GEO 474 RESEARCH PROJECT REPORT

DOMESTIC WATER SUPPLY IN KASEMPA

BY

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A GEO474 Project Report Submitted to the Geography Department of the University of Zambia in Partial Fulfilment of the Requirements of the Bachelor of Science Degree in Natural Resources.

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DECLARATION

I, Kiwala Jones Masonde do hereby declare that this report entitled 'Domestic Water Supply in Kasempa' was composed and written by me. All published work or materials from other sources which have been incorporated in this report, have been specifically acknowledged and references hereby given.

I further declare that to the best of my knowledge, this report has not been submitted for any academic award or degree at this or any other University.

Signed: ______________________ Date: 8th June, 2001

ABSTRACT

Kasempa is one of the places in Zambia experiencing the problem of inadequate supply of domestic water. Water supplied to Kasempa Township is abstracted from the Lufupa River. However, the river has not always been a reliable source of domestic water supply. The level of water in the river decreases to a very low level during the dry season or even dry up during drought periods resulting in critical water shortages in Kasempa Township.

This study assessed the adequacy of the water supplied to the residents of Kasempa Township. It looked at the water levels in the Lufupa River, the water distribution system and how the people are coping up with the problem of inadequate water supply.

Most of the information was collected through the use of structured and non-structured interviews. A stratified sampling technique with availability sampling was used in selecting the sampling units.

Part of the water distribution system was found to be inefficient and thus water was not proportionally distributed to all the residential areas creating a situation whereby some of the residential areas face critical water shortages whereas others do not.

Despite the common water shortages, the water that is supplied to most of the households in Kasempa Township is not adequate enough to meet all the resident's domestic water needs. And due to this persistent problem of inadequate water supply, the residents have found ways of coping up with the problem. Some of the coping strategies include collecting and storing water in containers, using tap water for cooking and bathing only and water from supplementary sources for other domestic activities. Others have even constructed pit-latrines in their back yards.

The study concludes that the amount of water supplied to Kasempa Township is not adequate for domestic use. It identifies two major factors contributing to the inadequate supply of water and these are the ineffective water distribution system and the critically low water levels in the Lufupa River during the dry season.

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TABLE OF CONTENTS

CHAPTER FIVE
PRESENTATION AND DISCUSSION OF RESULTS

CHAPTER SIX
CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABREVIATIONS

CSO	Central Statistics Office
DWA	Department of water Affairs
GRZ	Government of the Republic of Zambia
HD	High Density Area
INESOR	Institute of Economic and Social Research
IUCN	International Union for the Conservation of Nature
KDC	Kasempa District Council
LD	Low Density Area
MD	Medium Density Area
MENR	Ministry of Environment and Natural Resources
MEWD	Ministry of Energy and Water Development
PCU	Program Coordinating Unit
PHI	Presidential Housing Initiative
RWP	Raw Water Pump
SADC	Southern African Development Committee
TDNP	Third National Development Plan
TWP	Treated Water Pump
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
WASHE	Water and Sanitation Health Education
WHO	World Health Organisation
WP	Water Protected Area
WSSDG	Water and Sanitation Sector Development Group
ZESCO	Zambia Electricity Supply Corporation

CHAPTER ONE

INTRODUCTION

1.1 Background

Water is essential for life on earth. Living things require water for their metabolic processes which are necessary for life to take place, they cannot function without water. Water is supplied to points of consumption through water reticulation systems which are very costly to build and are usually targeted to serve a specific population size. In Zambia the population has been expanding while the water reticulation systems have not been augmented to matched with the increased demand for water brought about by the expanding population. The result has been a poor water supply delivery service.

Some residents of Kasempa as well as the public media have reported the occurrence of rampant water shortages in the district. In some areas of Kasempa Township, taps have almost dried up. Most of the water supplied for domestic consumption is abstracted from the Lufupa Rivers. However, there are reports to show that the Lufupa River almost or at times even dries up. (WASHE, 1995).

Undoubtedly, there is a problem in the supply of water in Kasempa. Both the occurrence of water shortages and the amount of water in the Lufupa River may have an effect on the amount of water that is supplied to the residents for consumption. Hence the need to undertake a study to assess the domestic water supply in the Kasempa Township.

1.2 Statement of Problem

The problem of lack of access to adequate safe drinking water supply is a common problem that is found through out the world. "WHO estimates that 1,200 million people through out the world lack a satisfactory or safe water supply." (Pickering and Owen, 1994; 133). Most of the people who lack sufficient water supply are found in Sub-Sahara Africa. Zambia is not spared from this problem of inadequate water supply. Even though a good number of households in Zambia may have access to safe water, there is still the problem that the amount of water supplied to each household is not adequate for domestic use. This is the case for Kasempa Township where the amount of water available per household is usually not adequate enough to meet the household's domestic demand for water. The amount of water that is now supplied to each household is increasingly becoming insufficient to meet all domestic water needs. The problem is compounded by the erratic supply of water. And thus the residents are not supplied with enough water.

1.3.0 Purpose of Study

1.3.1 Aim

The aim of the study was to assess the adequacy of the domestic water supply in Kasempa Township

1.3.2 Objectives

I. To assess the water levels in the Lufupa River

II. To find out how effective the water distribution system is.

III. To find out if the water supplied to each residential area is adequate for domestic uses.

IV. To find out the people's response to the water shortages

1.4. Significance of Study

It is said that the amount and quality of water consumed by a community determines it's standard of living (Bull, 2000). In this regard, this research is important in that it will show whether or not the amount of water that is supplied to the residents of Kasempa Township is adequate enough for their domestic uses and in a way provide vital information for measuring the quality of life of the residents in the township. The study will go further by identifying where exactly in the township is the problem of insufficient water supply more prominent and thereby give the relevant authorities a good lead as to which places should be given priority when it comes to improving the water supply and consequently the quality of the people's lives.

