UNIVERSITY OF ZIMBABWE

Assessment of the Performance of Urban Water Supply Utilities: A case study of Korogwe and Muheza towns, Tanzania

By

Victor Kimey

A thesis submitted in partial fulfillment of the requirements for the Master's Degree in Integrated Water Resources Management

Department of Civil Engineering

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ABSTRACT

The provision of adequate and reliable water supply in developing countries is becoming a challenge for most water utilities especially public service providers. Water demand has been increasing drastically in these countries due to many factors including population growth as a result of rural to urban migration. As a consequence, in many countries public service utilities have failed to provide consumers with adequate water supply and sanitation services. Apart from service coverage, there are other problems that affect public service providers such as high Unaccounted for Water (UfW) and financial problems due to a combination of low tariff, poor services, poor consumer records and inefficient billing practices.

This study set out to assess the performance of two urban water supply utilities in Tanzania. There are serious water supply problems in the districts under study and, at the same time, not much is known about the performance of water supply utilities since the implementation of the Tanzanian Government's new water policy in 2002. This assessment was based on two main indicators which are the quality of service and unaccounted for water. The quality of the service and UfW have been cited as some of the major factors which reflect the performance of many water utilities. Poor service quality as measured by the water quality, billing efficiency and customer care, affects consumer willingness to pay and consequently the performance of the water supply utility. Methods used in the study included documentary review, household questionnaires, key informant interviews and field observations. The household questionnaires were used to study customer perceptions on the quality of the service in terms of availability, reliability, affordability and adequacy of the water, water quality and customer relations. Key informant interviews were used to study the general performance of the utilities. Field observations were used to gather data to supplement the data gathered through interviews.

The results show that accessibility and reliability of water supply in Muheza town is inadequate compared to Korogwe town. On average customers receive water for 8 hours per day in Korogwe and 5 hours per day in Muheza. Water supplied by the respective utilities in the two districts is far below the total demand. More than 80% of customer complaints in both towns were about water quality, water shortage and customer relations. Poor billing practices and old infrastructure have resulted in high UfW of 42% in Korogwe and 47% in Muheza. The conclusion, therefore, was that the customers were not satisfied with quality of services and that the UfW was higher than the generally accepted value of 25% suggested by the World Bank. It is recommended that the reduction of UfW through appropriate water demand management strategies should be given priority and Authority should engage in environmental conservation at main water sources of water supply. In order to improve the quality of services, the utilities should improve customer relation and care.

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Most of all thank to God the Almighty for providing me with the strength, good health and everything else throughout my studies.

DECLARATION

I …………………………………………………… hereby declare to the University of Zimbabwe that the work contained in this thesis is the result of my original work. All information, including diagram and tables, copied from or based on the work of others, has its source clearly cited as it appears. This work is submitted for the Masters Degree in Integrated Water Resource Management (IWRM), Department of Civil Engineering in the University of Zimbabwe. To the best of my knowledge it has never been submitted before, for any degree or award at any University.

Signed …….............
Victor J. Kimey

DEDICATION

This work is dedicated to my late father Dr. Jafred S. Kimey. Ma y God Keep you in eternal peace

ACRONYMS

EWURA	Energy and Water Utility Regulatory Authority
KTC	Korogwe Town Council
KUWASA	Korogwe Urban Water Supply Authority
MUHUWASA	Muheza Urban Water Supply Authority
MOU	Memorandum of Understanding
NAWAPO	National Water Policy
TSH.	Tanzania Shillings
UWSA	Urban Water Supply and Sewerage Authority
UFW	Unaccounted For Water
USD	United States Dollar
UN	United Nations
WTP	Willingness To Pay
WHO	World Health Organization

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

The provision of adequate supplies potable water for use in urban areas in developing countries for drinking, cooking, cleaning and bathing is crucial for the well-being of the people. The demand for such supplies in the developing countries has been on the increase over time as a result of rising standards of living that occur with economic progress and population increase resulting from natural growth, not to mention rural urban migration and rising per capital income (Rewata and Sampath, 2000).

In many developing countries, however, the public service providers have failed to provide consumers with adequate water supply and sanitation services (Nickson, 2002; Mwanza, 2004). Despite the positive fact that between 1980 and 2000 an additional 2.4 billion people gained access to water supply and 600 million more people have access to sanitation services, it is estimated that some 1.1 billion people still do not have access to safe water and 2.4 billion lack access to sanitation (WHO-UNICEF, 2001). The existing problems of inadequate service provision is exacerbated by the fact that population growth and mounting pressure of increasing urbanization have offset much of the very gains in service coverage (Gentry and Fernandez, 1997).

Apart from serving coverage, there are other problems that affect public services providers. Many public utilities in developing countries, for example, experience high unaccounted for water (UfW) rates, which often average between 40% - 60%, meaning that half of the potable water produced is lost somewhere in the provision process (Schwartz, 2007). According to Mody and Haarmeyer (1997) public utilities in developing countries are generally over-staffed, and have five to seven times more employees than is considered efficient. Moreover the service providers often face financial challenges due to a combination of low tariffs, poor services, poor consumer records and inefficiency billing and collection practices (World Bank, 1994; Mwanza, 2004).

The Urban Water Supply and Sanitation Authorities (UWSAs) in Tanzania are still facing many challenges in its service provision. Rewata and Sampath (2000) point out that UWSAs in Tanzania experiences problems in the provision of quality service, high UfW, poor infrastructure and management structure. Various efforts have been made by the Tanzania government to address the issues of improving the performance of UWSAs. In 1997, the government established UWSAs in 19 regional centres of mainland Tanzania by amendment of Act No 8 of the Water Act Chapter 272 followed by the establishment of UWSAs at district level. The major obligations of UWSAs are to supply adequate potable water and provide sewerage services to customers at affordable cost. Among some of the changes was the formulation of autonomous water supply and sewerages

utilities, which were classified in three categories, namely, A, B and C as per the Tanzanian Waterworks Regulations of 1997.
According to this classification, category 'A' stands for all UWSAs which meet all of their direct and indirect costs of operation and maintenance and part of investments cost. category 'B' stands for all UWSAs which meet all of their direct and indirect costs of operation and maintenance for their plants except electricity. And lastly, category 'C' was created for UWSAs which can meet all direct and indirect cost of operation and maintenance except salaries and wages for permanent employees and electricity bills.

Korogwe Urban Water Supply Authority (KUWASA) and Muheza Urban Water Supply Authority (MUHUWASA) both fall under category 'C'. Korogwe and Muheza towns like most other towns in Tanzania experiences high unaccounted for water and poor quality of services. It was pointed out by Marobhe (2008) that shortage of clean drinking water continues to be significant problem in many parts of sub-Sahara Africa including Tanzania. The quality and coverage of services for most urban water utilities south of the Sahara remain poor and the situation is becoming worse with high urban population growth rate of 2-6% per year (Njiru and Sansom, 2003)

1.2 Problem Statement

The new National Water Policy (NAWAPO) of 2002 was the product of reforms of the Tanzania water sector which took shape in the later 1990's. Experiences have shown that in Tanzania for the water sector, the reforms have played a positive role impact to UWSAs, specially those who are in category A, however, little has been done to review and analyze the performance of the urban water utilities especially in small towns since the implementation of the new National Water Policy. As a consequence there is an information gap regarding the weaknesses and strength of the utilities performance since its implementation.

1.3 Justification

Korogwe Urban Water Supply Authority (KUWASA) and Muheza Urban Water Supply Authority (MUHUWASA) are among of the UWSAs which are found in Tanzania. The authorities like any other authorities in small towns are experience operational problems such as high UfW, poor quality of services and water shortage. Studies carried by Global Partnership for Output Bases (GPOB) in 2006, found out that urban water utilities in small towns were experiencing water shortages due to population growth in selected towns in Tanzania. According to Mhamba and Colman (2005) Urban Water Supply and Sewerage Authorities have been encountering a lot of challenges which include high unaccounted for water UfW and undeveloped management system leading to poor performance in delivering of water services. If these challenges are not treated with the seriousness they deserve, the performance of urban water utilities will continue to deteriorate. Therefore, since the aim of the Tanzania government is to transform all urban water supply and sewerage utilities into autonomous entities capable of being independent in all sectors of operations, it hoped that the results of this study will contribute to the improvement of the performance of urban water utilities in Tanzania.

1.4 Objectives

1.4.1 Main objective

The main objective of this study was to assess the performance of Korogwe and Muheza Urban Water Supply Authorities in terms of the quality of services and unaccounted for water (UfW).

1.4.2 Specific objectives

- To determine accessibility, reliability and adequacy of water supply services
- To assess consumer perception towards the services provided by the water supply authorities
- To determined the factors that contributing to UfW in Muheza and Korogwe towns
- To compare the level of performance of KUWASA and MUHUWASA in terms of unaccounted for water and service quality according to the specified local and international standards and recommendation.

1.4.4 Scope of study

Although there are several indicators that are used for the assessment of performance of urban water supply and sanitation, the focus of this research is mainly on the quality of services and unaccounted for water. UfW and quality has been cited by several researchers as the most critical problems in most water supply utilities. Mugabi et al. (2006) established that a common feature of public water utilities in developing countries is their lack of commercial orientation, as the result, many utilities find themselves locked in a cycle of poor cooperate performance with low coverage of services, huge amount of unaccounted for water and insufficient fund for maintenance and expansion. Also according to World Bank (1994) and Mwanza (2004) the public utilities often face financial challenges due to a combination of low tariffs, poor services, poor consumer records and inefficiency billing and collection practices that resulting to high UfW.

Although Urban Water Supply and Sanitation Authorities were created to deal with both water supply and sanitation, this research study focuses more on water supply operations because in all case studies the Authorities are concerned with water supply and sanitation part is the responsibility of district councils. Therefore the information contained in this study is limited to urban water supply only.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General introduction

According to UN (2003) the world is facing serious water crisis, and water access and service delivery in the developing world need to be improved dramatically and urgently especially if gains in the fight against poverty, hunger and diseases are to be made. Literature clearly shows that public utilities in the developing countries often serve only a fraction of the urban population, with the vast majority relying on alternative sources (World Bank, 1993; Whittington *et al*. 1994, WSP, 2003). World leaders not only agree that water is an important part of the core development agenda but have also committed themselves to ambitious targets for expanding access to water services (UN, undated). At the United Nations (UN) Millennium Summit in 2000 and subsequently at the Johannesburg Earth Summit in 2002, World leaders agreed to set time–bound and measurable development targets widely known as Millennium Development Goals for 2015 which include a commitment to halve the proportion of people without access to safe drinking water and also to halve the proportion of people without access to sanitation services (UN, 2003).

Many experts seem to agree that poor access to water supply is often the result of poor policies and management practices (Gulyani *et al*., 2005). However, there are disagreements over the approach to addressing the problems. In direct opposition to lobbies demanding that water be treated as human right, experts at agencies such as United Nations and the World Bank argue that a first or crucial step towards improving the water situation and its management is to treat water as an economic good (United Nation, 2003; World Bank, 2003). According to World bank (1993) the policy of keeping domestic water tariff low is not working, and has resulted in massive and poorly targeted subsidization of services that has helped the rich (but not the poor), has hurt financial viability of utilities and has lead to deterioration in service quality and subsequently to low willingness to pay by consumers.

Africa has the lowest water supply and sanitation coverage of any region in the world (WHO, 2000). In the year 2000, coverage level for water supply and sanitation in Africa were 62% and 60% respectively (WSP, 2003). Africa is also urbanizing faster than any other region with urbanization rate range between 3.2 to 5.2% per annum as compared to other continents with a maximum of 3% per annum (WSP, 2003). Between 1990 and 2025, the total urban population is expected to grow from 300 to 700million; and by 2020 it is expected that over 50% of the population in Africa countries will reside in urban areas (World Bank, 2003).

2.2 Water services

Euromarket (2003) defines water services as all services that provide water for households, public institutions or any economic activities. In the European Union (EU) definition, water services relate to the whole series of activities from the abstraction of raw water at the source to the delivery of (treated) water to the consumer and from the consumer back to a water sources. In water utility management the services are limited to the supply of drinking water and collection and treatment of wastewater.

According to van Hofwegen (2001), the implementation /management of water services may be shared between an authority responsible for the general organization and political decision and operators (utility) responsible for operation maintenance, management and in some cases investment. To carry out the services function and operate and maintain the infrastructure, the utility should meet several accountability criteria including liability associated with performance of its functions, political and social responsibilities embodied in the effectiveness of the utility in meeting the expectation of the government and customers.

2.2.1 Service provision and quality

According to Schwartz (2007), for water utilities to be effective and efficient in the service delivery the main component of quality services needs to be considered. General components of perceiving quality in water and further public services include the following:-

- Accessibility: location of service to population it services and waiting time for service.
- Relevance: of type/pattern of service to needs of population
- Equity: fairness of provision for different groups of people.
- Efficiency: economy of resource use and value for money.
- Acceptability: to the public of services available.
- Effectiveness: of services provided
- Reliability: service provision should always be there when needed.
- Responsiveness: of the utility towards their customers
- Creditability, employee attitude, communication, responding to demand of the customers

Although aspiring to provide quality services, the sustainable provision of Water Supply and Sanitation (WSS) services is problematic in mostly developing countries as there is a whole range of aspects constraining the provision of adequate WSS services (Schwartz, 2007). Samson (1999) identified the following constraints:

- A lack of clear direction and vision
- Definition and agreement of roles of key stakeholders not sufficiently clear.
- Fragmented and overlapping responsibilities between different organizations and stakeholders.
- Poorly defined financial and physical objectives/indicators
- A lack of capable trained staff
- Inadequate management information and systems and lack of transparency
- Comprehensive operation and maintenance procedures and cost recovery procedures are not developed

- Bureaucratic controls inhibit effective management
- Ineffective staffing policy and job definition
- A lack of resources
- Political management and interference and lack of a willingness to charge increased water and sanitation
- A lack of incentives to make improvements

2.2.2 Access to water

Access to water and sanitation, like access to healthcare, is generally better in urban areas than in rural areas (Global, 2007). But again, comparing aggregate urban and rural numbers hides the fact that-for example in Mbare neighborhoods of Harare, Zimbabwe, 1,300 people share one communal toilet with six squatting holes. As urban population increases, the number of people without access to improved water sources in Africa is also rising, doubling from 108 million in 1990 to 215 million 2010. In dense city environments and in even denser slum environment, communicable diseases can quickly become epidemics, making the consequence of unsafe water and poor sanitation much more severe than in rural areas. And more people are affected due to city concentration (Global, 2007).

Access to safe water is measured by the number of people who have a reasonable means of getting an adequate amount of water that is safe for drinking, washing, and essential household activities, express as a percentage of the total population. The measure reflects the health of a country's people and the country's capacity to collect, clean and distribute water to consumers. (World Bank, 2001)

Adequate supply of safe water involves an often complex mixture of social, economic, and environmental issues. In recent years, people, industries, farmers, and government have begun to acknowledge that water is an economic good, not a 'free' limitless resource (Global, 2007). And as an economic good there is a wide range in providing the quality and level of water delivery and sanitation services that people want and are willing to pay (Global, 2007).

According to World Bank (2001) experiences from around the globe shows that when people, even the poorest, have a choice in the quality of their water supply and sanitation services, they often are willing to pay a higher price to get a higher service quality. For example, people who are unwilling to pay for operating and maintaining low quality hand pumps and pit latrine but may be willing to pay more to get a basic system of piped water and sewers that work fairly and efficiently.

2.2.3 Water availability and reliability

The uninterrupted stream of drinkable water that flows from an urban consumer's fau cet is perhaps, how most people perceive and understand water supply reliability (Hawk, 2003). Consumers may also experience failure of this supply as absence of reliability. In either case, water supply reliability has become an expected part of modern ur ban living. Similarly, perceptions on reliability are common to other types of demand/supply context and engineers have formalized this perception by defining reliability as the probability that system does not fail, or conversely, it is the probability of system failure subtracted from one (Hawk, 2003).

Previous studies carried out by WSP (1998) of water use in Kibera (Kenya), report that households tend to rely on one source to meet most of their water needs, but reliance on additional sources has increased. In the study, households reported that their primary source accounts, on average, for 66 percent of their total water use. At the same time, as many as 42% of the households reported that they use two or more sources to meet their water needs. According to WUP (2005) households need to use multiple sources when their primary source is not fully reliable and does not provide the lev el of service that they require.

