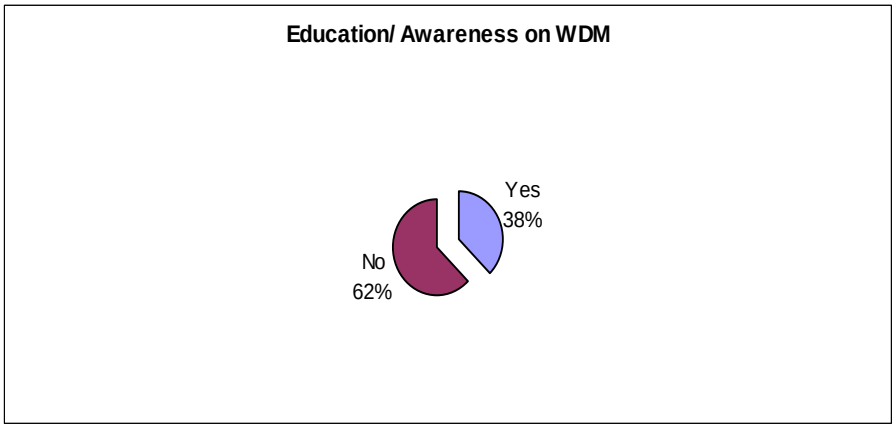

Fig 4.14: Customers awareness on WDM

4.3.2.3 Customer perception and satisfaction

a) Water quality

Customers surveyed at Mbeya about 46% are not satisfied with the quality of water supplied the reason being high turbidity especially in these rain season due to the fact that sources conservation is not well practiced erosion is still taking place. According to Mbeya UWSA water quality result shows turbidity level is high in some sources

compared to the standard. Customers explain in rain season water coming out of the tape can not be used immediately for any use unless it settles for sometime.

Table 4.4: Mbeya Turbidity Analysis

INTAKE	TYPE OF WATER	TURB (NTU)
IMETA INTAKE	Raw water	N.D
	Chlorinated water	N.D
SISIMBA INTAKE	Raw water	25
	Chlorinated water	19.7
IVUMWE	Raw water	5.8
	Chlorinated water	4.9
HANZYA	Raw water	5.7
	Chlorinated water	4.3
MFWIZIMO	Raw water	1.5
	Chlorinated water	4.3
NZOVWE	Raw Water	17
	Chlorinated water	15
NSALAGA	Raw Water	8
	Chlorinated water	7.4
	Ilomba borehole	N.A
*	Tanzanian standards on Indicated parameters	15

Table 4.4 explains the turbidity level for different water sources in Mbeya where there are some sources with high turbidity as comparing with Tanzania standards.

b) Tariff and Billing system

According to customers responses more than half of the customers surveyed in Mbeya are not satisfied with the amount of money their paying for water service. Mbeya UWSA they have different amount of tariff for customers of different category. The tariff per m^3 is 300 for domestic, 360 institutional, 450 Commercial and 900 for industrial but there are flat rate amount of 5000 for high density, 7500 Tsh for medium density and 9000 Tsh for low density if someone uses less than these amount he or she pays the flat rate, Example the use of 3 m^3 for high density instead of paying 900 Tsh the bill become 5000Tsh automatically. That resulted to the raise of customer complains and reduce the willingness to pay, most of customers are experiencing high bill than the amount of water used. So, water can be used roughly because the amount paid is the same no need of conserving. The table 4.15 below indicates customers' satisfaction on billing system according to the survey done where 47.95 are satisfied and 52.05 are not satisfied.