Lastly, this study has gone further by looking at the Lufupa River as a source of water for Kasempa. The idea is to see if the river is still a reliable source of water to the township whose population is expanding. It is also the researcher's desire to demonstrate that the management of water supply should not just include water treatment and distribution but rather it should also include the management of the source of the water supply so as to ensure a continuous availability of water through out the year.

1.5 Operational Definitions

I. 'Safe water' in this report refers to water that has passed through a treatment process and attempts were made to purify it or simply water from protected wells and boreholes.

II. 'Effectiveness of the distribution system' was used to mean the ability of the system to continuously deliver enough water to the consumers all the time.

1.6 Organisation of the Study

The report for the study is presented in six chapters. A review of relevant literature on the accessibility to safe water, the demand for safe water and the management of water resources in Zambia is presented in Chapter two. Chapter three presents the description of the area of study area while the methods used to collect the data are presented in Chapter four. Chapter five presents the results of the study and the associated discussion. The conclusion and recommendations are contained in Chapter six.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Water is the basis of life, its vital to all animals and plants. It has a unique quality of being an inexhaustible natural resource, which nevertheless is in short supply. Although there is a lot of water stored in rivers, lakes, seas and underground, "water of acceptable quality and quantity available at the right place and time is not inexhaustible." (Dasman,1968;173)

This chapter first looks at the level of accessibility to safe water sources in Africa in general and Zambia in particular. Factors that contribute to water demand are presented in this chapter based on studies done by different organizations and individuals and lastly it looks at the management of water resources in Zambia.

2.2 Access to safe water

The UNDP Human Development Report of 1996 indicates that of the 145 million people in the Southern Africa, only half had access to safe water. (UNDP, 1996) The majority of those without access to piped water lived in rural areas. Even though Zambia has a lot of surface and ground water resources, not all of its people have access to safe drinking water. "In Zambia, a survey conducted in 1980 showed that 40 percent of the rural population lacked access to safe water." (SADC/SARDC, 1996;10). Sixteen years later, this figure doubled. UNDP (1996) indicates that 89 percent of the rural dwellers in Zambia did not have access to safe water while only 9 percent of people in urban areas lacked safe water. Table 2.1 shows the number of people who have access to safe water in eight countries of Southern Africa.

Table 2.1 Population with access to Safe Drinking Water

Country	Population (Millions)	Percentage of Population in:-		Average For Country
		Rural Areas	Urban Areas	
Angola	7.0	15	69	42
Botswana	0.1	91	100	95
Malawi	0.9	49	70	60
Mozambique	10.1	40	70	55
Namibia	0.6	42	87	65
Tanzania	14	46	67	57
Zambia	4.5	11	91	51
Zimbabwe	2.5	64	99	82

Source: UNDP Human Development Report (1996;63)

Angola and Tanzania had the least percentage of people in the SADC region with access to safe water. Accessibility to safe water sources was very high in Botswana where all the inhabitants of the urban areas had access to safe water. Zambia is one of the countries were a very large number of the urban dwellers had safe water in the region. However, in almost all these countries, the rural population were not well served with safe water as compared to those in urban areas. The percentage of people with access to safe water in rural areas was always been lower than that of the urban areas. Studies by the Central Statistic Office show that ' 55 % of households in Zambia had access to safe water in 1998 as compared to 47% in 1996. In urban areas, it is estimated that 90% of the inhibitors had access to safe water in 1998 as compared to 82% in 1996 whereas only 38% accessed safe water in rural areas in 1998 as compared to 28% in 1996.' (Bull, 2000, 3). These Figures tally with the results of the UNDP study shown in Table 2.1 above for urban areas but there is a difference in the data for rural areas. The UNDP Figure is lower than that of the CSO probably due to differences in definitions for one. Nevertheless, there has been a steady increase in the number of households with access to safe water in Zambia from 1996 to 1998. Lusaka Province in Zambia is the best supplied with safe water. It has the largest percentage of households with access to safe water then followed by the Copperbelt province. This information is presented in Table 2.2 below.

Table 2.2 Access to safe water in Zambia in Percentage

Province	1996	1998
Lusaka	88	93
Copperbelt	67	77
Southern	-	63
Central	-	61
Eastern	-	44
Western	-	37
North-western	-	36
Northern	-	24
Luapula	10	20

Adopted from GRZ,1998

Luapula had the least percentage of households with access to safe water sources. The North-western province still had very few households with access to safe water.

Even though Zambia was one of the countries that had a very high percentage of people with access to safe water in the urban areas (next to Botswana and Zimbabwe), it had the lowest percentage of the rural population who had access to safe water. One may therefore be bound to conclude that in terms of supplying safe drinking water, most of the countries in Southern Africa do not treat the rural areas as priority areas.

2.3 Water Demand and Supply

The availability of safe water is affected by among other things, the population growth. There has been an increase in the demand for safe water in the world as a whole.

"Increasing demand is one crucial concern in Southern Africa because of the increasing human population and associated demand for resources." (SADC/SARDC,1996;7). In Zambia for example, the demand for safe water is increasing at an average of 4.2 percent since independence, which is higher than the population growth rate of 3.2 percent per annum. (Jayarajan, 1976).

The demand for safe water is increasing because of the rapidly growing urban population which is placing excessive demands on the water resource for industrial activities, mining, agriculture and domestic uses. A study by SADC and IUCN indicates that, "at current population growth rates, Southern Africa will experience chronic water shortages by 2030." (SADC/SARDC, 1994; 198). The region has to work hard to match the provision of adequate safe water with demands of the rapidly growing population. On the local scene, the situation may be more serious. Water shortages were expected to be chronic earlier than 2030. The Zambian government in its National Conservation Strategy of 1985 indicated that severe water shortages were expected by the year 2000. These fears were also echoed by Musambachime, (1990; 28) when he indicted that "due to the rapid population growth, it is feared that Zambia may experience a severe water shortage by the year 2000, if not marched with infrastructure development." However, it is difficult to tell whether Zambia is facing severe water shortages as predicted in 1985 and in 1990 by the government and Musambachime respectively. Nevertheless, Musambachime (1990) had raised a very important point that of augmenting water facilities to meet the increased water demand of the expanding population size. Most of the water reticulation systems in Zambia were built a long time ago to cater for a small population which has since grown.