Another indicator of water availability and reliability is the number of hours that wat er is available from a given system (Billing *et al*., 1999). A proper and reliable water supply system should be able to supply water to its consumers for 24hours a day (Schwartz 2007). In Kenya, 36 percent of the households with private connections, 36 per cent of those relying on kiosks, and 47 percent of those with yard taps report ed that water is available for less than 8 hours per day (WUP, 2005). According to Whittington *et al*. (1991) only about one-third of households that have private connections usua lly get water for more than 16 hours a day. Taken together, limited water availability and the highly curtailed hours of service offer one explanation for why overall water use, by the poor, has fallen and is at surprisingly low levels. In addition to cutt ing water use, households cope with the intermittent water supply by storing water

2.3 Performance of water services

The problems facing the water supply and sanitation services in many low and middle-income countries have not gone noticed (Schwartz, 2007). Countless interest group and authors have analysed the functioning of public utilities and presented explanation for their poor performance. Foster (1996) ar gue that two institution defects are the underlying causes for poor performance. These are the 'poacher-gamekeeper' and the 'politicization of management' the politicization of management relate to the tendency to base decision on political rather than technical criteria as result of external influences from government. These two underlying causes l ead to poor performance through a number of transmission mechanisms. Foster model of state -owned Enterprises failure can be portraying in graphic form as shown in Fig.1 .

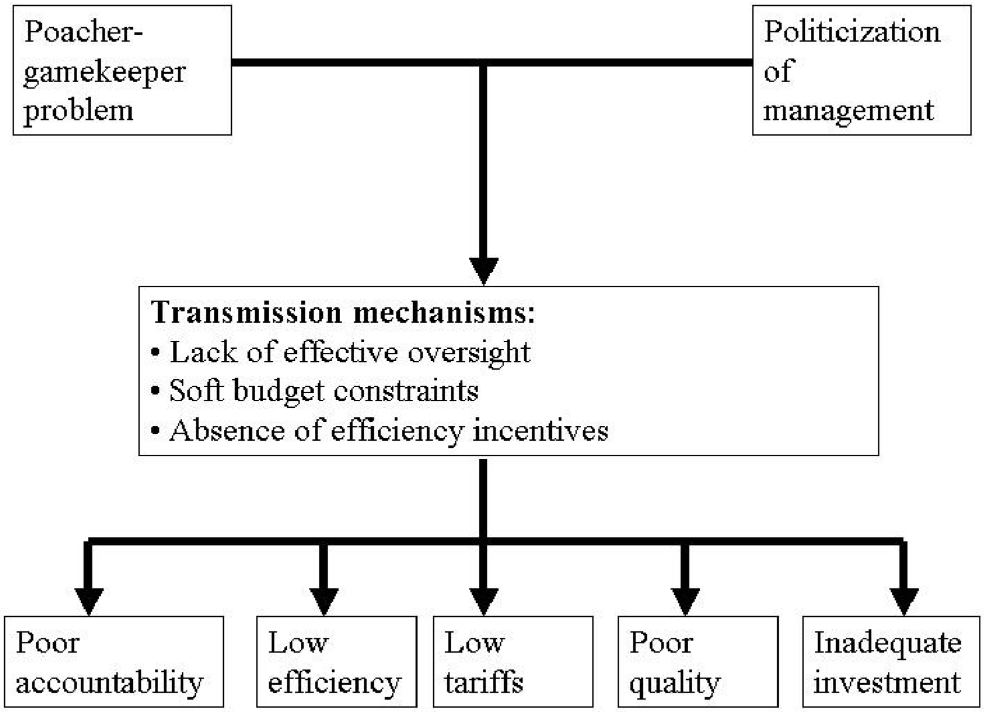

Fig.1: Fosters model of state owned enterprises failure (Source: Foster, 1996)

Spiler ***et al.*** (1999) who analyse the provision of water supply and sanitation services in Latin America find that inadequate provision of water services is largely consequences of 'the nature of sector, coupled with nation political institution, which toget her create incentive for government owners of public utilities to behave opportunistically, for the services provider to operate inefficiently and consumer to with hold support from the sector.

Literature available clearly shows that public utilities in d eveloping countries often serve only a fraction of the urban population (Whittington *et al*., 1991; World Bank, 1993). Recent reports emphasize that the world is facing a serious water crisis and that water access and services delivery in the developing wor ld need to be improved dramatically and urgently, especially if gain in the fight against poverty, hunger and diseases are to be made (United Nation, 2003)

According to WHO (2000), in order to meet the recently established millennium development goal num ber seven of 'halving the un-served population by 2015' urban Africa will require an 80% increased in the number of people served. Meeting this goal would require, on average, about 6,000 to 8000 new connection every day (WHO, 2000), also (WSP, 2003) argu e that a large fraction of the urban population growth is occurring in the community that are poor and settlement that are informal and unplanned, the task of providing water to unsaved is becoming increasingly difficult and challenging.

Performance of public utilities can sometimes be improved - interdependently - by increasing autonomy and ensuring adequate accountability mechanisms. This is done through separation of various functions into separate entities. Policy making remains with the local or central government, while an autonomous entity with a separate corporate oversight board becomes responsible for service delivery. This can either be a statutory body (functioning under public law) or a government owned company (functioning under commercial law, which in many countries offers more flexibility in operations).

2.4 Customer perception

A water sources may be rejected because of unpleasant but not harmful, aesthetic water quality parameters such as colour, taste and odour (Carter, 1996). According to (WUP, 2005) water should be free of taste and odour that would be objectionable to the majority of consumers. In assessing quality of drinking water, consumers rely principally upon their senses. Microbial, chemical and physical water constituents may affect the appearance, odour or taste of water and the consumer will evaluate the quality and acceptability of the water on the bases of these criteria (WHO, 2004).

According to Hoko and Hertle (2006) state that perception of water quality is partly subjective, apart from personal sensitivity to taste, adaptation could account for the differences, and adaptation is affected by such factors as duration of stay in the area, period of use and availability of other sources. Gulyan (2001) found that although some substances in water may have no direct health effect, water that is highly turbidity, highly coloured or has an objectionable taste or odour may be regarded by consumer as unsafe and may be rejected for the use.

2.5 Affordability criteria for the provision of services

According to Eberhand, (1999) one of the challenges of modern environmental management is the provision of safe drinking water at an affordable price to consumers. Consumers generally pay far less for water services than telecommunication services, although available statistic may mask water cost for consumers who pay through taxes or rent. Affordability is the function both of the price of water services and ability of households (and other water users) to pay for the services (Franceys, 2001).

Lopaying (2004) explain that, the notion of affordability is closely linked to the willingness to pay. However, whereas the willingness to pay survey gives information on whether the households are prepared to pay more for current and improve services or to avoid a worsening of the services, the affordability analysis gives information on whether the households have ability to pay. Affordability or ability to pay for water is expressed by the ratio of monthly household water consumption expenditure to average total household income. According to MacIntosh, (2003) some 20 years ago, a figure of 5% of household income was arbitrarily set as a realistic ceiling on affordability for water and sanitation services. This is in tandem with other authors and organisations that set the range of 3% - 5% of the average household income as the maximum affordable level of water services (World Bank, 2003: WSP, 2003).

Drinking water can be made more affordable by reducing the cost of services, increasingly the ability of users to pay or both and including institution efficiency. There are many other possible approaches to lowering cost of services. Franceys (2001) revealed that economic of scale offer the most promising means of lowering the unit cost of production and thus, consumers bills (although not in every circumstances). Economic of scale are particularly relevant for source of supply and treatment functions and can be achieved through mergers, acquisitions, interconnection and wholesale market. However, once system reaches a viable size, which varies by geographic location, there is a smaller benefit to an addition increase in system size. Finally low cost loans, grant and subsidies can help reduce the cost that must be recovered from customers.

2.5.1 Willingness to pay (WPT)

Lopaying (2004) states that the term willingness to pay describes the consumer's preferences in relation to changes in the water services and price. The willingness to pay is whether a user is willing to pay for a given service/product or given changes in service level or product attributes. When improvements are introduced, willingness to pay reflects the level of increase in payment that leaves the consumers indifferent as to the situation before and after change. Likewise, the willingness to pay to avoid deterioration of situation represents the compensation in payment which will be necessary to leave the consumer indifferent. According to Ntengwe (2004) willingness to pay for water services is affected by existing water quality, affordability and ability to pay, together with consumer's level of awareness of water management issues. According to Hensher (2005) the status quo can have a significant effect on willingness to pay amounts, with consumer's generally preferring status quo over changes in the service level and cost structure.

According to Raje *et al*. (2002) some consumers have zero willingness to pay more because of lack of faith in the management system for improve water services. This view is the reflected in the findings of a study conducted by UK Drinking Water Inspectorate (1998) which found that willingness to pay for improved water services was significantly influenced by consumer's attitude towards the water companies. Amongst the lowest income groups, it was affordability which limited their willingness (or ability) to pay more for water services (Raje *et al*, 2002).

2.5.2 Willingness to pay for improved water quality

Kim and Cho (2002) used contingent valuation method to determine consumer WTP for removal of high copper concentration in their water. The general findings were that in smaller community (in Minnesota, USA) the amounts that people were willing to pay would not cover the cost of improved treatment processed and systems.

Ready *et al*. (2002) showed that while Latvia consumers were prepared to pay up to 0.7% of their household income for improvements in surface water quality, this sum once aggregated was insufficient to implement the necessary changes. Also a study by Phiri, (2007) in Malawi revealed that, there was a slightly increase of willingness to pay for connection fees which was MK 1,864 ranging from a minimum of MK 800 to MK 4,000 as maximum. However this willingness to pay for connection fees is lower than the connection fees Lilongwe Water Board is currently demanding which is MK 2,460 (1US$=MK 140).

Willingness to pay for improvement to the water quality is also contingent on issues of ownership, and this has implication for the trend towards greater private sector participation. According to Raje *et al.* (2002) willingness to pay is lower when supplier is in the private sectors, and willingness to pay anything more is close to zero if the private sector supplier is seen to be wasteful or profiteering. When the state or regional government is responsible, WTP can be higher than the status quo.

2.5.3 Cost recovery

According to Eberhard (1999) the central challenges of modern environmental management in the provision of safe drinking water and sanitation lies in the affordability of the price to consumers. Yet, current argument is that public provision has not served the consumers well because they have been under-funded, badly operated, and ineffectively and inefficiently regulated such that some municipal system pose great public health and environmental threats Water pricing is primarily a function of water cost, which influenced by compliance by the utility drinking water standard, cost to replace and improve the water delivery infrastructure, and meeting the dema nd growth.

Fraceys (2001) states that in order to arrive at an equitable price mechanism that would be compatible with pricing trends and sustainable, there is need to conduct a study on value of water across sectors. As a value of water varies from one sector to another, it is important to link value with price consideration so that those deriving the maximum benefit from water make a greater contribution. Pricing must be based upon the user -pays principle, where the consumer pays for the full cost of water (capital and recurrent) including future development of supplies. This also implies that pricing of water should be base upon full cost recovery with tiered system to allow for cross subsidization between the different social-economic groups.

2.5.4 Tariffs and tariff structure

Water pricing has now been taken up by a number of donors "external support agencies" particularly World Bank (1993) as the most important tool for demand management (van de Zaag, 2003). One of the four Dubling principles is that water has an economic value and should be recognized as an economic good, taking into account affordability and equity. In the past, water was priced as a social good and government were obligated to provide water to its citizen as a social good. However, according to Warder (1994), water pricing using increasing block tariff has gained popularity. Increase block tariff are used to curb demands and are designed to ensure that customers demanding larger volume of water realize the high cost involved in developing new supply sources .

Despite the fact that water pricing is an important element of demand management, it is now the only issue that requires attention. Sevenjile and van der Zaag (2000) suggest that good water should mean a continuous process of integrated demand and supply management which will seek to match supply with demand through reducing water losses, increasing water yield and decreasing water demand.

The setting of tariff for water supply and sanitation services shall be the responsibility of the community in agreement with the services provider, based on the technology option selected and the cost of services. The tariff shall include the following:

- Estimated cost of operation
- Estimated maintenance and repair cost
- Cost for sanitation improvement
- Administrative cost
- Any other cost agreed by the community, such as loan repayment for financing higher service level, services to vulnerable members of their community.

Service tariff should not be pegged at levels higher than individual household can actually afford to spend on this commodity, out of total household expenditure budget. As a guide project for which the tariff exceeds 10% of the average household income should be carefully examine for ability to pay before implementation (Franceys, 2001).

2.5.5 Metering

Metering in a water supply system is necessary for the system's rationale and efficient operation and very important feature of service modernization and management improvement (Eberhard, 1999). Meter help bills to reflect the ups and downs of household water consumption and contribute to better water conservation, thus having reliable measurement at each stage of process of water supply starting at the water sources and ending with the consumer tap facilitate clear judgment to be made about the technical condition of each section in the system and enable prompt action to be taken to stop water losses and wastage. It is estimated that in developing countries more than 50% of the households have not been metered and this contribute to high unaccounted for water for the utilities (World Bank, 2003).

2.6 Concept of performance indicators of water utilities

According to Schwartz (2007) the term performance is frequently used in the field of water services. The term seems quite simple and often it is used without clarification of what exactly is meant by performance. A closer look at the concept of 'performance' shows, however, that the term has more dimensions than at first may appear (Schwartz, 2007). Indicators are standards used to measure achievement of an organization . They are measures of change or result brought about by an activities or series of actions. A performance indicator is a guide to show how well organizations are doing in meeting their goals and objectives. Indicators are pointers, numbers, facts, opinions or perception that measure organization performance (Wouter *et al*., 2005).

A useful frame work for analyzing the performance of water utility is provided b y Tynan and Kingdom (2002). The framework forwarded by Tynan and Kingdom was originally developed as a framework for benchmarking, meaning that a framework would allow for a comparison between different utilities. The framework distinguishes the following seven dimensions. 'operational efficiency', 'cost recovery', 'commercial performance', 'coverage and access', 'asset maintenance', 'price and affordability'.

2.6.1 Choice of performance indicators

Tynan and Kingdom (2002) urges for a choice of indicators that draw on data that are reliable, relative easy to collect and not susceptible to multiple inte rpretation. They should reflect condition over which the service providers have control. Yepes and Dianderas (1996) in addition note that operation indicators can be very useful in assessing the performance of water and waste water utilities in the course of evaluation. The idea of a comprehensive and up to date list of indicators from a large number of utilities world wide is attractive but probably not realistic due to the cost involved in collecting this information.

2.6.2 User performance indicators

Good performance indicators will represent the relevant aspect of water supply and allow a representation of the water management system by a limited number of parameters. They are suitable for representing the management aspect in a true and unbiased way an d reflect the results of the activities of different undertak ing in clearly define way (Schwartz, 2007). The international Water Association (IWA) has developed a wide range of performance indicators for evaluation of performance of water and sanitation infrastructure, and these indicators are still under review. T ynan and Kingdom (2002), Yerpes and Dianderas (1996) and WHO (2000) give a list of indicators from which those most appropriate to local situation can be selected. Guided by the ideas and concept from one of the indicators, it is possible to develop indicators that suit the local circumstances.

2.7 Assessing performance of water utilities

Tynan and Kingdom (2002) define four broad measures for assessing performance of water utilities

- Efficiency of investment
- Efficiency of operational and maintenance
- Financial sustainability
- Responsiveness to customers

2.7.1 Efficiency of investment

Efficient of investment refers to investment in new asset and operation of existing asset through daily maintenance. Water supply pipe networks are normally buried, so surrogates are needed to measure their status and maintenance. A crude measure of asset maintenance is unaccounted for water (UfW) the difference between water supplied and water sold as a percentage of water supplied. This measure not captures only physical losses but also commercial losses due to the inefficient billing or illegal connection. High level of unaccounted for water (UfW) indicates poor system management and poor commercial practices as well as inadequate pipeline maintenance.

2.7.2 Efficiency of operations and maintenance

Operational efficiency is defined by Tynan and Kigdom (2002) as the lowest cost use of input-labor, energy, water and material in the daily operation of the utility. The mo st efficient combination of inputs depends in a part on local input prices and past capital investment decisions. To measure operational efficiency, analyst use ratios of inputs to outputs. Once such ratio is staff per 1000 connections with a high ratio in dicating possible inefficient use of staff. Operational efficiency can also be measured through staff per 1000 people served, which eliminates the distortion caused when single water connections serve multiple households.

2.7.3 Financial sustainability

Failure to cover cost leads to under-investment in assets, weakened operations, and declining service quality. According to (Schwatz, 2007), pin point that definition of cost recovery vary with many debates on issue relating to capital asset value and rate of return investment. A simple measure of cost recovery is the working ratio, the ratio of total annual operation expenses, excluding depreciation and dept services, to total annual pretax collection from billing and subsidies. Financial sustainability also requires timely collection of payments, with a common measure of efficiency, in this area being collection period – account receivable as share of annual revenue express in month of sale.