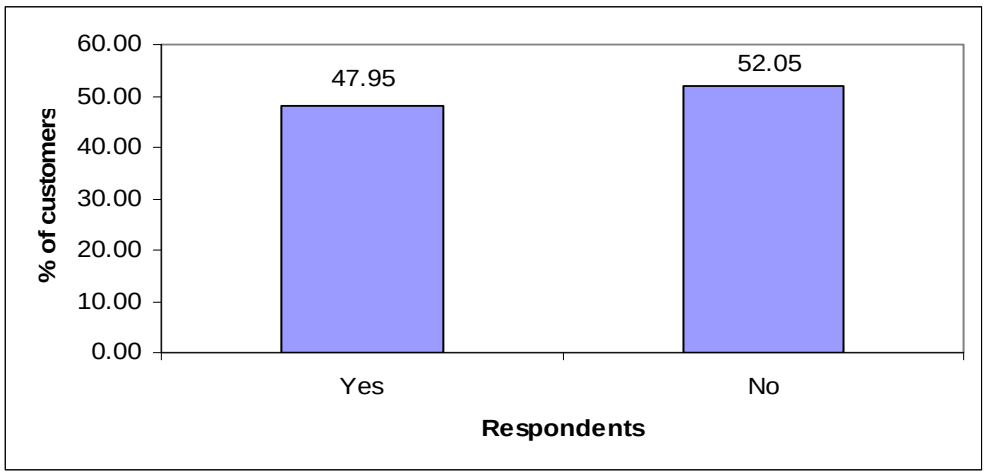

Fig 4.15: Customers satisfaction on billing system

4.3.3 Comparison of WDM Practices for the two Authorities

The two authorities receive water almost from the same type of sources that is springs and boreholes. Population served for Mbeya is higher than Moshi with a water demand of 28,000m^3/day while the production is 21,136m^3/day, and 24,500 m^3/day the same as production respectively. Quality wise Moshi has a good water quality comparing to Mbeya the reason being the sources are well protected in Moshi with a diameter of 250 surrounding the sources without any human interference. In terms of tariff is difference where in Mbeya there is both volumetric billing and flat rate together with minimum charges but for Moshi is only volumetric billing which is good and fair. Both water utility experience the problem of water loss where leakage, illegal connection is high that result to high UFW as compared to the indicator. Public education and awareness is almost the same where majority of the population were not educated on WDM.

In comparing with the indicators which was signed with the Ministry of water and urban water supply and sewerage department both utilities does not adhere with some of the target as it was supposed to be met by June 2008. The table below shows the situation for the time being in the authorities and performance indicators were the target was supposed to be met by June 2008

Table 4.5: Performance Indicators between MoU and UWSSD

PERFOMANCE INDICATOR	MBEYA UWSA		MOSHI UWSA	
	JUNE 2008		JUNE 2008	
	TARGET	NOW	TARGET	NOW
TECHNICAL INDICATORS				
Average quantity of water produced (m3/yr)	11,132,500	7,714,640	9,125,000	8,942,500
Proportional of water produced to water demand	95	75.4	100	100
Average quantity of billable water (m^3/yr)	8,349,375	-	7,446,000	-
Proportional of people served with water (%)	90	95	94	95
Average hours of service per day	23	21	24	23
Total number of water connections	16,800	18,772	16,600	15,791
Number of active water connections	15,300	18,772	14,110	15,791
Unaccounted For Water (UFW) (%)	30	32.5	22	32
SOCIO ECONOMIC INDICATORS				
Total number of metered connection	14,900	13,000	16,000	15,791
Number of active metered connection	14,900	13,000	14,400	13,603
Billing efficiency (%)	87	85	90	90
Tariff system	**Not stated in the document.**			
Unit costs of produced water	430		255	
Public awareness and Education	**Not stated in the document.**			

4.3.4 The challenges and gaps to WDM

Water conservation is an important tool that will be needed to meet the state's long-term water needs. It is also an important practice to ensure responsible use of a public resource. There are various obstacles and constraints to overcome before the full potential of WDM principles can be achieved. It is necessary to identify and

acknowledge these constraints in order to develop activities within the WDM strategies to address them. A number of these constraints can easily be overcome through public awareness programmes and appropriate legal and regulatory tools. Some of the constraints, however, are related to individual and institutional capacity and economics which are much more difficult to overcome. The following are some of the obstacles and constraints identified in Moshi and Mbeya UWSA:

a) Poor tariff system and willingness/ability to pay

The Authority suffers the problem of poor tariff system in which customers are not willing and able to pay bills. Taking an example of Mbeya Urban where there is volumetric bills and flat rate and customers are forced to pay amount of money they have not used the water. Flat rate payment in Mbeya UWSA is not considering the amount of water used due to unmetered connection. It result to inefficiency use of water and increase the amount of water loss.

b) Technological

Most of utility were helped by donors to construct water network of which after using for long time they lack money for repair. These old facilities are responsible for loss of water through leakage where the leakage detection system is not advanced is done through physical/eye observation. Among the technological challenges the Authorities are facing include:

- There is a problem of uneven pressure in the water supply systems though not much, which often causes pipe bursts, and faulty meters.