Jayarajan (1976; 68) had recognizes four major factors affecting water demand and supply as follows;

(i) Growth of urban population and individual wealth

(ii) Economic base or urban areas

(iii) Policies and programs for housing

(iv) The Third National Development Plan's (TNDP) strategies for urban development.

Population growth in urban centres causes an increase in the demand for water due to increased economic activity and domestic use of water. What Jayarajan(1976) meant by increased individual wealth affecting the demand for water is that, as people become more wealthy they tend to use more water which they have to use for bathing, cooking, watering their lawns, washing their cars, etc. The liberalization of the country's economy may lead to increased economic activity. More industries may come up hence more water will be required. Policies and programs for housing affect the demand and supply of water in that, the new houses built through housing schemes (such as the Presidential Housing Initiative) creates the need for new a water reticulation system to be set up to supply water to the new areas. Though new housing areas are established at a fast rate, the water supply system is not usually expanded just as fast thereby putting more pressure on the existing systems. The programs of the TNDP provided for the upgrading some of the squatter residential areas which meant that the council needed to start supplying water to these compounds thus increasing the demand for safe water. Another factor that affect the supply of water is that of wastage. Studies by the Department of Water Affairs in 1975 showed that a colossal wastage of water amounting to millions of litres per day occur every year. In Ndola for instance, of the 175 million litres of water that was consumed per day, about 40 percent (70 million litres) per day was lost through wastage. And in Arakan Barracks in Lusaka, the study showed a per capita consumption as high as 1200 litres per person per day, which was three times the normal consumption rate. (Jayarajan, 1976)

2.5 Water Resources Management in Zambia

'The institution that is responsible for the water resources management, the Department of Water Affaires (DWA) as always been through the Water Act of 1948. The DWA has been the main public institution charged with the responsibility of overall water resources management in the country.'(Bull, 2000, 4) . The DWA was involved in the supply of water in both rural and urban centres. Other government ministries were also involved in water resources management depending on their specific tasks. The Ministry of Agriculture was involved in irrigation and water use, Ministry of Land in land administration and use, Ministry of Environment and Natural Resources in pollution and environmental protection, Ministry of Transport and Communication in navigation canal and dredging and the Ministry of Local Government and Housing in township water supply. "As a result of diffuse institutional structures and lack of clear policy guidelines and conditions, there was at present pieces of legislation relating to various sectors in the water sector and this resulted in duplication of efforts and unnecessary rivalry for control" (Bull, 2000, 4). One of the problems resulting from this diffuse management of water resources is that the institution (or District Councils) that provide water to consumers are not responsible for the management of the water sources from which they extract the water. Thus in places like Kasempa, where the source of water (the Lufupa River in this case) is under threat of drying up, the District council, which is the main water user, cannot do much about it.

It can be established from the literature that the rural dwellers are not well supplied with safe water. The situation in urban areas is by far better than that of the rural areas. Population growth is one of factors contributing to the increasing demand for safe drinking water. This seems to be the common factor contributing to the demand of safe water in many other countries as well.

Most of the studies done on water supply seem to focus mainly on the accessibility to sources of safe water. There seems to be less information on the adequacy of the water supplied to those that already have access to safe water. Apart from the studies done by CSO on the accessibility of safe water the residents of Kasempa, there seem to be no studies on the water situation and the adequacy of the water supplied in the District.

The DWA stopped taking readings of the Stream Discharge on the Lufupa River a long time ago and there seems to be no information or water use inventory of the Lufupa River. The hydrological characteristics of the river are not well known either and this is probably why it is difficult to come up with a management plan for the Lufupa river basin.

This study was designed to provide information on the adequacy of the water supplied to the households in Kasempa Township. It has given information on where exactly this problem exists and has tried to project (both the degree and spatial) extent of the problem through quantitative and qualitative analysis.