2.7.4 Responsiveness to customers

Tinany and Kingdom (2002) identify customer focus as assessed on the basis of coverage, affordability and quality of services. The quality of services has several dimensions such as water availability or reliability, water quality, water pressure and customer relations. WHO (2000) advocate for a system of receiving and acting upon complaints as an essential part of consumer services, noting that these systems may exist without being well publicized and hence little known to consumers. WHO (2000) also note that the opinion of the users of services and their level of satisfaction will provide essential information about the operation of that services.

2.7.5 Remarks on Tinany and Kingdom's framework

The framework presented by Tinany and Kingdom (2002) can be very usefull in the sense that it is highlight different dimension of performance and allow for cross-case comparison. According to Schwatz, (2007) highlights some of shortfalls, first limitation concern the ability to catch a dimension in few indicators, for example UfW covers other practices other than asset maintenance.

Secondly, in some cases Tynan and Kingdom seem to contradict their own definitions, example operation efficiency as they defined it refers to the lowest cost use of labor, energy water and materials in a day to day operation of a utility, with the most efficient combination partly depend on local input prices and prior capital investment decision. However the indicators suggested by Tinany and Kingdom only relate to labor. The use of resources such as energy, water and materials are not covered by indicators, this is particular important when comparing low and middle income countries with low labor costs with industrialized countries with high labor costs.

Generally in assessing performance choice of indicators that suit in local environment is very important, for example in Netherlands, few consumers are really bothered about the price of water. Most important dimension of performance in country like Netherlands is not the efficiency of operation, level of coverage or price and affordability. Rather, the aspect of reliability and trustworthiness of service provision is much more important.

2.8 Tanzania water sector

2.8.1 Policy and legislation

Water service provision is governed by the policy and legal instruments. It is crucial for each Urban Water Supply and Sanitation Authority (UWSA) to understanding the key issues in the National water policy, Water legislation and other relevant legislation regarding the conduct of urban water supply and sewerage services. These instruments provide the framework within which to operate in providing much assistance on the UWSA part as well as the beneficiaries of the services.

National Water Policy (NAWAPO) advocates the necessary measure that shall be taken to ensure that all urban areas have adequate water supply and sanitation. UWSA as authorities vested with obligation for provision of water and sewerage services in urban areas shall take the necessary initiatives to implement such policy guidance.
Similarly, effort to educate the customers and stakeholders at large on policy and legal requirements are equally important to improve business performance. For instance payment for water services consumed as advocated in policy and legislation when understood will increase customer's voluntary compliance in paying water bills.

2.8.2 The Energy and Water Utilities Regulatory Authority (EWURA)

The Energy and Water Utilities Regulatory Authority (EWURA) is a regulatory authority established under the Energy and Water Utilities Regulatory Authority Act No. 11 of 2001. EWURA regulate four sectors: electricity, petroleum, natural gas and water and sewerage. According to government notice No. 133 of 22 September 2006 issues under the waterworks Act Cap. 272 regulation of UWSA in category A and B will be carried out by EWURA. The function of EWURA include issuing renewing and canceling licenses; establish standard; regulate rate and charges; making rules and monitoring performance.

UWSA are required to operate within the regulatory framework of the water sector and other relevant legal framework. In addition regulation 30 of the waterworks regulations GN No. 371 of 1997 and MoU require UWSA to have tools in place for regulation of their day to day activities.

2.9 The National Water Policy (NAWAPO)

Water sector development in Tanzania was governed by the 1991 National Water Policy, until the new 2002 National water policy came into force in 2002 (URT, 2002). One of the main developments that took place in the National Water Policy during the decade between these two policies was that the framework for planning, investment and operations and management changed. In 1991 the central government was given a mandate to be the sole investor, implementer and manager of projects in rural as well in urban areas. The 2002 policy on the other hand, has an objective to develop a framework for beneficiary participation in planning, construction, operation, maintenance and management (URT, 2002)

2.9.1 Urban Water Supply and Sewerage (UWSS)

Arvidson and Nordstron (2006) point out that due to the rapid rate of urbanization and overall population growth, urban water supply and sewerage infrastructure is hard pressed to meet all requirements. Between one third and half of urban population in Tanzania lives in unplanned or squatter areas, and only about 70% of the urban population has access to reliable water supply (URT, 2002). Existing infrastructure is old and in dire need of upgrading.

The specific objectives of the national water policy (2002) for urban areas are to:

- guide the development and management of efficient, effective and sustainable water supply and sewerage services
- create an enabling environmental and appropriate incentives for the delivery of water and sewerage services
- develop an effective institutional frame work and ensure that water supply and wastewater disposal entities are financially autonomous
- create an efficient and effective system of revenue generation from sale of water and wastewater removal
- enhance water demand management and waste water disposal

2.9.2 Present water resource management system

According to the National Water Policy (2002) the water utilization (Control and Regulation) Act No. 42 of 1974 and its subsequent amendments, govern the present water resources management system. Amendment Act No. 10 0f 1981 introduced pollution control aspects. However the water utilization Act and other sub -sector water related laws are inadequate to meet the growing water resources management challenges facing the country today. The country is divided into nine hydrological zone or river basins for purpose of water resource management.

2.8.5 Memorandum of Understanding (MoU)

Ministry of Water and Irrigation (MoW) and UWSAs entered in Memorandum of understanding (MoU) for the period of 2005 – 2008. This is the third MoU since establishment of UWSAs. One of the major parts of the MoU is the performance contract between the Ministry and every individual UWSA. The MoU highlights some important issues including the requirement for UWSAs to improve their performance targets have been set for each individual UWSA. The indicator has been categorized into Technical, Service, Efficiency, Financial and personnel. The Ministry's obligations under the MoU including regulation, Monitoring, evaluation and benchmarking the performance of the UWSAs on monthly, quarterly, annually and ad hoc basis by using indicators as stipulated in the MoU (URT, 2007)

CHAPTER THREE

3.0 STUDY AREA

3.1 Location and Population

The research was conducted in Korogwe and Muheza towns which are found in Korogwe and Muheza districts. These districts are among seven districts which are found in Tanga region in the North – East part of Tanzania as shown in Fig 2. Korogwe and Muheza towns are the administrative centers for the districts. Korogwe district has an area of 3,756 km^2 and shares borders with Muheza and Lushoto districts to the North and East and Handeni district to the South-West, respectively. According to the National Census (2002) Korogwe district had a population of 261,000. A growth rate of 1.4% was suggested for the next 10 years; from this background data the current population of the district is approximately to be 295,700.

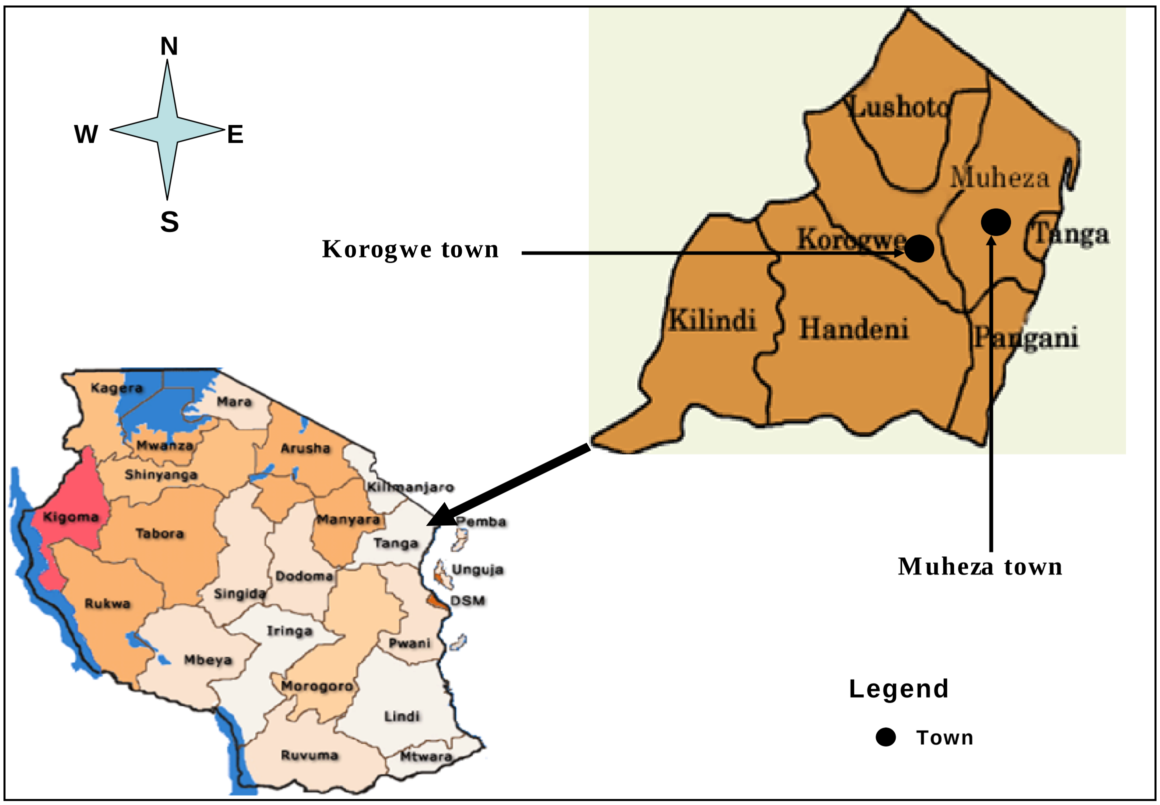

Fig 2: Map of Tanzania Showing Study area. (Source: NEC, 2002)

Korogwe Town Council (KTC) has an area of 212 square kilometers and lies in the latitude 5^0S and $5^0 14^0$ South and in the longitude of $38^0 23$ E and $30^0 33$ East. It is the second biggest settlement in the region after the municipality of Tanga. According to census (2002) the township had a population of 41,155. With a growth rate of 1.4% the current population of the township is approximately to be 45,000. The population stands at 255 people per square km while total household is approximately to be 9,000 with the average size of 5 per household. Based on the density of 255/km^2 this is categorized as district town.

According to the National Census of 2002, Muheza district had a population of 279,423 and with a population growth rate of 1.8% projected for 10 years, the current population of the district is 310,000. The district shares boarders with Tanga city to the East, Korogwe to the West and Handeni and Pangani to the south.

Muheza township had a population of 37,764 (exclude villages) according to census (2002) with growth rate of 1.8% the current population of the township is approximately to be 42,300. It has an area of 182 square kilometer and the population stands at 245 people per square kilometer while total household is approximately to be 8400 with the average size of 4.8 per household.

3.2 The physical feature of the study area

3.2.1 Korogwe topography

The scenic Usambara Mountain and Pangani River basin surround the topography of Korogwe. The Pangani River and its tributaries of Mbeza and Lwengera are the most important drainage system. The Pangani River is important for generating hydro–electricity and with other rivers has more than 1300 hectares of potential land for irrigation.

3.2.2 Climate

The climate ranges from tropical to sub tropical with a mean annual rainfall of 900 – 1000mm. Most of the rain is derived from the south easterly monsoon winds originated in the India Ocean. There are two rainfall seasons; the long rain (Masika) fall during February to May and the short rain (Vuli) fall during September to November. The average temperature during hot month (October – March) ranges from 30^0C – 32^0C and during cold season (May – October) temperature ranges from 23^0C – 28^0C in the day and 20^0C – 24^0C in the night. Humidity ranges between 65% - 100% high during the hot season. (KTC, 2007)

3.2.3 Agro – ecological zones

Korogwe Town experiences three types of agro – ecological zones. Korogwe Town Council falls under the low wetland zone which lies between 600 – 800 meters occupying about 5.6% of the District. It is hot humid and rainfall ranges between 800 – 1000mm per year. Several rivers including the Pangani and Lwengera meander through and drain this area a fact which enhances Irrigation potentials. The main food crops grown are maize, paddy, beans, cassava and potatoes while the cash crops cultivated include cashew nuts, cotton, sisal and Tropical fruits like mangoes, oranges and tangerines. Traditional and dairy cattle keeping are practiced for milk and meat. (KTC, 2007)

3.3 Korogwe Urban Water Supply Authority (KUWASA)

Korogwe Urban Water Supply Authority (KUWASA) started in 1998 as an Interim Exp Authority worked under Interim Advisory Board. In 2002 the Ministry of Water in accordance with Act No. 8 of 1997 declares this Authority to become Autonomous Water Utility Organization. It has a mandate to offer water supply service within Korogwe Town Council.

3.3.1 Existing situation

According to KUWASA annual report (2007) the first water supply project for the township was constructed 1956 from Mbeza stream on the side of Ambagulu Mountain (Usambara) to serve by then a population of only 400 0 people. Three supplement scheme were constructed using boreholes as the source of water to the town. The boreholes constructed were Kilole (1969), Old Korogwe (1998), and Mtonga which was constructed in 2005. The total present productions of these sources are 2700m ^{3}/day. The available storage facilities in township located in different location are as follow, Mtonga juu 90m^3, Mtonga chini 90m^3, Old Korogwe 135m^3, Kwamkole 45m^3, block B 1663m^3. (KUWASA, 2007)

3.3.2 Distribution system

The existing distribution system is made up of various lengths of DI, CI, GS, PE and PVC pipes with diameter ranging from 25mm – 200mm with the total length of 40,394 meter. Most of the net work is old therefore any long term development of the water supply system shall involve the rehabilitation of the network.

Table 1: The distribution pipes in Korogwe town

S/N	Details	Type of pipe	Size		Year
			Diameter (mm/inch	Length (m)	
	Gravitational main	CI	100	16340	1956
	Gravitational main	PVC	150	7795	1974
	Distribution main	DI	200	550	1956
	Distribution main	PTH	38	2990	1990
	Distribution main	GS	25	750	1980
	Distribution main	PTH	50	900	2001
	Distribution main	CI	75	200	1956
	Distribution main	PVC	150	1960	2000
	Distribution main	PVC	75	550	2000
	Distribution main	PVC	75	360	2000
	Distribution main	PVC	75	912	2006
	Distribution main	GS	75	282	2006
	Raising main	PVC	75	725	2001
	Raising main	CI	150	1040	1969
	Raising main	PVC	100	1135	2005

Source: (KUWASA, 2007)

3.4 The topography of Muheza

Muheza has a variety of relief features ranging from the coastal lowlands to high land area in the Usambara Mountains which are part of the Eastern Arc of Mountai ns. The coastal lowland extends between 20 – 30km inland from the Indian Ocean and rise to about 100m above sea level. The rest of district rises gradually from the east towards the northern and mid southern to about 400m above sea level (MTC, 2007). The Pangani, Zigi and Mkulumuzi rivers flow into the Indian Ocean and form the main drainage of the district.

3.4.1 Climate

The variation of topography contributes to the diversity of climate that range from hot and humidity to the coastal plain to temperate i n the mountains. The months of December to March are the hottest ones with the average temp of 31 ^{0}C during the day and 29^{0}C during the night. During cold season the average temperature is 28 ^{0}C during the day and 24^{0}C during the night. The average annual ra infall is between 1100mm to 1400mm and has two rainfall seasons which are (Masika) the long rains and (Vuli) the short rains. The rainfall is critical for agriculture product which is the backbone of economy and livelihood of Muheza people (MTC, 2007)

3.4.2 Muheza Urban Water Supply Authority (MUHUWASA)

Muheza Urban Water Supply Authority (MUHUWASA) started in 1998 as an Interim Exp Authority worked under Interim Advisory Board. In 2002 the Ministry of Water in accordance with Act No. 8 of 1997 declares th is Authority to become Autonomous Water Utility Organization. It has a mandate to offer water supply service within Muheza Town.

3.4.3 Existing situation

The first water supply project for the township was constructed in 1974 at Mkulumuzi River drain from Usambara Mountains to serve by then a population of only 8000 people. Up to date the towns still depend on that single source of water. The source was design to produce 1920m^3 per day and current production is 1425m^3 per day. The amount of water produced from this sources cover nearly 60% of the present population. The town has two storage facilities but current they are not used due to shortage of water. (MUHUWASA, 2007)

3.4.4 Distribution system

The existing distribution system is made up of various lengt hs of DI, CI, GS, PE and PVC pipes with diameter ranging from 25mm – 200mm with the total length of 17,246m, which is 24,486 for pipe line and 7,240m length for main line. Most of the net work is old therefore any long term development of the water supply system shall involve the rehabilitation of the network (MUHUWASA, 2007).

CHAPTER FOUR

4.0 MATERIALS AND METHODS

4.1 Research design

Korogwe and Muheza districts are among the seven districts which are found in Tanga region, Tanzania. The choice of these study sites (Korogwe and Muheza towns) were based on their similarities such as management structure, population and mostly the main source of water in both towns which is Usambara Mountain.