- High rate of illegal water connections, meter tempering
- Minimum usage of waste water
- Also the utilities are facing the problem of disorganized technical data where is not possible to get in any section of the Authority.

c) Financial

WDM measures depend on the financial status by the end users who may not have adequate resources to pay for water services. There is also disproportionate funding for demand management, that include operation and management expenses, rehabilitation of pipes and fitting to avoid leakage.

There is a problem of water debtors who are not paying the water bills mostly the government institutional like schools and hospital. This result to the low collection of bills that is used to run different activities as the two Authority are autonomous does not receive money from the government to run daily operation except for large projects.

d) Organizational

The main suppliers of water in urban areas are autonomous. Economic efficiency is their objective. However, pricing for their water is subject to control by the Energy and Water Regulatory Board under the government. So they are not free to use price as an instrument for controlling demand. Some of consumers' uses water roughly as long as is affordable they have no incentive to conserve water.

e) Public Perception

A big percentage of communities consider water as an abundant resources and natural gift from God where there is no need of paying for it, and they do not understand the need of application of water conservation and efficient use of water resources. Majority of customer surveyed are just using water efficiently because they fair high water bill in which failure to pay results to disconnection from the water services but few industries are aware of the WDM issues, Example Pepsi Cola Company in Mbeya they have changed from inefficient water use to efficient use of water after all workers being educated on WDM.

Taking an example from Pepsi Industry at Mbeya

Total water consumption for the industry is 500m^3/day. Water usage break down at the industry includes:

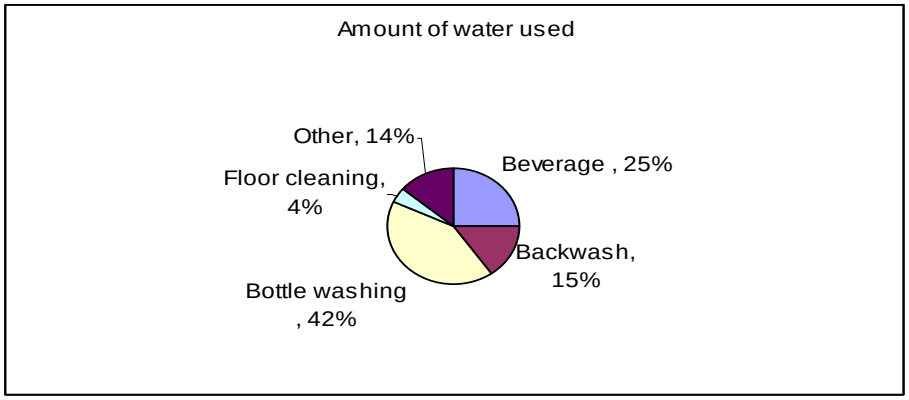

Fig 4.16: Water use in Pepsi industry

Estimated cost of treated water is Tshs 45 per crate. Out of all industry Pepsi industry is the only which perform water demand management and workers aware of water

conservation and water saving. There are using three simple aspects on water savings: Pipe Wrench, Conservation Checklist and Water Awareness

4.3.5 Proposed WDM strategies

- A number of water demand management strategies exist. According to the discussion above, the proposed water demand management for the authority consist of water demand reduction strategy and supply rationalization strategy. These are illustrated in Figure 4.17 below:

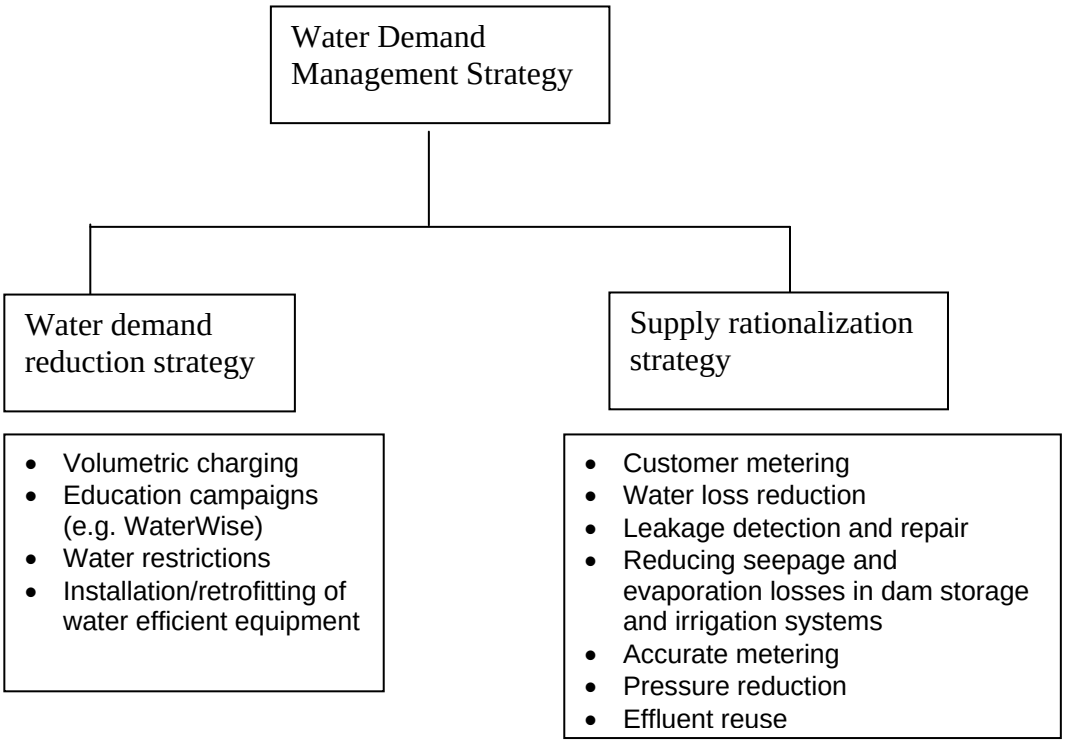

Fig 4.17: Water demand management strategies

Water demand reduction strategy involve the reduction/restriction of the over use of water where it can be done by tariff setting according to the volume of water used and the removal of flat rate charging by metering all customers. Education campaign

is also important on water use efficiency and installation of water efficient equipment let say flash toilets which uses less water.

Another strategy is supply rationalization includes customer metering if possible prepaid meter to avoid delays in payment, effluent reuse, water loss reduction through leakage detection and immediate repair, reducing seepage and evaporation losses in dam storage and irrigation systems, accurate metering and pressure reduction.

The strategy proposed need to be seriously taken into consideration in order to satisfy the need of present water demand and to be able to serve water for the future water demand.

4.3.5.1 Moshi Urban Water supply and Sewerage Authority WDM Strategies

According to the WDM practices in Moshi, the following strategies are proposed:

- Water loss reduction through proper replacement of old pipes and fitting to reduce leakage and control of illegal connection.
- Installation of water efficient equipment.
- Education on water demand management on a wise use of water resources where different group of water users need to be involved.
- Increasing the level of waste water reuse.

4.3.5.2: Mbeya Urban Water supply and Sewerage Authority WDM Strategies.

From the result obtained in the chapter four, the following strategies need to be adopted in Mbeya Authoriy:

- Water loss reduction to meet the targeted UFW that is from 32% to 30% these can be done through reduction of leakage rate, replacement of old pipes and fitting and also controlling illegal connection.
- Adaptation of volumetric charges by installation universal customer metering and if possible to use prepaid meters.
- Increasing the level of education dissemination regarding WDM through conducting seminars, workshop where community from all level need to be involved.
- For water resources use maximization the authority need to start reusing the waste water produced to be able to meet its demand taking the fact that some people may use treated water for watering the gardens, car washing where reused water can be used instead.