CHAPTER THREE

DESCRIPTION OF STUDY AREA

3.1 location and size

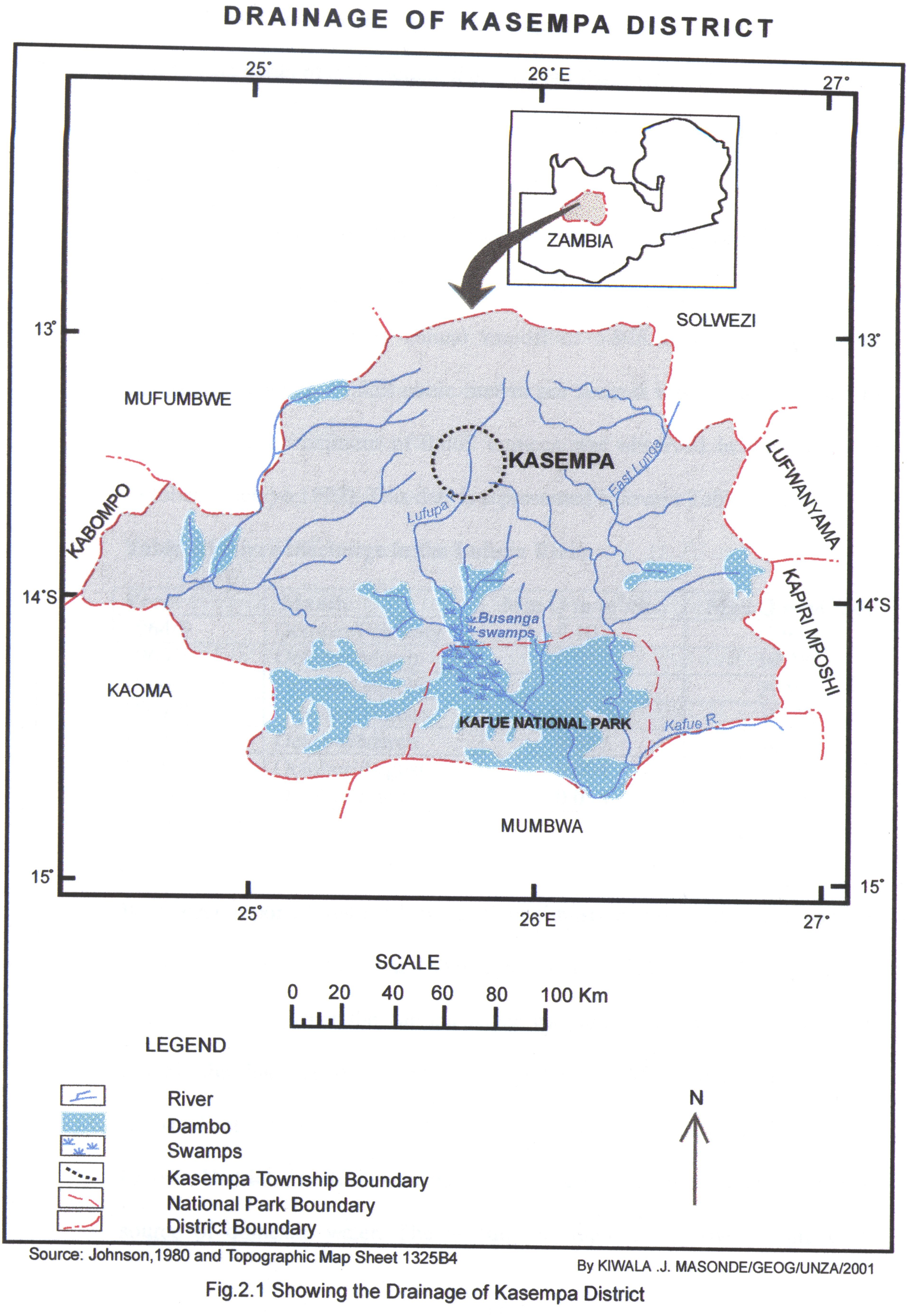
The study was conducted in Kasempa Township in the North-western province of Zambia. Kasempa lies between $25^0 45'$-$25^0 58$ E and $13^0 25'$-$13^0 30'$S. The district covers a total area of over 41,000 square Kilometres. The Kafue National Park and other game and protected forest areas occupy almost half of the district. (See Fig 2.1)

3.2 Relief and Drainage

Kasempa lies between 1000m and 1200m above sea level. It forms part of the northern plateau region of Zambia and has a relatively level topography but with a few hills in the central part of the district such as Kamekela and Shidamona Hills. The slightly undulating Tableland descends from the north towards the south where the land becomes flat in the Busangu and Kafue flats.

The landscape in Kasempa is transected by a number of rivers. The Lufupa River is the biggest river in Kasempa Township and it is the major source of drinking water for the residents of Kasempa Township.

As shown in Figure 2.1, its source is near the Kasempa turn-off 50 Kilometers north of the Kasempa Township. It flows from the north through southeast of the Township and down into the Busanga swamps before empting its waters



Source: Johnson,1980 and Topographic Map Sheet 1325B4

By KIWALA .J. MASONDE/GEOG/UNZA/2001

Fig.2.1 Showing the Drainage of Kasempa District into the East Lunga River. The Lufupa River has an average width of 12 meters and a mean depth of 0.52 meters. It is wide but shallow.

Its riverbed is hard as it flows over a hard rock only identified as belonging to the Katanga group of rocks.

The tributaries of the Lufupa River include the Kamusongolwa, Lamadamba, Chifika and Kamishima. All these rivers are perennial.

The river has an average annual run-off of 5.948 cumecs. A maximum discharge averaging 11.829 cubic meters per second was usually reached in March, while a minimum of 0.067 cumecs was observed in the month of October (Yachiyo,1992). This data is represented below in Table 3.1.

Table 3.1 River Discharge in the Lufupa River

Year	Month	Min Q in m^3/Sec	Max Q in m^3/Sec
1964/5	October/February	0.101	5.955
1965/6	October/March	0.052	19.281
1966/7	October/March	0.0069	29.932
1967/8	October/March	0.0096	9.673
1973/4	October/March	0.087	6.215
1988/9	October/August	0.004	0.508
1991/2	October/January	0.058	11.239

Source: Yachiyo (1992; 37)

It has been reported that the Lufupa River almost dries up in the dry season as was experienced in 1988/9 and 1991/2 seasons (GRZ,1995). Chileshe (1997; 85) also reported that the Lufupa River was one of the perennial rivers in Zambia that had become intermittent together with the Chalimbana River in Lusaka East, Mansa River in Mansa, Kaleya in Mazabuka, and Kalomo in Kalomo District. The Lufupa in its current state has become not a very reliable source of domestic water. The amount of water in the river is gradually becoming inadequate and may soon not be enough to meet all the demands for domestic and other uses.

3.3 Climate

Average annual rainfall is about 1100mm to 1300mm. The rainy season starts in mid November to March. There is an annual dry period of 6.5 to 7 months. Considerable seasonal and spatial variations in rainfall are experienced. The Climate in Kasempa described, as a moderate Sudanese type is tropical insofar as it has pronounced dry and rainy seasons. Climatically Kasempa forms part of the warm-dry zone of Zambia with an annual temperature mean of 20.4 ^{0}C.
A maxima and minima average of 29.8 ^{0}C and 13 ^{0}C are experienced respectively. July is the coldest month and can have a mean daily temperature of 5 ^{0}C to 7.5 ^{0}C while mean daily maxima of 32 ^{0}C to 35 ^{0}C is reached in October the warmest month in Kasempa.

3.4 Vegetation

Due to the type of climate that prevails in Kasempa, deciduous plants characterise its vegetation. Miombo woodlands and grasslands occupy large portions of land in the district. The most common type of tree species are the *Brachystegia* and *Termitaria* which are occasionally interrupted by dambos that are predominant in the southern parts of the district.