4.1.1 Data collection

The data collection was based on the descriptive survey. Descriptive survey is a method of collecting information by interviewing or administering questionnaires to a sample of individual (Orodho, 2003). The survey data was obtaining by administering questionnaires, key informant interviews and field observation.

4.2 Quality of water services

4.2.1 Accessibility of water services

Factors that considered in assessing accessibility of water supply were supply coverage of piped water system and its production capacity. In the assessing production capacity the study was looking on whether the utilities were able to meet water demand of the towns in both seasons (Dry and wet) however this study was done in wet season. In addition, the quantity of water used in households for daily needs was determined by using monthly meter readings. For unpiped houses, daily water consumption was assessed by administering structured questionnaires to the consumers.

4.2.2 Reliability of water services

Factor that considered in assessing reliability of water supply wer e duration of water supply, water supply pressure and downtime period. To determine the duration of water supply direct observations were made to determine how long water was available per day. Structured household questionnaires were also used to gather information from customers and the data obtained were verified by interviewing utility staff and historical record check. In order to assess downtime period of the facility, direct observation on the facilities that were not working at the st art of the research was done and random checks on some facilities were done until the end of the s tudy to check if broken facilities were repaired.

4.3 Key informant interviews

Semi-structure questionnaires for the key informant interviews were used to assess mainly performance of the utilities and to seek opinions of key stakeholders such as water managers and workers on technical, economic, regulation s, political influence and other management issues that influence the performance of the utility.

4.4 Questionnaire survey

A structured questionnaire was pre-tested on five household for clarity and usefulness in obtaining the desired information. Minor adjustments were made to come up with good questionnaire which was used for data collection in this study. Generally, the survey paid more attention to the need to ask questions that did not require long-term detailed memory and therefore answerable with a high degree of accuracy. The questionnaires were administered to 100 household water consumers in Korogwe town and 75 household water consumers in Muheza town.

The households were randomly selected in terms of geographical location and housing category. Taking into consideration that the towns were heterogeneous therefore, there was no clear demarcation on the areas, which can be classified as low, medium or high density. Special focus was given to the consumers at extremes of the distribution pipeline and those at the highest altitude. In the questionnaire survey the emphasis was on exploring the customer perceptions of the services delivery in term of accessibility of water, reliability and affordability as well as sufficient of the service provision. The household questionnaires also focused on water quality and quantity, customer-operator relation and customer's preference and opinion.

4.5 Field observation

The purpose of the field observation was to crosscheck and supplement on the data gathered from interviews. The condition of reservoirs, reticulation systems, boreholes and community kiosk were assessed Also the observation was made on distance from household to water kiosk, visual quality of water supplied and piped water pressure at household level and water kiosks.

4.6 Data analysis

4.6.1 Tools for qualitative analysis

The tool for qualitative and quantitative analysis of the data collected in the field by administering questionnaire was Statistical Packaging of Social Science (SPSS Version 11.0). Other data collected through literature review and key informants interviews were analyzed by desk analytical method.

4.6.2 Investigating the accessibility and reliability of water

Descriptive statistical method was used to summarize data and obtain a description of the responses to the surveyed questions. The method includes frequency tables and cross tabulation. The main factors which were used to analyzed accessibility of water were

- Pipe water supply system
- Household main water source
- Per capital water used
- Seasonal water shortage

In determining reliability of water, the analysis was based on the following factors

- Duration of water supply
- Water supply pressure
- Downtime period

4.6.3 Assessment of consumer perception on service quality

Descriptive statistical method was used to summarize data and obtain a description of the responses to the surveyed questions. These methods included frequency tables and cross tabulation. The main factors which were used in analyzing accessibility of water were as follows;

- Water quality perception
- Affordability
- Customer operator relations
- Customer complaints

4.6.4 Determination of the factors contributing to unaccounted for water (UfW)

In order to determine the factors that contribute to UfW in both utilities, the desk study analysis was performed by analyzing the key informant questionnaires accompanied by the data obtained from field observation and annual utilities reports. Unaccounted for Water was calculated by taking the averaging monthly total UfW for the past two years (2006 and 2007).

CHAPTER FIVE

5.0 RESULTS AND DISCUSSION

5.1 Quality of services

5.1.1 Accessibility of water supply

Water supply coverage and production capacity

The results presented in this section are based on field observations, interviews and utilities annual reports. The available water resources of Korogwe town are shown in Table 2. At present the sources of piped water supply in Korogwe town consist of three boreholes and one spring stream. Water from different boreholes is pumped into the different storage tanks, Mtonga juu (90m^3), Mtonga chini (90m^3), Old Korogwe (135m^3), Kwamkole (45m^3) and Mount view (673m^3). Kilole borehole which pumps water to Mtonga juu and Mtonga chini storage tanks was found not working. The utility operator indicated that the pump had not been working for nearly ten months. Other boreholes were found to be in a good condition and they were operating well. Water from Mbeza stream is collected from the Usambara Mountain through gravity and directed to the main reservoir tank at block B which has a capacity of 675m^3. It was also observed that water is distributed to consumers from the main distribution tank without being treated although physical inspection seemed to show that the water was in good state interms color and odor smell. Responding to the question on whether utility was doing regular water test, the Korogwe utility personnel said that the water laboratory was not functioning for the past several years and this necessitated carrying water samples to Tanga city which is almost 100km from the town on an had hoc basis for analysis.

Table 2: Current water production of four different sources in Korogwe town

S/No	Existing water source	Type of water conveyance	Water production in m^3/day	
			Rain season	Dry season
1	Mbeza stream	Gravity	1241	270
2	Kilole borehole	Pumping	-	-
3	Old korogwe borehole	Pumping	259	259
4	Mtonga borehole	Pumping	300	300
Total			1800	829

Source: (KUWASA, 2007)

From table 1, water production is varying according to the seasons. In the dry season the water production drops almost by 47%. The major reason is that the major source of water is the stream whose spring is up in the mountain and during the dry season the supply of water drops and affects the whole water production. According to KTC (2007) report there has been serious environmental degradation along the water sour ce caused by local people reside and engaged themselves in various social economic activities such as grazing, farming and tree harvesting. This has caused rampant deforestation, pollution and depletion of the natural resources and might be one of the factors that contribute to low water inflows during the dry seasons.

In Muheza town, the source of piped water supply is Mkulumuzi stream from Usambara Mountain. Water from the stream is directed by gravity to the main distribution tank (673 m^3) in Muheza town before it is re-distributed to consumers. The study established that the general condition of the main distribution tank was in bad condition, means that some of the parts have been broken down; that the authority had decided to distribute water to consumers without treatment while some of the customers had been direct connected to the main pipe that draws water from source to the main distribution tank. When asked about why the utility was supplying untreated water to consumers, the water manager indicated that the authority had no alternative as they had no adequate funds to rehabilitate the water infrastructure. Water production of this source is also varying according to the seasons. In the rainy season water production is 1425 m^3/day while in the dry season the production drops to 522 m^3/day.

From this study, it can be concluded that the water supply systems in both towns is not adequate but the situation in Muheza is worse compared to Korogwe town. During the dry season, the water yield drops by almost 47% in Korogwe and 63% in Muheza and the utilities were able to supply only 33% and 26 of water demand respectively. This is an untenable situation when one considers that, according to Schwartz (2007) a well - performing utility should be able to supply 100% of water demand. Further, this study has shown that the utilities are supplying un-treated water to consumers in contravention of the Tanzania Government Water Policy (2002) and WHO (2004) recommendation which stipulates that the surface water for potable use should be treated up to recommended standards before distribution to consumers.

Per capita water use

Per capita water use of the houses that have in-house connection and yard tap was derived from monthly meter readings of February and March 2008 which are presented in appendices 3, 4, 5 and 6. The per capita water use for un-piped houses was derived from household questionnaires.

As shown in table 3, the average household size for both towns is 5.0 human units. These values were derived from the 100 questionnaires administered in Korogwe town and 75 questionnaires administered in Muheza town. The values are almost corresponding to those obtained from The Tanzania Bureau of Statistics (2005) which show that the average household size were found to be 4.8 in Muheza town and 4.6 in Korogwe town. This difference might be caused by the different sample size taken under the study.

Table 3: Average household size for a period of January to April 2008

	Mean	**Std Deviation**
Muheza	5.0	1.249
Korogwe	5.0	2.242

Table 4: Per capita water consumption for a period of February and March 2008

	In house connection	**In yard connection**	**Un piped household**
Korogwe	60l/c/day	37l/c/day	N = 29 Average = 26/c/day
Muheza	46/c/day	31/c/day	N =34 Average= 22l/c/day

As shown in table 4, the per capita water use in Korogwe town is higher compared to Muheza town. The reason for this might be the high production yield; on average the utility can produce 40 l/c/day in Korogwe town while that in Muheza town the source can produce 33 l /c /day. The sanitation systems for both towns were found to be pit latrines and septic tank system. According to Gulyani *et al.* (2005) these average water use is within to that reported in the Drawers of Water II (DOW II). DOW II reported that average urban water use in Kenya was 45 l/c/d in piped households and 28 l/c/d in un - piped households while in Uganda were 47 l/c/day for piped houses and 23 l/c/d for un - piped households. When this per capita consumption is compared to non African towns such as those found in Asia countries, these results are lower. For example, using meter consumption data, water use in 13 Asian cities was found to be in the range of 91 l/c/day to 209 l/c/day (Asian Development Bank, 1997).

It can be concluded from the tables that un-piped households have lower per capita water consumption compared to other types of connection. According to World Bank (2004) and WHO (2003) recommendations, the average per capita per day for urban area should be not less than 40l/c/day for the household uses. This is a true minimum to sustain life in moderate conditions and average activity level.

Type of household main water source

The results presented in this section are based on 100 household interviews conducted in Korogwe town and 75 household interviews in Muheza town. The types of questions are presented in appendices 1. Responses regarding the main type of water source used by the households indicated that 87% of respondents in Korogwe town derived their main water supply for domestic uses from piped water sources provided by the utility while 13% get their main water supply from other sources such as rivers, private and non private wells. For the respondents that used piped water from the utility as the main water supply, the results show that there is a variation in the type of piped connections used by the household as shown in fig. 3. The vast majority of the respondents were found to have private in-house connections. When asked what their alternative sources for water supply were when piped water supply by the utility is not available in their houses, 85% of households interviewed at Korogwe town responded that they sourced water from wells or rivers, 6% said that they resorted to communal kiosks and the remainder 9% said that they bought water from vendors.

In Muheza town 75% of the respondents were found to use piped water supplied by the water utility, 18% depended on water vendors and the remainder 7% of respondents said that their main sources were wells and river water. When asked about their alternative sources when piped water supplied by utility is not available in their houses, 60% replied that their other sources were wells and rivers, 28% said they derived water from nearby house while 12% said that they usually used water vendors as their alternative source.

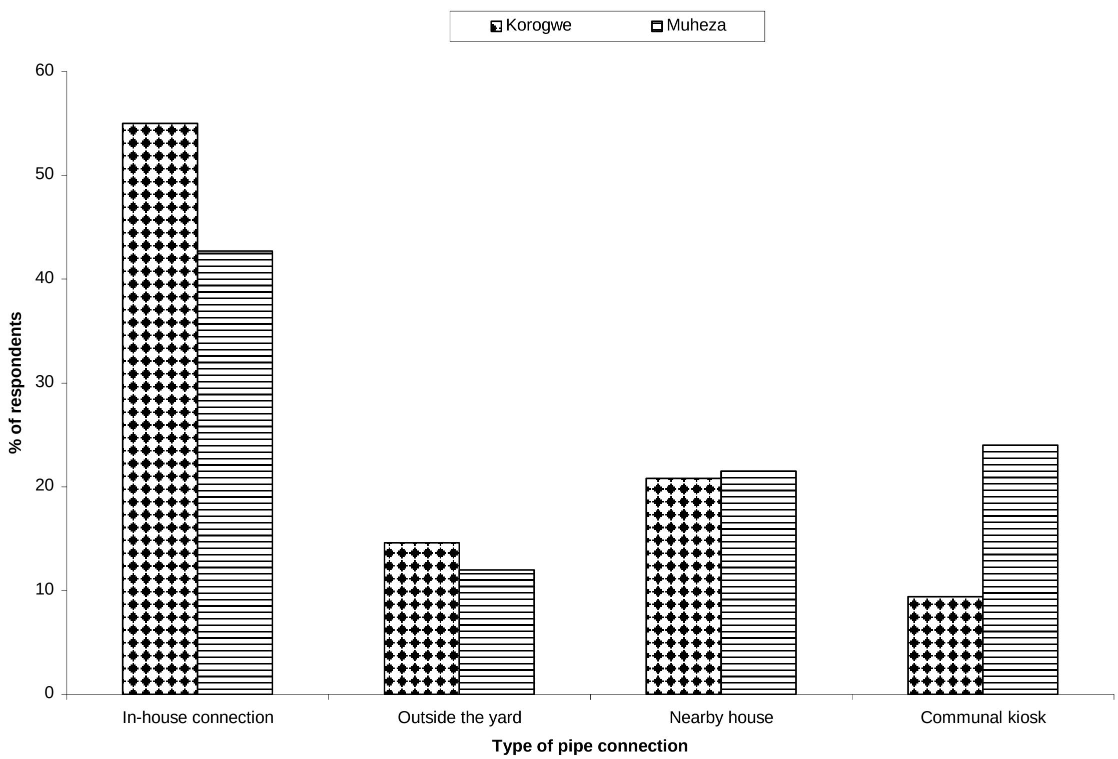

Fig. 3: Type of water supply used by household for Korogwe and Muheza towns

Korogwe town has a significant proportion of households that have piped water supplies compared to Muheza town. This is due to a better water supply infrastructure and a higher yield. Korogwe town has four water production sources which have a combined yield that can produce 40 l/c/day compared to one water production source in Muheza town which yield produced 33 l/c/day. Although in both towns the households have access to piped supplies, the supplies are inadequate by local or international standards as it has been demonstrated that more than 60% of respondents used wells or rivers as their alternative water sources due to water shortages. According to van der Zaag (2003) throughout the region there has been a general deterioration in the quality and reliability of piped water services over the last 30 years. A number of factors have contributed to this deterioration including a lack of system maintenance and the stress placed on existing network capacity by an ever increasing urban population. Despite the deterioration of services in previous piped site, piped household are now found in sites which were totally unpiped in 1967, indicating a general improvement at these sites (van der Zaag, 2003).

5.1.2 Reliability of water supply

Reliability and availability of water supply for both towns were measured by looking at duration of water supply, frequency of water supply, supply pressure and downtime period.

Duration of water supply

Results of this section are based on consumer responses from the question presented in appendices 1 and field observation. When consumers of Korogwe town were asked about the duration of piped water availability in a day, it was established that the overall average duration for piped water availability was generally 8 hours. About 81% (15) of respondents who get water from communal kiosks indicated that water was generally available for 6 hours. Of the respondents with individual connection, 67% indicated that water was available for 7 hours while the remainder (33%) indicated that water was available for 10 hours on average. Those who get water for an average of 7 hours stay on the higher altitude and those who received water on average of 10 hours stay on the low altitude of the town. In the former area during the field study, it was observed that the water was coming out from the tap from 8am to 4pm. The consumer responses confirm the utility annual report (KUWASA, 2007) reported that the average service hour is 7hours per day. On whether average service hours was the same throughout the year, the utility operator also revealed that during the dry seasons the customers received less water service hours due to water rationing.

In Muheza town the situation is more serious compared to Korogwe town, the average service hours were found to be 5hours. The majority, 83% (21) of respondents who get water from kiosks indicated that water is generally available for 4 hours. Of the respondents with individual connection 76% indicated that water was available for 4 hours and the remaining 24% indicated that water was available on average for 7 hours per day. Those who got water for an average of 7 hours stay on the higher altitude and those who received water for an average of 4 hours stay on the lower altitude of the town.

It is a known fact that the period water is available to the customers in a day is an indicator of reliability of the water supply system, which in turn has a significant bearing on the quantity and accessibility of water available to the customers. The study carried out by Gulyani *et al*. (2005) indicated that service availability, apart from easy access, strongly influences household satisfaction. This is evident from their findings (Gulani et al., 2005) in which there was 56% satisfaction level for utility piped connection compared to a 100% satisfaction for own private source.

From the study it can be concluded that, there is difference of water supply serving hours to the towns as well as different areas of the towns due to geographical terrain. Although Korogwe town seems to have long duration of water service hours compare d to Muheza town, still, the average water service hours for bo th towns is inadequate and have an impact on customers' satisfaction with their respective water service providers. According to the guidelines from The World Bank (2003) which agreed with those by Tinany and Kingdom (2002) a good performing utility should be able to supply water to its customers for 24 hours.