CHAPTER FIVE

CONCLUSIONS AND RECCOMENDATION

5.1 Conclusions

The study has identified a number of WDM practices applied by the utilities. From the result obtained and discussed in chapter four on technical and socio-economic practices Water Demand Management for the Authorities shows to be in adequate. The technical and socio economic practices by the utilities and customer perceptions on WDM is as follow,

5.1.1 Moshi Urban Water Supply and Sewerage Authority

For Moshi the technical WDM practiced are:

- Water loss control to reduce UFW level, these is done through leakage reduction by physical observation and report from community as well as facilitating the community to report the illegal connection.
- Pressure management is done in a zoning method and regulated in the storage tanks and pressure reducing devices.
- Water sources conservation and protection.
- Waste water reuse from ponds and wetland for paddy cultivation

Social economic aspect

- All 15,791 customers are metered and out of that 50 are using prepaid meters.

- Public education on WDM though in small extent where more than 50% are not aware.

5.1.2 Mbeya Urban Water Supply and Sewerage Authority

Technical aspect of WDM practiced in Mbeya includes:

- Water loss control through physical and information obtained for leakage control and detecting illegal connection.
- Pressure management by using dedicated service reservoirs serving areas lying over a particular range of elevation.
- Conservation and protection of water sources.

On social economic aspect the practices are:

- Consumer metering where 70% of the customers are metered.
- Water rationing due to the fact that water production is low than the water demand
- Public awareness and education where there a lot of plans to improve WDM practices.

Consumers' perception and satisfaction obtained from respondents of water consumers are as follow:

- Water quality: In Mbeya majority of population surveyed are not satisfied with the quality of water due to high turbidity. In Moshi there were no complain in terms of water quality.
- Tariff and billing system: The use of volumetric units there were no complain for both authorities surveyed. In Moshi there is only volumetric billing but for Mbeya there is volumetric, flat rate and minimum charge.

- Willing and ability to pay depends on the tariff and billing system as mentioned above. But there are other few customers who are willing to pay especially the un-metered customers due to the fact that water can be used in any amount for the same amount of money. These result to the increase inefficiency use of water.

The practices are almost the same but the performance differs, in comparing with MoU between MoW and urban water supply the utilities does not adhere with some of the target as it was supposed to be met by June 2008. The two utilities does not have proper measure for water loss, that is high leakage rate, illegal connection that result to high UFW, the UFW are of 32.6% in Moshi and 32% in Mbeya as compared with the target where is supposed to be 22% and 30% respectively. More than 50% of consumers are not aware of WDM issues for both authorities, in Mbeya 46% were not satisfied with the quality of water supplied but for Moshi they do. Only 44% have seen to have 24 hours in average water supply in Mbeya equals to 21 hrs in average while in Moshi they get service for 23 hrs services per day in average, according to the performance indicator is supposed to be 23 hrs in Mbeya and 24 hrs services per day in Moshi.

The challenges which the authority are facing include technical especially water loss control, financial and organizational together with social on community awareness, education and satisfaction.

There are different water strategies for WDM, for the case of the two authority surveyed the proposed strategy is categorized into two part, Water demand reduction

strategies; and Supply rationalization strategies. From there different strategies were proposed for the two individual authorities

5.2 Recommendations

For any WDM effort to succeed, measures must be both effective (doing the right things) and efficient (doing things right). Effectiveness is thus related to the criterion of acceptability. Education and information campaigns should also form an integral part of WDM.

To enhance proper monitoring, O&M of water supply system need to be managed in order to facilitate this exercise, drawing showing all pipes network should be prepared, maintained and updated regularly through a computerized mapping and information system.

Recommendation for Moshi UWSA

i) To carry intensive leak detection and pressure control programme regularly in order to cut down the UFW

ii) Increase community awareness so they can be able to protect their own sources and improve efficiency use of water.

iii) Improvement of customer services, quality services and water reliability and supply.

iv) To involve community (water users) through water education campaign regarding cutting pipes and the effect of leakage.

v) Rain water harvesting should be adopted as a serious supplementary source of water supply.

vi) To adopt the block tariff system in order to improve tariff system for both classes of people to obtain water in an affordable price.

vii) Identification of all customers legal and illegal connections as well as potential consumers who are still unaccounted for.

viii) Increase working hours for plumbers to be on duty overnight for emergency leakage control.

ix) To implement time plans which is on the paper to action, Example Environmental conservation plans, strategies of reducing %UFW.