3.5 Population

Kasempa District has a population of 39,583 of which 21.8% (8,615) live in the township. It has a population density of 2.3 persons per square kilometre. Only about half of the district is inhabited since the Kafue National Park, protected forests and other protected areas occupy the rest of the land. Population growth is estimated to be at 3.1% per annum. Changes in population are mainly due to migration to urban centres. The population is concentrated along rivers nearer to agriculturally utilized areas and along the main roads. The population density of Kasempa Township is greater than that of the entire district.

3.6 Urban Development

Kasempa district has been growing at a very slow pace. There are no manufacturing or processing industries in the entire district other than the defunct Kalengwa Mine. It is largely a rural district. Formal employment is found largely in the few local and central government departments in the district.

Development in the district has been seen mainly in the expansion or construction of new schools, clinics and government administrative offices. Developments that are more recent include the tarring of the Solwezi-Kasempa Road. At the time of the study, the establishment of a commercial water utility was still in progress. A diesel powered thermal station is used to supply electricity to Kasempa Township.

3.7 Selection of Study Area

Kasempa was selected as a study area because of the reports of water shortage emanating from people living in the district and from the researchers own experience. The selection of Kasempa Township was also based on the fact that it was easily accessible to the researcher. However, only the township was selected for the study, as there were no financial or material resources available to conduct a study through out the entire district.

CHAPTER FOUR

METHODOLOGY

4.1 Sources of Data and Collection Method

4.1.1 Primary data

Primary information was collected from the following sources: -

(a) Residents of Kasempa Township

This was done with the aid of questionnaires, which were administered to the selected respondents.

The questionnaire was designed such that

it highlighted among other thing the following issues;

i. The source of water to the household

ii. Adequacy of water supplied

iii. The reliability of the water supply through out the year.

iv. Copying strategies of the resident to the water shortages

Questionnaires were used because the made it possible to collect information from many different households and from all different residential areas. This helped to collect results that were representative of the whole population.

(b) Council and department of Water Affairs employees

Non-schedule structured interviews were used to extract the required Information from the District Director of Engineering (DWA) who was the officer-in-charge of Township water supply and the Supervisor at Water Works.

The interview mainly focused on the following; -

i. The main sources of water supply
ii. Reliability of the source of water.
iii. The distribution of the water and its effectiveness
iv. Number of households supplied with piped water.
v. The extent of the water shortages in the Township
vi. The water levels in the Lufupa river

This type of interview was used to make sure that all the required information was collected on the study without living out any piece of information that later would have been found to be important. Non-scheduled interviews allowed the researcher to seek further clarification where information seemed inadequate. This type of interview was very helpful especially in this case were the research was designed based on the very little information that existed on the study area and the situation being studied.

(c) **Field Observations**

These were conducted at the Water Works and along some parts of the Lufupa River.

Field observations targeted the following information;

I. The operations of the Water Works and Problems affecting the supplying of water to the Kasempa Township

II. Activities on the banks of the Lufupa River

4.1.2 Secondary Data

This was mainly archival information which was collected from different sources. Rainfall data was collected from the Meteorological department in Kasempa and Lusaka. Working papers of the Kasempa District Council were consulted for data on the water levels of the Lufupa River. Information on the River Discharge and other parameters of the Lufupa were obtained from the Water Sector Reforms Support Unit

The University of Zambia library and the Institute of Economic and Social Research provided population statistics and information on the characteristics of the study area and on the management of water resources in Zambia.

4.2 Sampling Procedure

4.2.1 Definition of Population and Sampling Unit

The total number of households (units) that had a reticulated water system and was found within Kasempa Township was taken as a population. It included households from the Low-density, Medium-density and high-density residential areas.

Any household found in a water-reticulated residential area within Kasempa Township was taken as a sampling unit.

4.2.2 Sample Size and Sampling Method

A sample size of 46 respondents was picked and interviewed. Only 46 households could be interviewed because of lack of resources to engage a larger sample size.

Stratified sampling was used to pick the 46 respondents with each type of residential area forming a stratum. There were three strata, A, B and C representing the low, medium or high-density residential area respectively.

This was done to make sure that the entire population was represented and to maintain the quality of the sample. Stratified sampling made the sampling procedure and the administration of the questionnaires in the strata easier for the researcher.

The number of households interviewed in each stratum was proportional to the total number of houses in that particular stratum. The number of respondents was distributed at follows;

Table 4.1 Number of respondents

Stratum	**Number of Houses**	**Number of Respondents**
A (Low density)	26	7
B (Medium density)	28	7
C (High density)	125	26
Total	**179**	**46**

After determining the total number of sampling units to interview in each stratum, availability sampling was used to pick each sampling unit (house) in each stratum and then a questionnaire was administered. Availability sampling was found to be more convenient since a sampling frame could not be constructed, as there was neither a list of houses nor plot numbers to use. And most of the streets did not even have names neither where all the houses numbered.

4.3 Data Analysis

Both qualitative and quantitative methods of analysing data were used.

The analysis of the data employed methods that ranged from rudimentary techniques such as the use of percentages and means to the more advanced statistical techniques such as Analysis of variance and the Product-moment correlation coefficients.

CHAPTER FIVE

PRESENTATION AND DISCUSSION OF RESULTS

5.1 Introduction

In this chapter, the findings are presented, analysed and discussed. The findings include the water levels in the Lufupa River, factors affecting the levels of water in the river and how in turn it affects the supply of water. The chapter then looks at the water distribution system in terms of its ability to deliver adequate water to the residents and if the water supplied through the distribution system was adequate for domestic uses. Lastly, the findings on the peoples response to the water shortages, their other sources of water, coping strategies and attitudes are presented.

5.2 Water Levels in The Lufupa River

Information collected from the Department of Water Affairs indicated that lately, the water level in the Lufupa River becomes very low during the dry seasons. The Water level in the Lufupa start to rise in late November or early December until it reaches its peak in March. The mean maximum depth is 0.83 meters and the mean minimum depth as been 0.45meters. The highest water levels reached so far in the last four years have been a depth of 1.14 meters, which was recorded in March 1999 (Appendix I.a).