Frequency of water supply

When asked whether consumers experienced consistent supplies throughout the seasons, 93% of respondents to the household questionnaires in Korogwe towns said that they experienced seasonal water shortages during the dry season (December– March) while 7% said that they do not experience seaso nal water shortage as shown in Fig.4. Those who do not experience seasonal water shortage s were found to have private wells. On a question of how frequently they received piped water during the dry season, 36% of respondents said that they received water once a day, 52% said th ey received water almost thrice a week and remaining 12% said that they received water twice a week.

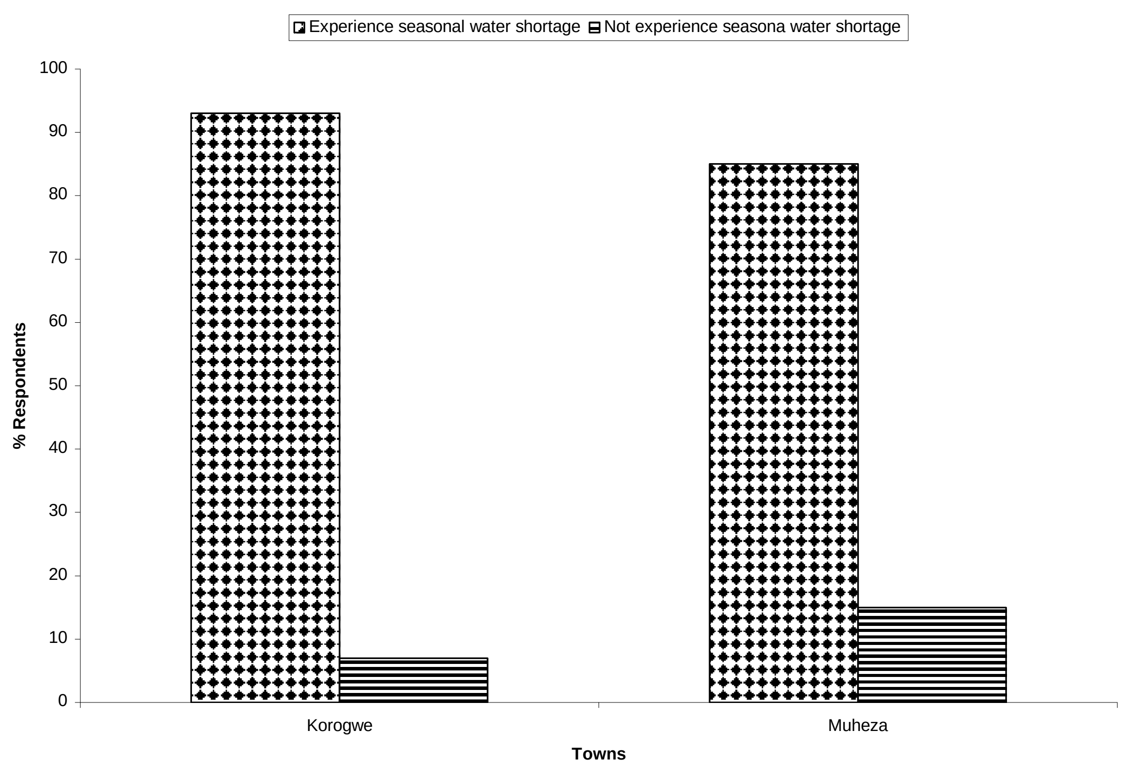

Fig. 4: Consumers experiences on seasonal water shortage

In Muheza town the situation is more critical compared to Korogwe town. 66% of respondents said that they received water twice a week, 22% said they received water after two days and 12% said that they received water once a day. The situation in Muheza town can be explained due to the fact that during the dry season the water production from Mkulumuzi stream drops by 63% while in Korogwe town yield drops by 47%.

Water supply pressure

The pressure from piped water for both towns was judged on the basis of consumer's perception on the rate of water flow from the tape. As shown in Figure 5, there is diversity on rating the water pressure from the consumers. The vast majority of respondents in Korogwe town rate their water pressure as average, while respondents in Muheza town rate their water as low. It is possible to explain the Muheza consumers rating of water pressure received as low on account of the differences in topography between Muheza and Korogwe town. For, while in Korogwe, a large portion of the town is flate, in Muheza, a large portion consists of hillside terrain. As a consequence of this when water level at the supply tank is low, the pressure head also decreases. Therefore, consumers who reside on the hillside receive low pressure water supply.

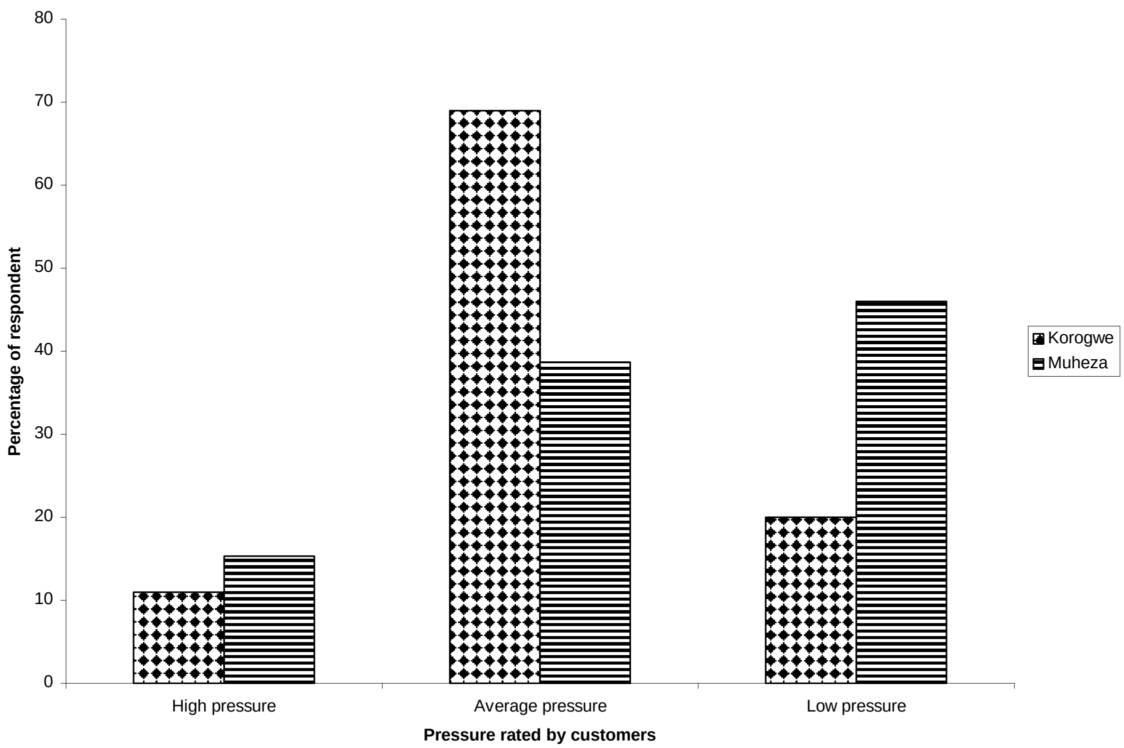

Fig. 5: Water pressure as rated by consumers

Downtime period

From the utility reports (2006/2007) it was difficult to get the average time taken by the authority to repair breakdown facilities (pipes, water pumps, kiosks) due to the absence of relevant records. There was no data indicating when facilities broke down, when they were reported and when they were repaired. The only record available was the total number of facilities broke down and repaired annually. However, when asked how long it took to repair broken facilities, Korogwe utility personnel revealed that on average it took from one week to one month depending on the type of breakdown. However during field study in Korogwe town, it was observed that out of a total of 21 kiosks, only 5 (23%) kiosks were functioning. A member of the community living nearby a non-functional community kiosk indicated that the facility had been broken down since the beginning of the year 2006. On his part, the acting utility manager at the time explained that the kiosks had been contracted to agents for operation and maintenance so it was no longer the responsibility of the utility to repair them. One would assume that given the fact that the utility has the ultimate responsibility over these kiosks, they would also review and or cancel the agents' contracts. Cater (1996) states that it is important to minimize downtime even if the breakdown frequency is high; a facility which breaks down frequently but which is quickly repaired is better than one that breaks down infrequently but takes a long time to repair. Below, Fig. 6 shows one of the community kiosks which were found not working during the field research.

Fig. 6: Picture showing a non functioning communal kiosk in Korogwe town. (Taken on 26/03/2008)

In Muheza town there were a total of 6 communal kiosks. It was, however, observed that 3 of the communal kiosks were functioning and 3 were not repaired for the whole period of the field study, which was almost three months.

The normal downtime for water facility as recommended by WUP (2003) is 2 -3 days. Also Carter (1996) suggests an upper limit of 2 % (7 days in one year) for downtime. The

long downtime period might contribute to the non-reliability of water services in the area and in the process undermining the service quality.
Table 5.0 summarizes the performance indicators of the reliability of water supply system in both towns. It can be seen from the table that all most all indicators scored very low and so it can be concluded that the reliability of water supply in the areas was low when compared to international and national standards.

Table 5: Summary of reliability indicators

Indicator	**Contribution to reliability**	
	Korogwe	**Muheza**
Duration of Water supply	Low	Low
Frequency of Water supply	Low	Low
Water supply pressure	Medium	Low
Downtime period	Low	Low

Note;

- Duration of water supply (1hr – 8hrs = Low, 8hrs – 16hrs = Medium, 16hrs – 24hrs= High)
- Frequency of water supply (1-3 days a week = Low, 3-5 days a week= Medium, 5-7days a week= High)
- Downtime period (1 -5 days = High, More than 5 days= Low)

5.2 Consumer perception on service quality

The results presented in this section are based on 100 household interviews from Korogwe town and 75 household interviews from Muheza town. The perception on the service quality provided by utilities is divided into two parts, namely: 1). Perception of water quality, 2) Perception of customer-operator relations.

5.2.1 Water quality perception

The results of this part are based on the three important aspects of human perception according to Smith *et al.* (1995) which are clarity and color, odor and taste. Consumers were asked to give opinion on the quality of water supplied by the utility in terms of color, particle content (turbidity) and taste.

In Korogwe town, when consumers were asked to give an opinion whether piped water supplied by utility was good for drinking, 76% of respondents felt that the piped water supplied was not good for drinking while the remaining 24% felt that the piped water supplied was good for drinking. The reason for varied opinion might be adaptation or duration of stay in the area. When consumers were asked to give an opinion of the quality of the water in terms of odor, color and particles contents, there were differences in responses as shown in Fig.7. In the opinion of the majority of respondents, water supplied by the utility contained particles as an indication of turbidity and was colored while the rest said that water supplied by the utility was not satisfactory taste wise.

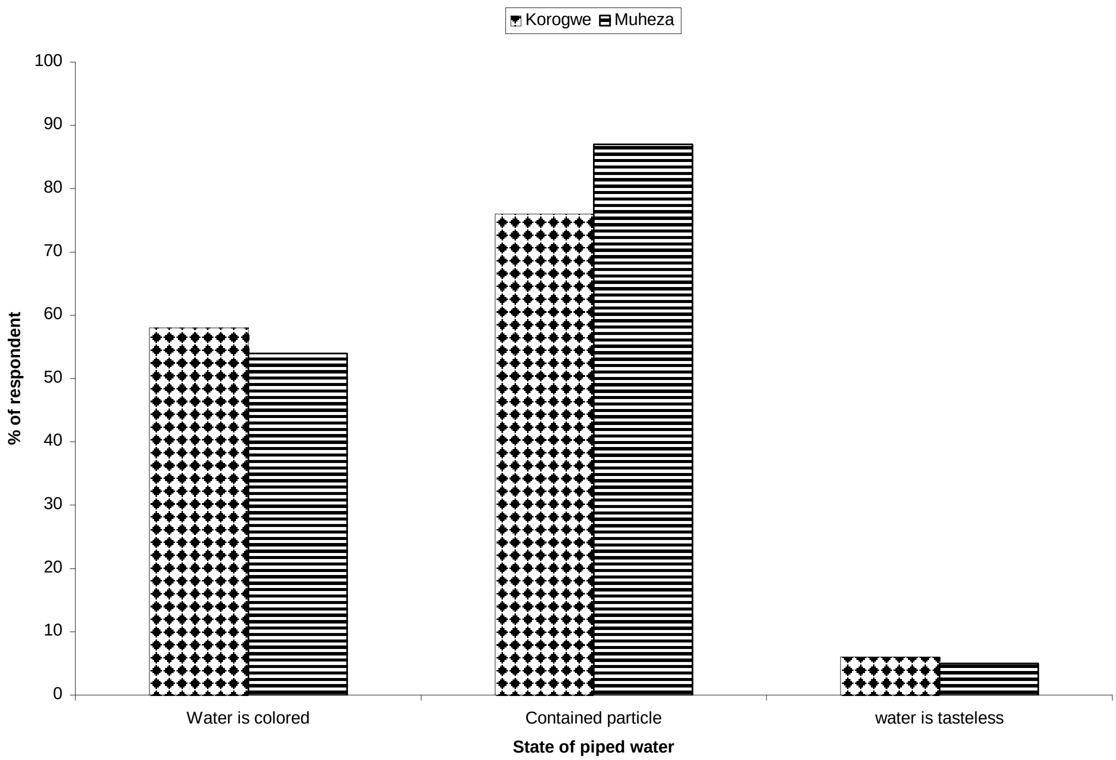

Fig. 7: Consumer perception on the state of water quality

In Muheza town, 88% of respondents felt that the water utility does not supply good (in a sense that you can drink without boiling) water for drinking and the remaining 12% felt that piped water supplied was good for drinking. When asked to explain the different state of water in terms of odor, color and particle, the vast majority of respondents gave the opinion that water supplied by the utility contained particles and is colored as shown in Fig.7.

In Muheza town, the majority of consumers were not satisfied with the quality of water compared to Korogwe town. The reason for this might be that in Korogwe town some of water sources are underground where they are less exposed to particles compared to Muheza town which has one stream for its water supply which is exposed to pollution during the rainy season.

The result of analysis of the relationship between perceived service quality and customer satisfaction by using Paired Sample T-test is shown in Table. 6. The values of significant level for both towns were found to be less than 0.05. Since the significant values were less than 0.05 for 95% confidence interval, it can therefore be concluded that there is a relationship between perceived water quality and customer satisfaction.

Table 6: Paired Sample T-test results on customer satisfaction and water quality

		Korogwe			Muheza		
Customer Satisfaction with services	Water Quality	Mean	SD	Sig. 2-tailed	Mean	SD	Sig. 2-tailed
		0.08	0.427	0.049	0.12	0.331	0.002

Hoko and Hertle (2006) stated that perception of water quality is partly subjective. At the same time and that apart from personal sensitivity to taste, adaptation could account for differences in perceptions. Adaptation is affected by such factors as duration of stay in the area, period of use and availability of other sources (Hoko and Hertle, 2006). According to Gulyani (2001) some substances in water may have no direct health effect, water that is high in turbidity, is highly coloured or has an objectionable taste or odour may be regarded by consumers as unsafe and may be rejected for use. In conclusion, highly coloured, turbidity and taste of water may account in large part for the dissatisfaction with the quality of water supplied by the utilities among the majority of consumers in Korogwe and Muheza.

5.2.2 Customers-operator relation

The results of this section are based on two factors which are consumer awareness on the utilities activities and second the handling of customer's complaints by utilities.
When consumers in Korogwe town were asked to give an opinion on the level of information they have about the water service providers (billing procedures, water demand management measures and water price), of the 100 respondents, 44% indicated that they did not get information from the utility, 40% said that they were well informed and the remaining 16% said they very well informed about their water service provider. However, when compared with the respondents of Muheza town as shown in Fig 8, more than 50% of water customers in Korogwe town said they had information about their water service provider while in Muheza town less than 40% of customers said they did not have information about their service provider. One major reason could explain this is that, in Korogwe town the number of houses that have meters is higher (63%) compared to Muheza (32%), therefore, most likely the majority of customers were getting information when they went to pay for their water bills and other reason is in Korogwe town the utility use employ staff for hand delivery of water bill while in Muheza the system of water bill delivery is through customer postal addresses. It was observed that both utilities do not have special departments that are concerned with public awareness that will inform customer about issues concerning water services provision.