Recommendation for Mbeya UWSA

i) To improve tariff system by the adaptation of volumetric charges through installation of universal customer metering and if possible pre-paid meters for sustainable development of water supply.

ii) To adopt the block tariff system in order to improve tariff system for both classes of people to obtain water in an affordable price.

iii) To improve extension of service capacity to increase water coverage.

iv) Reduction of water loss through reduction of leakage rate by replacing old pipes and fittings, controlling illegal connection through, meter tempering

v) The Authority need to start reuse waste water produced to meet the demand and at the same time to make proper utilization of nutrient available.

vi) Education campaigns regarding WDM and conservation need to be emphasized for efficient use of water resources.

vii) Rain water harvesting should be adopted as a serious supplementary source of water supply.

viii) To learn from MUWSA and other authorities as it can be seen it is performing better in teams of production, water services hours etc

ix) To implement the plans which are on the paper to the real practices by involving different consultant with different knowledge, Example in Water sources conservation and how to compensate household leaving near the sources so as to avoid water sources contamination.

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APPENDICES
QUESTIONNAIRES

A) Authority Questions

a) Profile of Water Supply Scheme

S/NO	Questions	Response
1.	Name of water supply scheme	
2.	Source of water	
3.	Type of technology	
4.	No of households used	
	What was the cost of investing this supply project?	
5.	How much did the community contribute to the project?	
6	What kind of mechanisms do you employ for the community to recover the cost of implementation?	
7	How much do households afford to pay for water supply service?	
8	What are the problems do you experience in managing this project	

1. What is the coverage of water supply?
……
……

2. What are the service hours of the supply?
   a) 24 Hrs
   b) 12 hrs
   c) Other specify

3. What is the percentage of UFW? Historical data
……
…….

4. How many leakages are reported per month?
……
……

5. Do you experience any effect of high pressure?
……
……
……..

6. What is its impact to water delivery?

……
……
……

7. After how long leakage is reported?
   a) Hrs
   b) Day
   c) Specify

8. Who is reporting leakage?
   a) Customers
   b) Office members

9. What are the service hours of the workers dealing with water services?
   a) 24 hrs
   b) 12 hrs
   c) 8 hrs
   d) Other specify

10. If not 24 hrs how is the leakage going to be reported?
……
……
…….

11. Do you think the community understands the issue of water demand management?
   a) Yes
   b) No

12. Which effort is utility taking to ensure the community is aware of the issue?
……
……
…….

13. To what extent are communities involved in water demand management?
……
……
……
…….

14. Do you have any programme of educating community in water demand management?
   a) Yes
   b) No

15. If yes what extent?

……
……

16. Is waste water re use practiced in your utility?
    a) Yes
    b) No

17. How many numbers of illegal connections occurs per month? Historical data
……..

18. What is the main reason for illegal connection to occur?
……
……
……
…….

19. Is the current tariff enough to recover the cost of production?
……
……..

20. If yes to what extent.
……
……
……

21. If No what effort is utility taking to recover the cost.
……
……
……

22. Which criteria is used to estimate the bills for un metered customers?
……
……
……

23. Are the community willing to pay the bills per month?
    a) Yes
    b) No

24. If No what is the main reasons?
    a) Affordability
    b) Resistant to pay
    c) Any other specify

b) Knowledge about WDM in utilities

1. Do you know about any WDM Technologies
    a) Yes
    b) No

2. Do you apply WDM Technologies in the Authority?
    a) Yes
    b) No

3. If yes, which ones?
    a) Metering
    b) Awareness and Education
    c) Recycling
    d) Retrofitting
    e) Others specify

4. Do you think the WDM Technologies being applied in the utility, are appropriate?
    a) Yes
    b) No

5. Do you have any conservation Management Plans in you're Authority?
    a) Yes
    b) No

6. If yes Please explain
……
……

7. Do you carry out Water Audits in your factory?
    a) Yes
    b) No

8. If yes, is there someone responsible for Water Auditing in the Authority and how often it is done?
    a) Yes
    b) No

9. Do you have leakage control and reduction mechanism for unaccounted for water in the Authority?
    a) Yes
    b) No

10. If yes indicate which mechanism are employed,

……

……..