Figure 5.1 shows the fluctuating water levels in the Lufupa River over a period of twelve months for the selected threes seasons. The graph shows how the water levels fall drastically in the dry season to about 0.17 metres in October/ November while in 1994 it completely dried up in October.

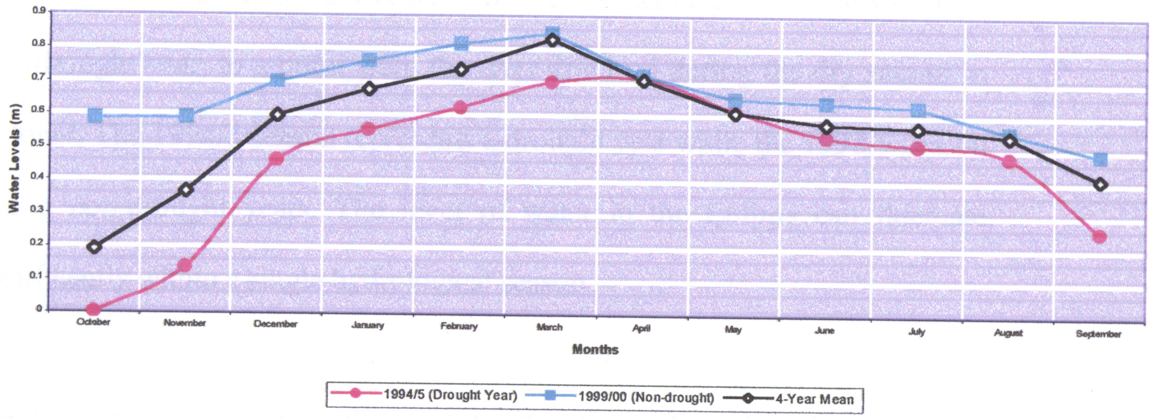


Fig 5.1 Average Water Levels In the Lufupa River

It can be seen from the figure that the water levels in the Lufupa fall way below average in the months of October to April during the drought year. Below average water levels continues through out the year in the drought year. In October there is a big difference in the average monthly water levels between the drought and non-drought years.

An analysis of variance F-Test conducted on the data of water levels for the four seasons (1994/5, 97/8,98/99 and 99/00) yielded a significant difference at a significant level of 0.5 (see working in Appendix I.b). This indicated that there was a significant difference, first in the mean water levels within each season and secondly between the seasons. Water levels in the Lufupa fluctuate significantly within a single hydrological year between seasons. The water levels fall drastically during the hot season around September and October and rise to it's highest usually in March. The occurrence of droughts in the recent years can also explain the differences in the water levels between the different hydrological years. Fig 5.1 above show how the water levels fell below average in a drought year, to a point were the river dried up during the dry season in October. The 1994/5 season represents a drought year while the 1998/9 season was a non-drought years. The level of water in the Lufupa can fluctuate significantly within a single hydrological season.

Rainfall influences the quantity of water that flows through a river. It is the primary source of water for rivers. In Kasempa district, an annual mean of 1147 mm of rainfall has been recorded in the last 50 years. A Mean maximum monthly of 256.2mm of rainfall is recorded usually in December. (See Appendix two). Figure 5.2 shows the mean monthly rainfall distribution over a period of fifty and for two seasons in Kasempa respectively. Drought events (below average rainfall) in Kasempa are common.

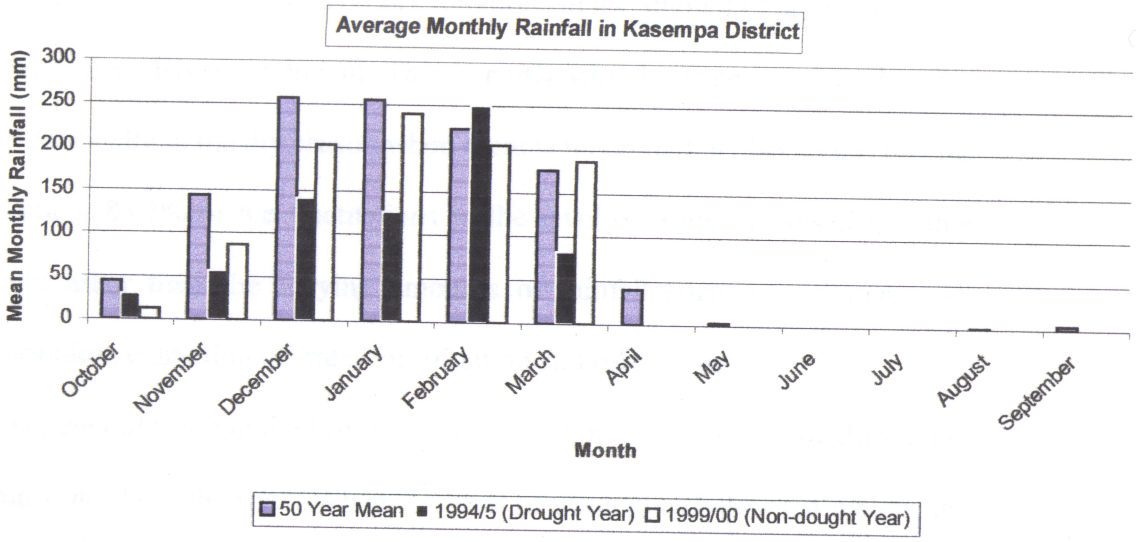


Fig 5.2 Shows the distribution of rainfall in season and compare the 50-year rainfall with the 1994/5 and 1999/00 seasons.

Compared to the 50-year mean rainfall, it can be seen that the amount of rainfall received in the 1994/5 and 1999/00 season were actually both below the 50-year mean.

To find out the correlation between rainfall and the water levels in the Lufupa, a Product-Moment Correlation analysis was conducted (Appendix III).