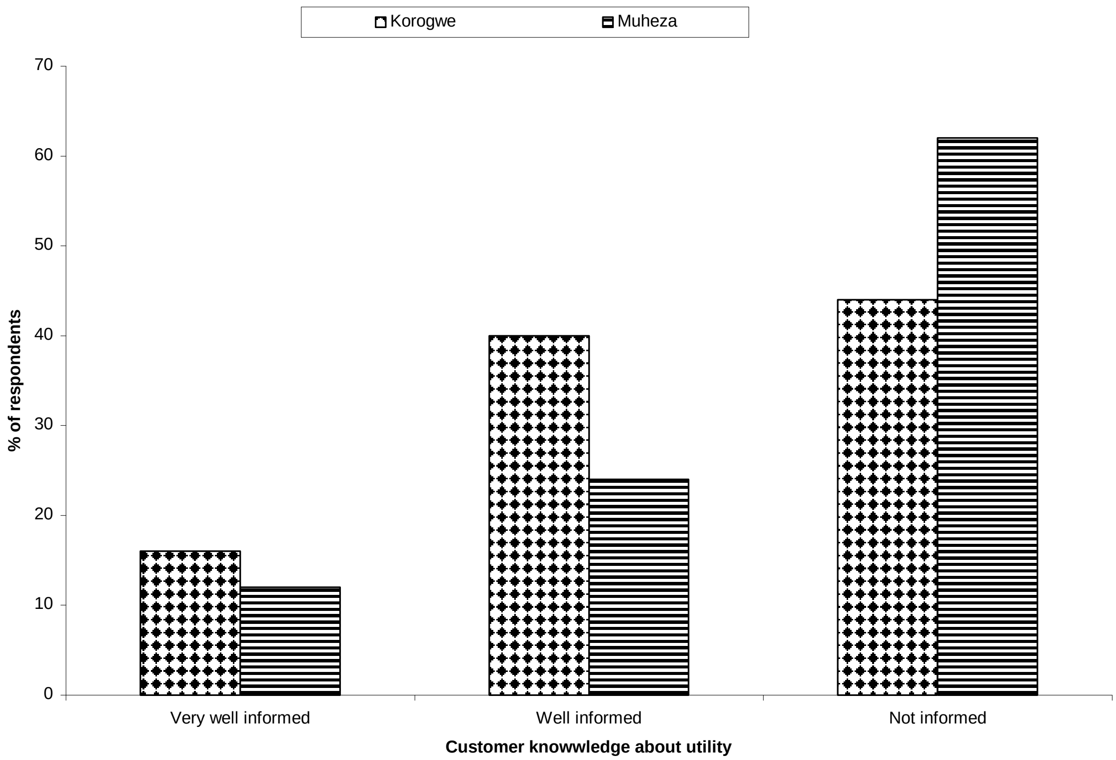

Fig. 8: Customer perception on the knowledge about water provision

In Korogwe town, when customers were asked to explain whether they have ever made any complaint to the utility, 54% of the customers that have water meter in their houses said that they made complaints to the utility and out of those only 21% of the customers made complaints said that their complaints had been taken care of and that they were happy with the way their complaints were handled while in Muheza town, 72% of the respondents that have meters in their houses indicated that they had made complaints to the utility but only 11% out of all complaints expressed satisfaction with the way their complaints were handled. When the customers were asked to give the details of what kind of complaints they raise with the utilities, the major complaints were mainly about water bills, water quality and others such as pipe burst. However, water quality complaints were found to be in the majority as shown if Fig.9.

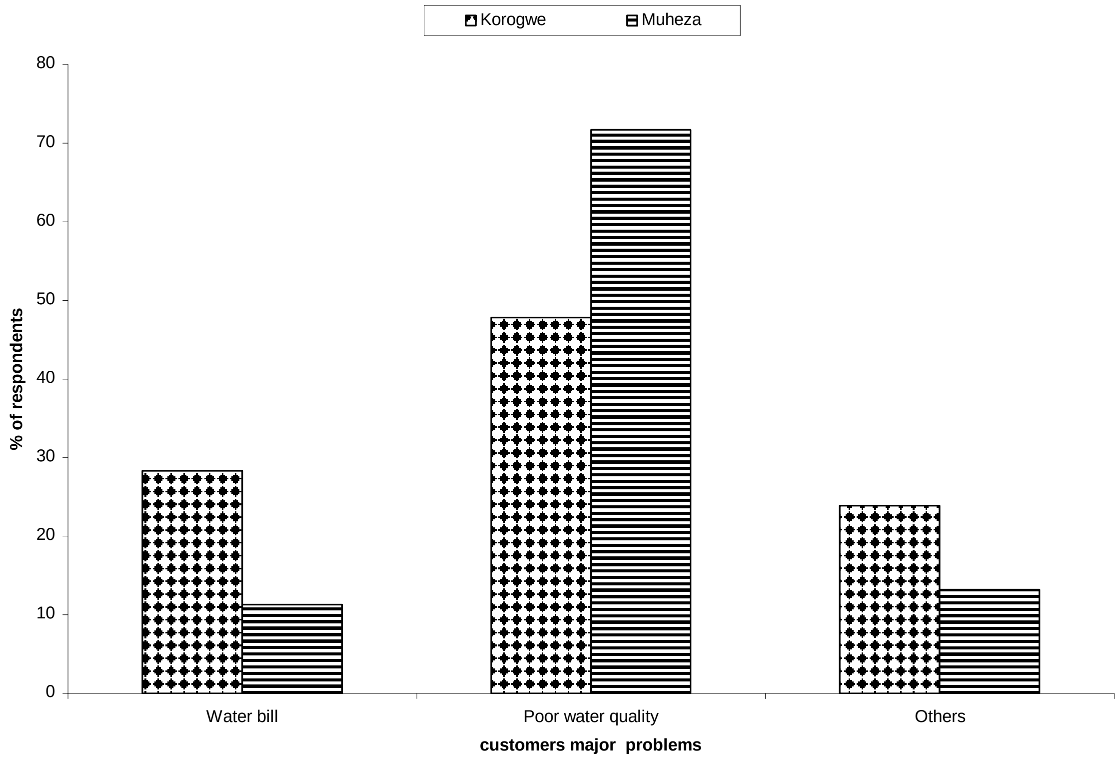

Fig. 9: Customer complaints

One of the most important aspects of strengthening customer-operator relations is the way complaints are handled. According to Coates *et al*. (2001), focusing on customers first is of particular relevance to the water and sanitation sector in developing countries because household consumers, particularly in urban centre, obtain water from numerous providers and sources. Another aspect of strengthen customer-operator relation is by improving the quality of internal customer services. Research carried out in service management by Slater and Narver (1995) found that increase collaboration between various departments increased the level of customer services offered by an organization.

It was found out that both utilities do not have special departments for customer care and that concerned with public awareness and campaigns about issues concerning water provision. It was confirmed by the utility manager in Muheza that currently the utility does not have a separate department of customer relation and that the utility faced a problem of unqualified staff where the highest level of education of almost 90% of staff is standard seven (upper primary) in stead of the secondary level of education required for public employees. A study carried by Coates *et al*. (2001) indicated that National Water and Sewerage Corporation (NSWC) in Uganda was able to reduce a number of pending complaints by 83% and number of received complaints by 75% after strengthen customer relation management by customer care training seminars and workshop and introducing a powerful computerized billing system that is used in a few of large town and cities in East Africa.

It can be concluded that in both towns the utilities do not have a special customer care department whereas a number of customer complaints that are pending is high compared to those complaints that were handled by utilities. According to WHO (2002), the opinion of the users of the services and their level of satisfaction provides essential information about operation of those services.

5.3 Pricing and affordability of the services

5.3.1 Pricing

Through interviews with key informants on the pricing system, it was revealed that both Korogwe and Muheza authorities had the same procedure for pricing. The utilities management decided on the new price before forwarding the proposals to the Water Board for approval. The water Board is a group of people appointed by district council. One of the major responsibilities of the Board is to approve any alteration in the water tariff and other water charges. This system of pricing has an impact on the water utilities as study carried by Schwatz (2007) in Uganda found out that political interference has a bearing on the pricing of water for many reasons. From KUWASA (2007) it was observed that for the past five years water price had not been revised. The study done in Uganda (Schwatz, 2007) observed that from 1994 to 2000, the tariff charged by NWSC was not changed, causing the real value of the tariff in 2000 to be 45% of the tariff charged in 1994. As shown in Table 7 and 8, in Korogwe town the tariff structure is the same for all users compared to Muheza town. However the utility has categorizes customers depending on the amount of the water consumed per month. For example customers were supposed to pay Tsh. 2800 (USD 2.33) for a consumption range from 0 - 7 m^3 and have to pay an extra of TSh. 400 per m^3 if the water consumption was over that limit.

Table 7: Tariff structure for different users in Korogwe town as per year 2007/2008

Category	**Tariff**
Domestic	Tsh. 400 (USD 0.33) per M^3
Institutional	Tsh. 400 (USD 0.33) per M^3
Commercial	Tsh. 400 (USD 0.33) per M^3
Un metered house	Tsh. 2800 (USD 2.33) per M^3
Water consumption categorization	
0 – 7 m^3	TSh. 2800 (USD 2.33)
7 – 12 m^3	TSh. 4800 (USD 4.00)
12 – 16 m^3	TSh 6400 (USD 5.33)

1 UD$ = TSh. 1200

Table 8: Tariff structure for different users in Muheza town as per year 2007/2008

Category	**Price**
Domestic	TSh. 150 (USD 0.125) per M^3
Institutional	TSh. 200 (USD 0.160) per M^3
Commercial	TSh. 350 (USD 0.300) per M^3
Un metered	TSh. 3000(USD 2.50) per month
Water consumption categorization	
0 – 5 m^3	TSh 1000 (USD 0.83)
5 – 10 m^3	TSh 1500 (USD 1.25)
5 - 15 m^3	TSh 3000 (USD 2.50)

1 UD$ = TSh. 1200

It can be seen in Tables 7 and 8 that the water price in Muheza is low compared to Korogwe town. According to Fraceys (2001), in order to arrive at an equitable price mechanism, one that would be compatible with pricing trends and sustainability, there is a need to conduct a study on the value of water across sectors. As a value of water varies from one sector to another, it is important to link value with price consideration so that those deriving the maximum benefit from water make a greater contribution. Water pricing is often conceived as an instrument of cost recovery, there is a relationship that low pricing lead to weak cost recovery translate into inadequate financial resources to maintain minimum operation and maintenance hence poor utility performance. Pricing must be based upon the user-pays principle, where the consumer pays for the full cost of water (capital and recurrent) including future development of supplies. This also implies that pricing of water should be base upon full cost recovery with tiered system to allow for cross subsidization between the different social-economic groups.

It can be concluded that water pricing can be effective for managing water services in general. Therefore, from this, utilities should have different water tariff for different users in order to have equitable and fair water use and be able to recover the cost and improve water service provision

5.3.2 Affordability of services

The results of this section were an outcome of two main questions asked during household interviews. The consumers were asked to give their opinion on the price of water and also on whether they could afford to pay for the services.

In Korogwe town, 60% of the respondents said that the water price charged by the utility was not very high and that, therefore, they could afford to pay for that service while 40% complained that the price charged by the utility was too high and, that, therefore they could not afford to pay for the services. It was observed that the customers paid TSh400 (USD 0.33) per m^3 and TSh 12000 (USD10.00) as connection fees for new customers. A Study done by National Bureau of Statistic (NBS) in Tanzania in 2005 indicated that the average minimum income for urban workers was approximately TSh.80,000 (USD 66.6) per month.

Comparing the consumer average income and the current water price charged by the Utilities, it was found that consumers spend an average of 3.5% of their income on water alone for an average of household size of 5.0. According to the World Bank recommendation which states that a household should not spend more than a maximum of 5% of monthly income on water supply and sanitation service. It is assumed that the sanitation services takes approximately 30% to 40% of the total money spend on water supply and sanitation. Take into consideration of the sanitation services, it can be found out that the consumers in Korogwe town were spending slightly above the recommended 5% of their total monthly income.

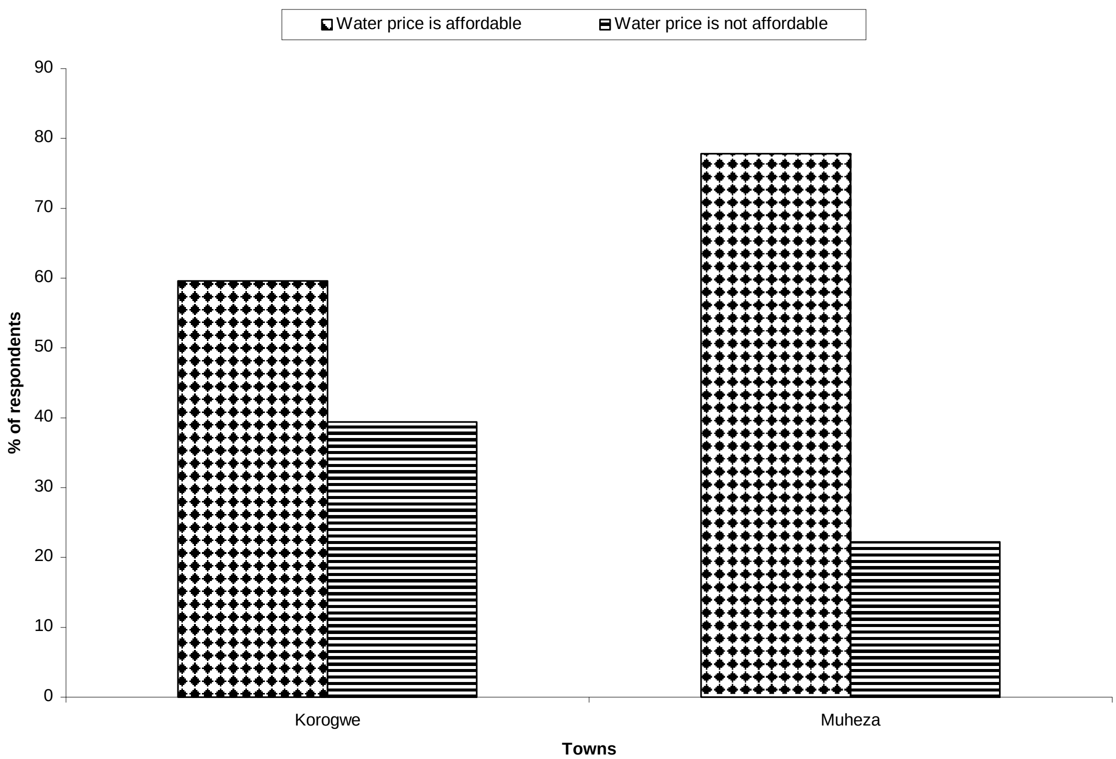

Fig. 10: Customers' perception of water price affordability

The results from Muheza town as shown in Fig.10 show that the more than 70% of the respondents agreed that the water price charged by the utilities was not very high and they could afford to pay for that service. Customers in Muheza town were paying Tsh 150 (USD 0.125) per m^3 for household consumption and TSh.10,000 (USD 8.33) for the new user connection fees. Taking the average income of TSh.80,000 (USD 66.6) per month, it can be found that consumers in Muheza town spend on average of 1.3% of their income in water alone and this is within World Bank recommendation.

For un-piped houses it was found out that consumers were paying much higher for water supply compared to those supplied by utilities. In Korogwe town, the prices were ranging from TSh.30 (USD 0.025) to TSh.50 (USD 0.042) per bucket of 20 litres. Translating to a range of USD 1.25 to USD 2.1 per m^3 which is almost 6 times the price charged by the utilities. Consumers in Muheza town were paying amount ranging from USD 0.83 to USD 1.25 per m^3 which is almost 10 times the price charged by utility.

Generally water tariff can have negative impact to the Willingness to Pay (WTP) for the consumers, but many researchers has proved otherwise, study carried by Kaliba *et al*. (2002) in Tanzania show that consumers were willing to pay 20 times of the existing water tariff for the improve water services, also study by Genius *et al*. (2008) show that mean WTP for Rethymno citizen for improved water quality services was estimated to be 17.67% of their water bill, this means that consumers are willing to pay amount of money over their water bill for an improve services. From these examples, it might be concluded that the consumers of Korogwe and Muheza town might be willing to pay more for the improved services.

Generally it can be concluded that, the price charged by water utilities in both towns is reasonable and it is in the range of the recommendation from the World Bank (2003) and WSP (2003) that the maximum threshold of household income spending in water and sanitation should be no more than 5% of the total household income. The consumers from the households which were not connected to water supply network were found to pay much more, compared to consumers of the households which were connected to utility network.

5.4 Unaccounted for water (UfW) in Muheza and Korogwe towns

The results of this section were based on data obtained from utilities reports, key informant interview and field observation. Unaccounted for Water is the difference between water supplied and water sold as a percentage of water supplied. Over a period of the two years, Muheza town was found to have higher average unaccounted for water (UfW) annually compared to Korogwe town as shown in Fig.11 and Fig 12. The average annual UfW was derived from the monthly UfW for the year 2006/2007 and 2005/2006.