11. In your view, are the mechanisms employed above, effective in leakage control and reduction?

a) Yes
b) No
c) Other specify

12. Does the authority have an equipment maintenance program?

a) Yes
b) No

13. What are the problems associated with the operation and maintenance of your Water Supply system?

……
….
……..

14. In your view what should be done to evade such problems from occurring?

…. …….
……..

B) HOUSE HOLD QUESTIONNAIRE

a) General household profile

1. Name of respondent (optional)……..

2. Household head (tick)

Male	
Female	

3. Household size (tick)

Household size	**Tick**
01 – 05	
06 – 10	
11 – 15	
16 - 20	
> 20	

4. Accommodation tenure status of the house (Tick)

Owner occupier	
Renting	
Others	

5. What is your main source of income (economic activity?)

Source of income	**Tick**
Salary (employment)	
Business	
Livestock keeping	
Farming	
Others , specify	

(b) Water supply services

6. What is your main use of water being supplied to you?

Uses of water	**(Tick)**
1. Domestic	
2. Livestock	
3. Business	
4. Industrial	
5 Others, specify	

7. What is the main source of water?

Source	**(Tick)**
Borehole	
Public kiosks	
Public stand post	
House connection	
Buying from nearby house connection	
Others, specify	

8. If you have house connection, did you pay for connection costs?

(a)

Yes	
No	

(b)If yes how much did you pay for house connection?.....

(c) Do you think the money is reasonable to the service they offer?

a) Yes

b) No

Reason;……
……
……
……

9 What is your average daily household water consumption?

Litres/d	**(Tick)**
<100	
100 – 200	
200 – 300	
>300	

10 What is the level of water supply in your area/house?

(a) 24 hours

(b) Duration in hours/minutes

© Morning…….Day time……Evening……

11. Do you think the quality of water being supplied is adequate?

Yes	
No	

12. If NO what is the problem?

Water quality	**(Tick)**
Gives poor taste	
Has turbidity	
Smells bad	
Other comments (specify)	

……
……
…….

13. Does your household store water?

Yes	
No	

14. Why do you store water?

Reason	**(Tick)**
No answer	
Unreliable water supply	
Used during water shortage	
Others (specify)	

15. How do you get water incase there is shortfall in water supply? How much do money you spend per month for these sources?

Source of water	**(Tick)**	**Cost (Tshs)**
Public kiosks/ stand post		
Buying from nearby house connection		
Using nearby river		
Buying from water vendors		
Fetching from nearby shallow wells		
Others (specify)		

16) Is the cost of buying water equals to the cost of being connected?

a) Yes
b) No

Reason:……
……
……
……

17) Do you have meter?

a) Yes
b) No

18) Is the water you're getting enough for the daily consumption?

a) Yes
b) No

19) If is not enough, what is the main reason

a) Rationing
b) High cost that limit water use

20) Are you using water efficiently?

a) Yes
b) No

21) If yes what is the main reason?
a) High bills
b) Water conservation
c) Other specify

22) Do you have Knowledge of Water Demand Management?
a) Yes
b) No

23) If yes which ones?
Explain……
……
……
……

24) Do you think is of important to apply in water use system
a) Yes
b) No

25) Are you responsible to report leakage to the Authority?
a) Yes
b) No

26) After how long leakage is repaired from the time you have reported?
……

©Water Fee contribution and Tariff Payment Systems

27) How much in average are you paying per month?
……
……
……
28) Do you think is appropriate for you to contribute construction cost and pay water supply service? (Tick)

Yes	
No	

29) If the answer to the above question is No why? State reasons
……
……
……

30) Are you able and willing to devote more than the amount of money you are currently paying for improved water supply service? (Tick)

(a)

Yes	
No	

(b) If Yes, how much Tshs……..

31) How do you pay for Operation and Maintenance of water supply service?

Payment system	**(Tick)**	**Rate (Tshs)**
Fixed charge		
Metered/volumetric bill		

32) What do you prefer as the water payment or billing systems?

Fixed charge	
Metered/Volumetric bill	

33) Are you able and willing to devote more than the amount of money you are currently paying for Operation and Maintenance of water supply service (Tick)

Yes	
No	

34) If the answer is No why?

……
……
…….