A correlation of +0.3366 was obtained which implied that that there was a positive correlation between the amount of rainfall and the level of water in the Lufupa River. This means that the average water levels in the Lufupa River rise when the amount of rainfall increases and when there is a drop in the amount of rainfall, the water levels will correspondingly fall. A coefficient of determination (r^2) of 0.1133 implies that 11.3 percent of the fluctuations in the water levels were attributable to the variations in the amount of rainfall received in the Lufupa River catchment. This is partly why the water level in the river falls drastically in the dry season when there is no rainfall. It also means that the remaining 88.7% of the fluctuations in the level of water is caused by other factors other than the varying amounts of rainfall such as sedimentation, evaporation, extraction of water for irrigation and other uses.

As the level of water in the Lufupa River falls, it becomes increasing difficult to pump water from the river. When the level of water goes below 0.4 meters, the pumping equipment operate way below it's full capacity, pumping very small quantities of water to avoid choking the machines with soil particles. Thus during the dry season, from late August to November, water shortages are frequently experienced as indicated in Table 5.1.

Table 5.1 Time of the Year In Which Water Shortages Are Most Frequently Experience

Period	LD	MD	HD	TOTAL %
August to November	2.2	8.7	26.1	37.0
Through out the Year	13	0	2.2	15.2
At any time of the year	0	6.5	28.3	34.8
At no time of the year	0	0	0	0
*Can not tell	0	0	13	13
Total	15.2	15.2	69.6	100

*Had no Taps due to vandalism

A total of Eighty-seven percent of the responses obtained confirmed that water shortages were more frequent and severe in the dry season. The amount of water supplied to the residents becomes inadequate during this period. The problem becomes more acute during the drought periods when the Lufupa River dries up. As the level of water rises, the supply of water to the residents improves and so none of the residents complained of the any shortages from January to June. The occurrence of water shortages is looked at further in section 5.5.

There are many other factors that may be contributing to the lowering of the water levels. Some of these are human activities along the banks of the Lufupa River.

5.3 Activities along the Banks of the Lufupa River

Large portions of land at the source of the Lufupa had been cleared for cultivation of crops. In some places, villagers had sunk shallow wells on the banks of the river. They used these wells to draw water for irrigation and for domestic purposes. As a matter of fact, information collected from maps show that a large part of the Lufupa River catchment had been turned into a general agriculture area. Clearing of trees at the source of the river and along the river banks stimulates excessive evaporation of water and promotes soil erosion, which in turn contribute to the lowering of the quantity of water in the river. Consequently, there won't be enough water to pump out from the river especially in the dry season and so water shortages are increasingly becoming common and more serious every year. As will be seen in section 5.5, the supply of water has become more erratic in Kasempa Township during the dry season. The average discharge at a particular time in the Lufupa River is also decreasing every year as shown in chapter Two. This means that the amount of water available for domestic and other uses is reducing. The situation has been exacerbated by the commercial Brick-making activities on the riverbanks of the Lufupa. Those involved in this venture tend to block the river upstream thereby reducing the amount of water reaching the pumps at the water works. There were four places found within the Lufupa river basin where such activities took place.

The area from somewhere near the bridge on Mumbwa road stretching about 5 Kilometres upstream is a Water Protected area as shown on Figure 5.4. The water Protected area covers a width of 100 meters on both sides of the river. However, residents of Kizhingezhinge compound were encroaching into this area. Within the Water protected area, land clearing and gardening was a common feature besides brick making and extraction of water for irrigation and domestic uses. The loss of vegetation on the banks of a river contributes to sedimentation in the river. This later results into low water levels making it difficult to pump water from the river and therefore the supply of water becomes very erratic and inadequate to the water consumers.

5.4 Water Distribution

All the water supplied to the consumers in Kasempa Township was abstracted and treated at the new water works. (Refer to Figure 5.4). Water was pumped from the Lufupa River using two Raw Water pumps (RWP). After going through the treatment process, the treated water was pumped to the distribution tanks using three Treated Water pumps (TWP). Each TWP had a maximum