The result from statistical analysis from Fig 11 and Fig 12 show that average UfW in Muheza town was found to be 47% while in Korogwe town it was 42%. The reasons for the towns to have higher UfW compared to the World Bank recommendation (less than 25%) could be explained by the economic factors includes metering and billing system experiences by utilities while that of technical factors could be explained in terms of the existing condition of the entire reticulation system and monitoring tools employed by each town.

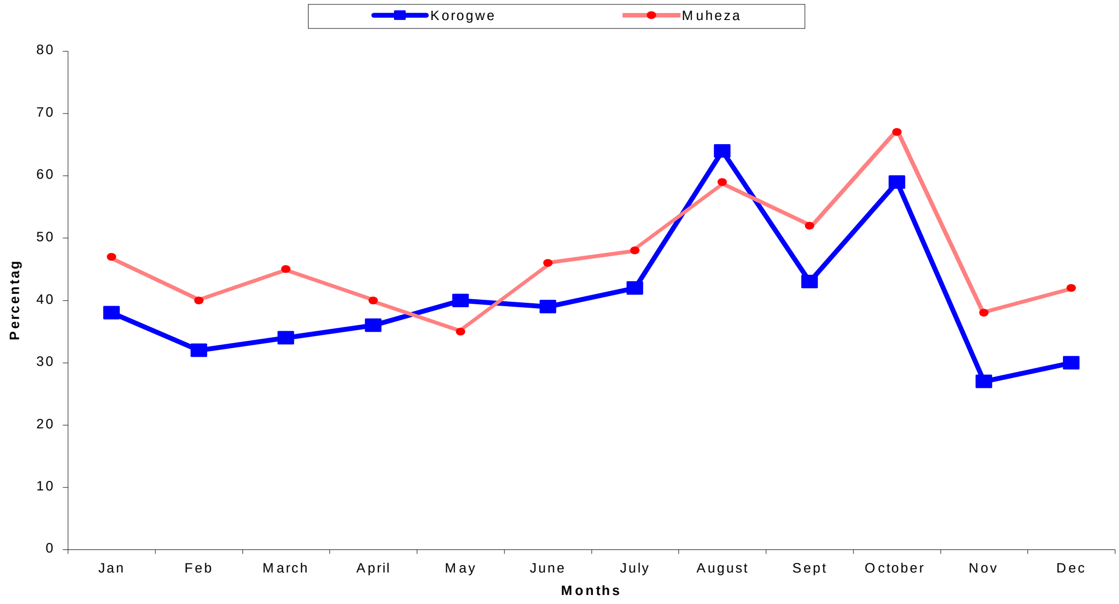

Fig 11: Monthly unaccounted for water for the year 2006/2007

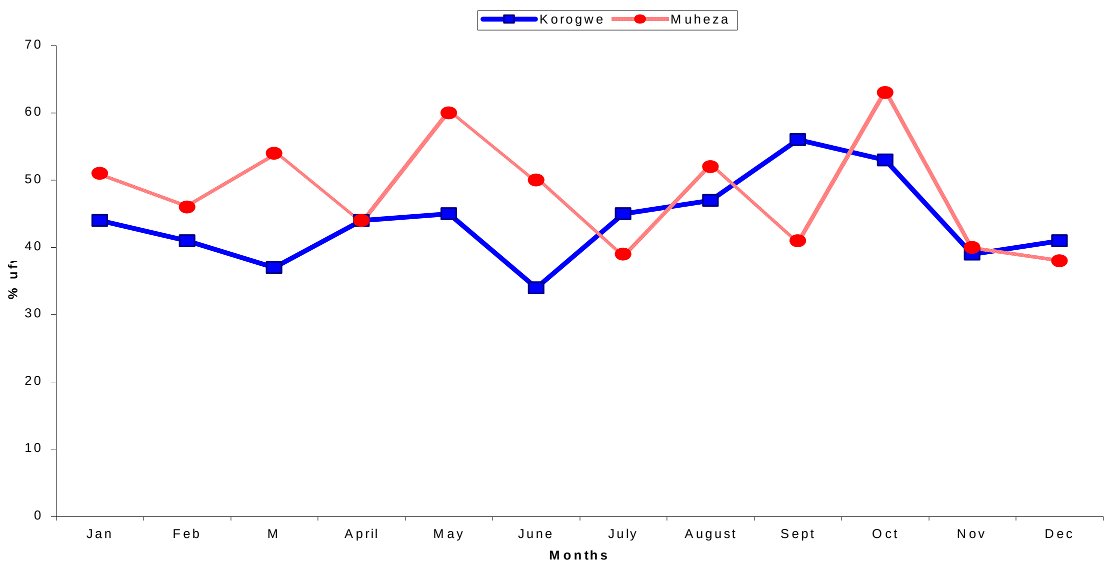

Fig 12: Monthly unaccounted for water for the year 2005/2006

5.5 The Economic factors

5.5.1 Billing system

A computerized system is used by Korogwe Urban Water Authority (KUWASA) for the billing system. In the past the authority used to send water bills through customers postal addresses but they decided to change the system because of the complaints from customers. Customers were complained about not receiving their water bills in time. Now the authority employs staff specifically responsible for meter reading and handling water bills to the customers. This has had a positive outcome on the customer relations of the authority in that during household interviews 82% of the respondent said that they receive their water bills in time. The debtor collection time ranges from one to three months from the last paid bill and billing efficiency is 72% (KUWASA, 2007). Despite the fact that the billing efficiency of KUWASA is high compared to MUHWASA, still the billing efficiency is far from the 100% recommended by Schwartz (2007).

The system of billing used by Muheza Urban Water Authority (MUHUWAS A) was found to be old and outdated. The utility does not have a special computer programmes or software for billing. Customer records were not computerized, hence it is difficult to use when tracking of customers bills and payments. Also it was found that the utility does not have a clear cut time schedule between the raising of the bills, delivery to the consumers and payment by customers. The utility uses postal addresses to send the water bills, which has results the delaying of the payment that might be caused by the changes of customer's addresses. The debtors collection time was found to range from two months to four months thus reducing the revenue collection efficiency to 46% (MUHUWASA, 2007). More than 70% of customers complained that they were not receiving water bills in time and that it took an average of one to two months to receive the water bills after they had paid the last bills. Through interviews with billing personnel it was found that due to lack of proper computer software, the authority faced delays in dispatching water bills in time. Effective billing and collection systems are critical component for ensuring the viability of service provider. According to the World Bank (2004) improving billing and collection activities have an immediate impact on the revenue streams of utilities that can, in turn, help the utilities in improving services also Gumbo et al. (2002) highlight the of accuracy in metering and billing as the way of ensuring that the revenue is collected with the minimum inconveniency to the utility and provide the necessary confidence to customers. Schwartz (2007) recommended that a well-performing utility should have 100% billing efficiency.

It can be concluded that poor billing efficiency especially in Muheza town is the reasons for the high unaccounted for water (UfW) but it does not show to what extent poor billing efficiency is contributing to (UfW). Both utilities are far below of the recommended 100% billing efficiency.

5.5.2 Metering

In Korogwe town it was found out that the total number of connections was 2048 and the total number of the houses that were metered was 1293 (63%). The rest of the customers pay flat fee that does not depend on volume of water used. As shown in Table 9. 136 (12%) of these meters were not working. This is evidence that utility does not have a proper planned bench testing programme to determine the performance of the meters through out their planed life. The faulty meters could also account to high UfW as it was found out by Marunga *et al*. (2006) used water audits to calculate UfW in the city of

Mutare, it was found out that faulty meters were contributing up to 25% of the total UfW for the city.

Table 9: Meter connections in Korogwe town for the year 2007

Category	**Domestic**	**Institution**	**Commercial**	**Kiosk**	**Total**
Current number of meter	1,157	36	79	21	1293
Working	1,071	20	60	5	1156
Not working	86	16	19	15	136

It was also found out that in Korogwe town there was no bulk meter or sub meter in different locations of the towns which also might result in poor estimation of unaccounted for water (UfW). This can be proved by Gumbo and van der Zaag (2002) that had a problems ascertaining water losses within the reticulation network of the city of Mutare, (Zimbabwe) because none of the bulk meters installed at the inlets and outlets of the 15 reservoirs were functioning. According to Mugisha (2006) lack of bulk meter or sub-meter to different areas results in the wrong estimation of UfW as it is extremely difficult to control what you can not measure. A study by WUP (2006) in Tanzania found out that Mwanza Urban Water and Sewerage Authority (MWAUSA) was able to reduce unaccounted for water from 45% to 35% by installing bulk and sub meters to different area of the towns, and making the appropriate monitoring and follow up.

In Muheza town it was found out that the total number of connections was 1,800 and out of those connections, only 581 (32%) houses were metered. There was low metering rate in Muheza town compared to Korogwe town and this might be the evidence that the higher unaccounted for water in Muheza town could be contributed by the lack of metering in the town. During field study, it was observed that 4 out of 10 of the meters inspected by researcher and key personnel from utility were not working. This is also evidence that the utility does not have a proper planned bench testing programme to determine the performance of meters from their installation onwards. It was also established that in Muheza town there was no bulk meter or sub -meter for different areas.

Table 10: Metered installation in Muheza town for the year 2007

Years	Existing meter	New installation	Annual % increase
2004	374	100	21%
2005	474	28	5%
2006	502	20	3.8%
2007	522	59	10.%

As shown in table 10, the number of new meter installation has been varying from 2004 to 2007. From the utility annually report, the big increase in the meter installation in 2004 was due to some funds given to the utility by the government. In 2006/2007 there was also a slight increase in meter installation as a result of the campaign conducted by authority for the collection of debts and payment of the bills.

In general, it can be concluded that lack of bulk meter and sub meter and low metering rate in Korogwe and Muheza towns are the reasons for higher unaccounted for water (UfW) which was found to be 42% in Korogwe town and 42% in Muheza town compared to 25% as recommended by the World Bank.

5.6 Technical factors that account to UfW

5.6.1 System condition

The condition of the water supply system was investigated through field observations and key informant interviews. From the interviews it was revealed that, the current water supply systems of Korogwe and Muheza towns are based on the old system which has been in operation approximately 50 years old in Korogwe and 35 years old in Muheza town and using old technology hence they can not meet the current water demand. According to Malcon *et al.* (2003), an acceptable life span for a water supply system ranges from 20 to 25 years depending on the type of pipe materials. When asked if utilities have programme for the piped replacement, in both cases (Korogwe and Muheza) the utilities personnel revealed that the utilities have medium and long term plans but the implementation of the plans depends on the government or donor funds. Sylivia and Lutaaya (2005) highlight that old water supply infrastructure can contribute to more than 50% of the total UfW due to pipe burst and leakages in the entire reticulation.

The records from annual reports 2006 cited here show that there were 310 cases of burst and leakages (155 per 1000 connections) reported in the entire reticulation in Korogwe town in a year 2005/2006 and 112 cases (67.7 per 1000 connections) in Muheza town. Muheza town has few number of cases compared to Korogwe town, the reason could be that in Korogwe the infrastructure is very old compared to Muheza which has fairly new infrastructure. According to the KUWASA acting manager, almost 60% of the leakages and bursts were caused by the old infrastructures. Sylivia and Lutaaya (2005) notes that assets that are used to produce and distribute water must be well managed and their lives determined for replacement. There needs to be proper documentation related to their use, maintenance and disposal for proper management.

5.6.2 Monitoring tools

Both utilities were found lacking in proper monitoring tools for leak detection. Through interviews with one field technician it was found that the utilities do not do regular checks for the system and therefore have to wait until customers make reports to the authority. According to Sylivia and Lutaaya (2005) for the detection of UfW it is important that a utility purchases at least minimum equipment to enable it to detect and fix leakages. Examples of minimum leak detection equipment include listening sticks and flow data loggers. It is known that invisible leaks exist and contribute greatly to water losses and thus they should be managed together with the visible ones. Leak detection equipment is, therefore, key for any utility if UfW is to be controlled.
Summary of all factors that are contributing minimization of unaccounted for water in both utilities are shown in Table 10. The scoring of high, medium and low is based on utility management guidelines, Schwartz (2007). High score means utilities is doing well

to overcome unaccounted for water, medium score means utility is on the average minimizing UfW and low score means utility is not doing well to overcome UfW.
The categorizations of scores are shown in annex 7. As can be seen from the table, almost all factors scores low. It can be concluded, therefore, that the utilities are not doing well in controlling unaccounted for water.

Table 11: Scores on measures for controlling unaccounted for water

Item	**Factor**	**Scores**	
		Korogwe	**Muheza**
Economic	Billing	Medium	Low
	Metering	Medium	Low
Technical	System condition	Low	Low
	Pipe replacement	Low	Low
	Monitoring tools	Low	Low

Unaccounted for water which may exceed one quarter of the water put into supply can represent financial loss to any water undertaking. In a study carried by Goldbalatt et al (2000) in City of Kwekwe, Zimbabwe show that introducing a water loss management programme using electronic leak detection resulted in reduction of water loss from 30% in 1992 to 14% in 1996.

Generally it can be concluded that poor billing systems, old infrastructure and lack of proper monitoring tools have contributed to high UfW (47% and 42%) in Muheza and Korogwe towns. According to World Bank (2004) a well performing utility should have at least less than 25% of unaccounted for water (UfW).

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

From the research findings and analysis, the following conclusions can be drawn:

- Accessibility and reliability of water supply in both towns was found to be inadequate however the situation is more critical in Muheza town compared to Korogwe town. The utility was able to supply only 26% of total demand in Muheza town during dry season compared to 32% in Korogwe town . The average service hours in both towns was found to be very far below the recommended 24hrs per day.

- More than 80% of customers in both towns were not satisfied with the quality of services provided by water utilities. The major problems were water quality, water shortage and customer operator relations.

- Unaccounted for water was found to be 42% in Korogwe town and 47% Muheza town. The reasons for higher UfW in both towns were found to be poor billing system especially in Muheza, low metering, old infrastructure and lack of monitoring tools but the study could not explore to what percentages do each factors (poor billing and old infrastructure) contribute to unaccounted for water (UfW).

6.2 Recommendation

The following recommendations have been proposed to ensure the improvement of urban water supply of small towns:

- In order to increase water production during the dry season, utilities should engage in environmental conservation measures at the water's source in order to reduce pressure of the degraded environment considering that the main water source of water supply for both utilities is in Usambara Mountain

- The utilities should introduce a separate customer care department. The customer care department should seek the views of consumers on how to improve water supply provision because the opinion of the users of services and their level of satisfaction provides essential information about the operations of those services and the possibility of their improvement.

- Both utilities should employ water demand management strategies such as metering and regularly monitoring tools should be implemented such as leaks detection in order to reduce unaccounted for water (UfW) to the acceptable standards.

- The authority should review and revamp billing systems and water price in Muheza town in order to improve billing efficiency and revenue collection.

- In order to improve the general performance of the utilities, it is recommended that further studies need to be done on other areas, more specifically, on financial and management structures as well as human resource base.

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8.0 APPENDICES

Appendix 1: Household questionnaire

GENERAL INFORMATION

Name of region ………………………………………………………………………………

Name of district …………………………………………………………………………….

Name of ward ……………………………………………………………………………….

Name of street ………………………………………………………………………………

Date of interview …………………………………………………………………………..

PART A

1. Please indicate your name {optional}………………………………………………………
2. Please indicate your household size………………adult…………….….…children
3. Please indicate type of house
   [ ] Semi permanent   [ ] Flat   [ ] Bungalows

   [ ] Mansionatte   [ ] Other ………………………………...…

PART B

(a) accessibility of water

1. What is the main water source used by the household?
   [ ]. Piped water   [ ]. Water vendor

   [ ]. Well/borehole   [ ]. Tanker truck

   [ ]. River/pond   [ ]. Other ………………………… …………

2. If it is piped, where is the source connected?
   [ ]. In own house [ ]. In own yard/plot
   [ ]. In neighbor's house [ ]. A nearby communal kiosk

3. If well/borehole, who is the owner?
   [ ]. District council [ ]. Private
   [ ]. Community [ ]. Others ……………………… ………

4. What is the distance from the source of water?
   [ ]. Less than 20m [ ]. Between 20m and 50m
   [ ]. Between 50 and 100m [ ]. More than 100m

5. Do you experience each year a seasonal water shortage?
   [ ]. Yes [ ]. No

6. If yes which months in a year?
   [ ]. Dec – March [ ]. March – June
   [ ]. June – Sept [ ]. Sept - Dec

7. On average how frequently do you receive piped water?
   [ ]. Once a day [ ]. Twice a day
   [ ]. Once a week [ ]. Continuous/ every alternate day
   [ ]. Other (describe) ……………………………………… ……………………..

8. When piped water is available for how long do you received water?

   …………………..…………………… ………………………………………………..

9. In a situation where pipe water is not available what is your alternative source?
   [ ]. Public kiosk [ ]. Neighboring house
   [ ]. Well/ river
   [ ]. Others …………………….
   [ ]. Water vendors

10. How much do you pay for this?

    ……………………………………….

11. What is the distance to that alternative source?
    [ ]. Less than 20m [ ]. Between 20m and 50m

    [ ]. Between 50 and 100m [ ]. More than 100m

(b) Affordability/reliability

12. What is your average water consumption per day for the household use?
    [ ]. 30 – 50 litres [ ]. 50 – 100 litres

    [ ].100 – 150 litres [ ]. 150-200 litres

    [ ] Other ………………

13. Is your house metered?
    [ ]. Yes [ ]. No

14. If yes, how much do you pay per cubic meter/ unit of water?

    ………………….

15. If no, how much do you pay per month/daily? (Please indicate daily/ or monthly)

    …………………..

16. In your opinion how do you perceive water price
    [ ]. High [ ]. Low

17. Do you afford to pay for water services
    [ ]. Yes [ ]. No

18. Have you ever experience in last a situation where you could not afford to pay water bills for the past 12 month?
    [ ]. Yes [ ]. No

19. If yes, give reasons(s) ………………………………………………………………

    ……………………………………………………………………………………….

20. In your opinion do you think water services had improved for the past three years?
    [ ]. Yes [ ]. No

(c) Sufficiency / effectiveness

21. Do you receive water bill in time every month?
    [ ]. Yes [ ]. No

22. If no, how long it takes to receive your water bill?
    [ ]. 1- 2 month [ ]. 2 – 4 month

    [ ]. 4 – 6 month [ ]. > 6 month

23. Have you ever made any complaint to the authority about water services?
    [ ]. Yes [ ]. No

24. If yes, what kind of complaint?
    [ ]. Water bills [ ]. Pipe burst

    [ ]. Poor water quality [ ]. Other (specify)……………………….

25. Did your complaint handled?
    [ ]. Yes [ ]. No

26. If yes, were you happy the way your complaint was handled?
    [ ]. Yes [ ]. No

27. Does the authority supply good water for drinking?
    [ ]. Yes [ ]. No

28. If no, please state why?
    [ ]. Odor [ ]. Colored

    [ ]. Particle [ ]. Taste

29. When pied water is available how do you rate the water pressure?
    [ ]. High [ ]. Average

    [ ]. Low [ ]. Don't know

30. In your opinion do you think that the authorit y is providing good services?
    [ ]. Yes [ ]. No

31. What do you perceive as major problems as relation to water service provision?
    [ ]. Cost of water [ ]. Water shortage

    [ ]. Customer services [ ]. Others ……………………………

32. How would you describe the level of information you have about the water Water utilities?

    [ ]. Very well informed [ ]. Well informed

    [ ]. Not at all informed [ ]. Don't know

33. In your opinion what do you think should be done by the authority to improve water service provision?

    ………………………………………………………………………………………

    ………………………………………………………………………………………

    ………………………………………………………………………………………

    ………………………………………………………………………………………

Appendix 2: Key informant interview guideline

Name of respondent………… ……………………… Position ………………………

Date ………………………………..

(A). General information

1. When did the authority started? (history of authority)
2. Briefly explain the organization structure and there functions
3. What is your current number of the customers
4. What kind of people in the community do you target?

(B). Water supply

5. What are the sources of water for your production?
6. What is the current production of water per day?
7. What is current percentage of production v/s demand in water supply?
8. What is the estimation of unaccounted for water in percentage?
9. What is the total number of customers have been connected in the system?
10. How many out of them have been metered?
11. How many community stand pipe do you have?
12. How many are they working?
13. Which month in a year do you have critical water shortage?
14. What are the main causes of this water shortage
15. What is the unit operational cost of production?

16. What is average water tariff for different users?

17. What are the total revenues collected per year?

18. What are the connection charges for new users?
19. What is the labor cost as proportional of operational cost?

20. Briefly explain how water billing system is operated?

(C). Customer service provision

21. What are the ways in which customers can get access to the utility? (pho ne, in person, internet etc)

22. To what extent are customers involved in decision making to the utility? (suggestion boxes, customer council, etc)

23. What are the natures of complaints over the past years? (poor services, pipe burst, water shortage, poor water quality etc)

24. How do you resolve the customer's problems? Or how authority use the information generated by the complaints?

25. Has the nature of complaint changed?

26. How do you cater for the urban poor?

(D). External factors

27. What are the existing roadbl ocks (regulatory, institutional, structural, etc..) in water supply provision?

28. How does these roadblocks affect your organization's action related to the customer relation?

29. What market strategies do you have of your services?

30. What is the procedure used for establishing tariffs?

31. In your opinion, what problems do you see when you look at the management of your water prov ision? What do you think should be done?

Appendix 3: Meter readings (Korogwe town)

February 2008

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
B/328	61789	00485	00498	13	400	200	5400/=
B/340	61792	00268	00269	1	400	200	2800/=
B/344	61795	00059	00070	11	400	200	4600/=
B/345	61798	00356	00363	7	400	200	3000/=
B/346	61801	00425	00429	4	400	200	2800/=
B/59	61804	00057	00065	8	400	200	3400/=
B/47	61807	02142	02166	24	400	200	9800/=
B/99	61810	00510	00522	12	400	200	5000/=
B/357	61813	00093	00114	21	400	200	8600/=
B/100	61816	00315	00323	8	400	200	3400/=
B/349	61819	00178	00198	20	400	200	8200/=
B/78	61822	00269	00284	15	400	200	6200/=
B/174	61550	00257	00273	16	400	200	6600/=
B/80	61560	00173	00198	25	400	200	10200/=
B/356	61570	00572	00591	19	400	200	7800/=
B/111	61580	00723	00726	3	400	200	2800/=
B/88	61590	00223	00235	12	400	200	5000/=
B/91	61600	00123	00128	5	400	200	2200/=
B/139	61610	00457	00461	4	400	200	3000/=
B/267	61620	00668	00674	6	400	200	2600/=
B/96	61630	00206	00218	12	400	200	5000/=
B/95	61640	00737	00742	5	400	200	2200/=
B/104	61650	00296	00303	7	400	200	3000/=
B/94	61660	00234	00242	8	400	200	3400/=
B/103	61670	00266	00275	9	400	200	3800/=
B/296	61680	00936	00957	21	400	200	8600/=
B/155	61680	00251	00262	11	400	200	4600/=
B/125	61680	00746	00756	10	400	200	4200/=
B/347	61680	00846	00849	3	400	200	3000/=
B/97	61825	00136	00156	20	400	200	8200/=
B/325	61828	00238	00263	25	400	200	10200/=
B/330	61831	00636	00642	6	400	200	3000/=
B/289	61834	00535	00539	4	400	200	3000/=
B/32	61837	00236	00241	5	400	200	2200/=
B/334	61840	00720	00727	7	400	200	3000/=
B/123	61843	00706	00710	4	400	200	1800/=
B/278	61846	00930	00945	15	400	200	6200/=
B/223	61849	00786	00788	2	400	200	3000/=
B/892	61852	00731	00735	4	400	200	1800/=
B/091	61855	00258	00270	12	400	200	5000/=
B/321	61858	00554	00559	5	400	200	2200/=
B/202	61612	00267	00274	7	400	200	3000/=

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
B/76	61614	00988	00997	9	400	200	3800/=
B/262	61616	00243	00257	14	400	200	5800/=
B/478	61618	00672	00676	4	400	200	3000/=
B/092	61620	00878	00882	4	400	200	3000/=
B/456	61622	00126	00135	9	400	200	3800/=
B/231	61624	00244	00247	3	400	200	3000/=
B/323	61626	00311	00324	13	400	200	5400/=
B/412	61625	00101	00103	2	400	200	3000/=

Appendix 4: Meter readings (Muheza town)

February 2008

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
TM/034	13712	00056	00077	21	150	200	3350/=
TM/123	13721	00111	00113	2	150	200	2000/=
TM/432	13345	00213	00226	13	150	200	3000/=
TM/476	13236	00412	00414	2	150	200	1200/=
TM/234	13625	00235	00249	14	150	200	3000/=
TM/411	13330	00199	00204	5	150	200	1200/=
TM/448	13264	00162	00163	1	150	200	1200/=
TM/486	13198	00126	00128	2	150	200	1200/=
TM/524	13132	00689	00695	6	150	200	1700/=
TM/561	13267	00453	00457	4	150	200	1200/=
TM/599	13553	00217	00218	1	150	200	1200/=
TM/637	13565	00620	00634	14	150	200	3200/=
TM/674	13131	00356	00362	6	150	200	1700/=
TM/712	13697	00767	00772	5	150	200	1200/=
TM/750	13263	00129	00133	4	150	200	1200/=
TM/788	13329	00165	00174	9	150	200	1170/=
TM/825	13395	00202	00213	11	150	200	2200/=
TM/ 863	13461	00238	00244	6	150	200	1700/=
TM/901	13527	00275	00277	2	150	200	1700/=
TM/938	13593	00311	00319	8	150	200	1700/=
TM /976	13658	00347	00350	3	150	200	1200/=
TM 1014	13724	00384	00386	2	150	200	1200/=
TM 1051	13790	00420	00433	13	150	200	3200/=
TM 1089	13856	00457	00474	17	150	200	4000/=
TM 1127	13922	00493	00507	14	150	200	3200/=
TM 1165	13988	00529	00531	2	150	200	1200/=
TM 1202	13254	00566	00570	4	150	200	1200/=
TM 1240	13120	00602	00603	1	150	200	1200/=
TM 1278	13186	00639	00642	3	150	200	1200/=

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
TM 1315	13799	00675	00677	2	150	200	1200/=
TM 1353	13802	00711	00732	21	150	200	5200/=
TM 1391	11314	00748	00764	16	150	200	4200/=
TM 1428	11212	00784	00786	2	150	200	1200/=
TM 1466	117	00821	00828	7	150	200	1700/=
TM 1504	121	00857	00863	6	150	200	1700/=
TM 1542	126	00893	00896	3	150	200	1200/=
TM 1579	130	00930	00935	5	150	200	1200/=
TM 654	135	00966	00968	2	150	200	1200/=
TM 102	139	00913	00925	12	150	200	3200/=

Appendix 5: Meter readings (Korogwe town)

March 2008

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
B/328	61789	00485	00498	11	400	200	4800/=
B/340	61792	00268	00269	3	400	200	3000/=
B/344	61795	00059	00070	9	400	200	4600/=
B/345	61798	00356	00363	5	400	200	3000/=
B/346	61801	00425	00429	5	400	200	3000/=
B/59	61804	00057	00065	6	400	200	3000/=
B/47	61807	02142	02166	18	400	200	7200/=
B/99	61810	00510	00522	13	400	200	5000/=
B/357	61813	00093	00114	23	400	200	9200/=
B/100	61816	00315	00323	5	400	200	3000/=
B/349	61819	00178	00198	15	400	200	6200/=
B/78	61822	00269	00284	12	400	200	5000/=
B/174	61550	00257	00273	13	400	200	6200/=
B/80	61560	00173	00198	22	400	200	9000/=
B/356	61570	00572	00591	15	400	200	6200/=
B/111	61580	00723	00726	5	400	200	3000/=
B/88	61590	00223	00235	8	400	200	3200/=
B/91	61600	00123	00128	7	400	200	3000/=
B/139	61610	00457	00461	3	400	200	3000/=
B/267	61620	00668	00674	4	400	200	2600/=
B/96	61630	00206	00218	14	400	200	5000/=
B/95	61640	00737	00742	2	400	200	2200/=
B/104	61650	00296	00303	3	400	200	3000/=
B/94	61660	00234	00242	7	400	200	3400/=
B/103	61670	00266	00275	11	400	200	3800/=
B/296	61680	00936	00957	16	400	200	8600/=
B/155	61680	00251	00262	7	400	200	3000/=

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
B/125	61680	00746	00756	8	400	200	3400/=
B/347	61680	00846	00849	2	400	200	3000/=
B/97	61825	00136	00156	14	400	200	5600/=
B/325	61828	00238	00263	21	400	200	8400/=
B/330	61831	00636	00642	9	400	200	3600/=
B/289	61834	00535	00539	2	400	200	3000/=
B/32	61837	00236	00241	4	400	200	3000/=
B/334	61840	00720	00727	5	400	200	3000/=
B/123	61843	00706	00710	2	400	200	3000/=
B/278	61846	00930	00945	13	400	200	5400/=
B/223	61849	00786	00788	3	400	200	3000/=
B/892	61852	00731	00735	3	400	200	3000/=
B/091	61855	00258	00270	7	400	200	3000/=
B/321	61858	00554	00559	8	400	200	3400/=
B/202	61612	00267	00274	5	400	200	3000/=
B/76	61614	00988	00997	5	400	200	3000/=
B/262	61616	00243	00257	12	400	200	5800/=
B/478	61618	00672	00676	5	400	200	3000/=
B/092	61620	00878	00882	1	400	200	3000/=
B/456	61622	00126	00135	4	400	200	3000/=
B/231	61624	00244	00247	5	400	200	3000/=
B/323	61626	00311	00324	11	400	200	5000/=
B/412	61625	00101	00103	4	400	200	3000/=

Appendix 6: Meter readings (Muheza town)

March 2008

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
TM/034	13712	00056	00077	17	150	200	4100/=
TM/123	13721	00111	00113	3	150	200	1200/=
TM/432	13345	00213	00226	9	150	200	1700/=
TM/476	13236	00412	00414	4	150	200	1200/=
TM/234	13625	00235	00249	16	150	200	3900/=
TM/411	13330	00199	00204	7	150	200	1700/=
TM/448	13264	00162	00163	3	150	200	1200/=
TM/486	13198	00126	00128	3	150	200	1200/=
TM/524	13132	00689	00695	4	150	200	1700/=
TM/561	13267	00453	00457	5	150	200	1200/=
TM/599	13553	00217	00218	2	150	200	1200/=
TM/637	13565	00620	00634	21	150	200	4600/=
TM/674	13131	00356	00362	7	150	200	1700/=
TM/712	13697	00767	00772	2	150	200	1200/=
TM/750	13263	00129	00133	3	150	200	1200/=

No.	Meter No.	Previous	Present	Units (m^3)	Rate	Meter rate	Charges (Ths)
TM/788	13329	00165	00174	11	150	200	3100/=
TM/825	13395	00202	00213	8	150	200	1700/=
TM 863	13461	00238	00244	5	150	200	1700/=
TM 901	13527	00275	00277	4	150	200	1200/=
TM 938	13593	00311	00319	11	150	200	3400/=
TM 976	13658	00347	00350	5	150	200	1200/=
TM 1014	13724	00384	00386	1	150	200	1200/=
TM 1051	13790	00420	00433	8	150	200	3400/=
TM 1089	13856	00457	00474	20	150	200	4700/=
TM 1127	13922	00493	00507	16	150	200	3200/=
TM 1165	13988	00529	00531	4	150	200	1200/=
TM 1202	13254	00566	00570	2	150	200	1200/=
TM 1240	13120	00602	00603	3	150	200	1200/=
TM 1278	13186	00639	00642	2	150	200	1200/=
TM 1315	13799	00675	00677	4	150	200	1200/=
TM 1353	13802	00711	00732	16	150	200	3900/=
TM 1391	11314	00748	00764	11	150	200	4200/=
TM 1428	11212	00784	00786	3	150	200	1200/=
TM 1466	11745	00821	00828	5	150	200	1700/=
TM 1504	12111	00857	00863	7	150	200	1700/=
TM 1542	12690	00893	00896	1	150	200	1200/=
TM 1579	13045	00930	00935	4	150	200	1200/=
TM 654	13522	00966	00968	3	150	200	1200/=
TM 102	13956	00913	00925	9	150	200	3200/=

Appendix: 7 Scores on measures for controlling unaccounted for water

Factor	**High**	**Medium**	**Low**	**Korogwe**	**Muheza**
Billing system	75% – 100% Efficiency	50%-75% Efficiency	25%-50% Efficiency	72%	46%
System condition	<25 years old Regular pipe replacement	> 25 years Regular pipe replacement	>25 years old No regular pipe replacement	>50 years old No regular pipe replacement	>36 years old No regular pipe replacement
Metering	90% - 100% Metering	50%-90% Metering	0% - 50% Metering	63%	32%
Monitoring tool	New techniques		Old techniques	Old techniques	Old techniques

- According to this study the high billing efficiency is range from 75% -100%, Medium efficiency range from 50% - 75%, Low efficiency range from 25% - 50% and Very low billing efficiency range from 0% - 25%
- Also according to this study, the utility is considered has high metering efficiency on the range of 75% - 100%, Medium 50% - 75%, Low efficiency 25% - 50% and very low metering efficiency when it range from 0% - 25%