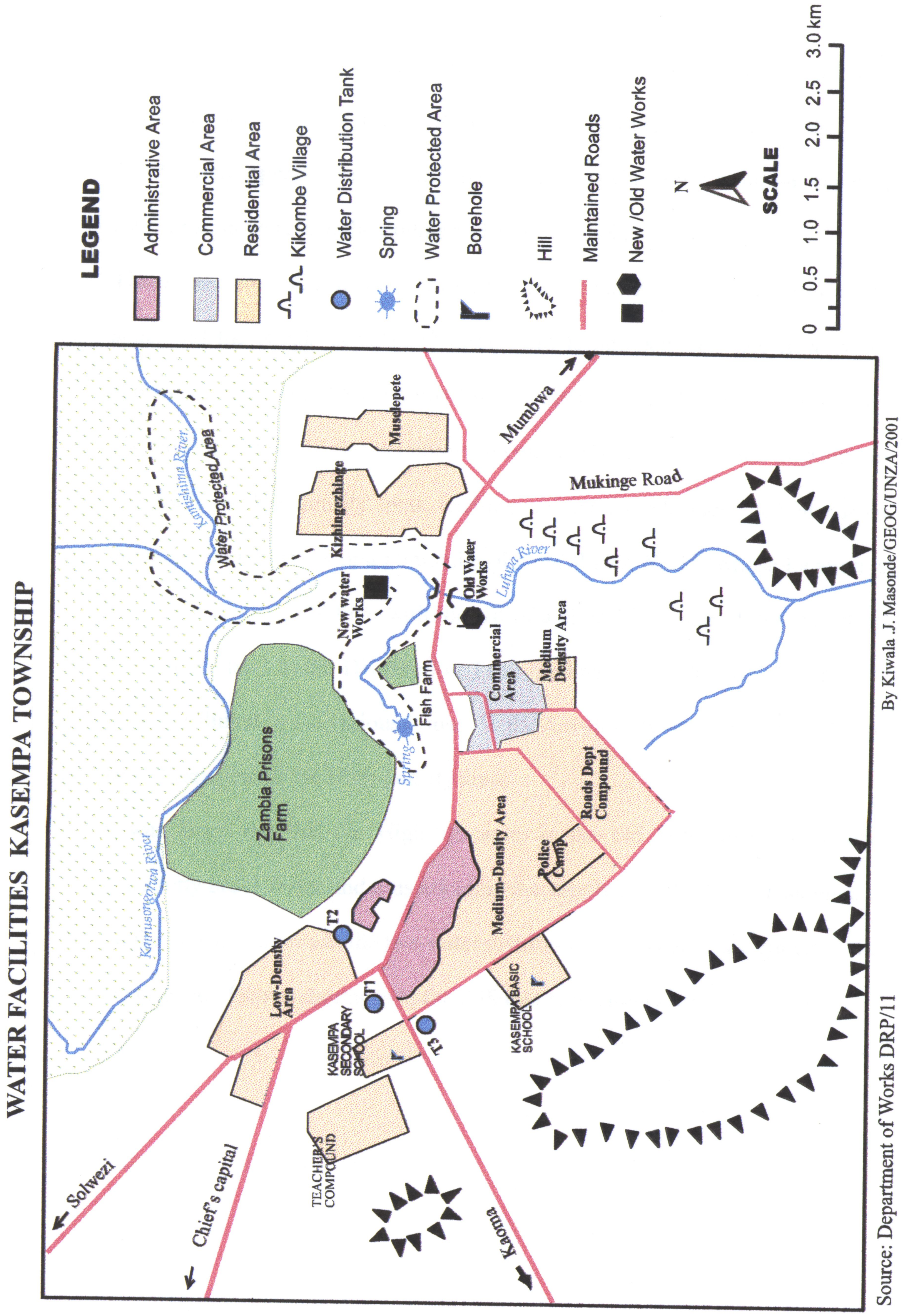


Fig 5.4 Showing Location of Differrent Residential Areas

pumping capacity of 40 cubic meters (40,000 litres) per hour and were allowed to operate for 15 hours a day. At the time of the study, only two of the three TWP's were operational, one had broken down. Maximum pumping capacity was not achieved since the pumps had broken down.

There are two major water distribution lines. Water for the medium density areas and the Roads department compound is pumped from the new Water Works directly to the Distribution Tank marked T2 then to T3 (refer to Figure 5.4) and finally to the various points of consumption. The second distribution line feeds the low-density areas, Kizhingezhinge and Muselepete. Water from the new water works is first pumped to the old Water Works (whose location is shown on Figure 5.4), then with the aid of a High-Lift pump, water is sent up the sloping land to the Distribution Tank marked T1 on Figure 5.4 were it is then distributed to the various houses in the low-density areas, Kizhingezhinge and Muselepete in the High-density areas.

It was found out that the High-lift pump in the old water distribution line constantly broke down and thus affecting the supply of water to the residents.

In fact, the operations of the two water distribution lines had some effects in the occurrence of water shortages in the different residential areas.

5.5 Occurrence of Water Shortages

The occurrence and extent of water shortages in the different residential areas was used as an indicator of the ineffectiveness of the water distribution system. The problem of water shortages was more serious in some areas than in others. Table 5.2 shows the frequency of the occurrence of water shortages in the different residential areas of Kasempa Township.

Table 5.2 Occurrences of Water Shortages

Response	**Number of Responses**			**Total**	**% of Total**
	LD	**MD**	**HD**		
Very frequent	7	2	10	19	41.3
Not so frequent	0	5	16	21	45.7
No shortages	0	0	0	0	0
*No Taps	0	0	6	6	13
Total	7	7	**32**	**46**	**100**

It can be seen from the Table that water shortages were most frequently experienced in the low-density areas where all the respondents indicated that the water shortages were very common. Though shortages are experienced in all the residential areas, in the medium-density area water shortages are not so frequent. Only 2 out of 7 (29%) of those in the medium-density areas indicated that water shortages were not frequent.

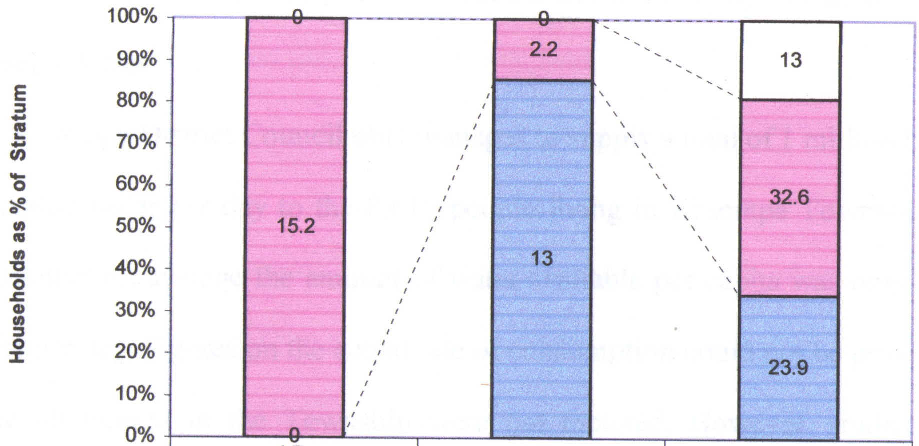
The medium density area was better supplied with water than any other residential area. This could be attributed probably to the fact that the water distribution line supplying water to this area was more efficient and less problematic than the other distribution line which supplied water to the Low-density areas. In the high –density areas, water shortages where mostly experienced in the peri-urban compounds of Muselepeta and Kizhingezhinge and not so much in the Roads compounds which is located in the main township area called the Boma. The six people in the high-density areas (Kizhingezhinge and Muselepete) had their only taps vandalized and so were not receiving any water at the time.

Water shortages were very common in low-density areas, Muselepete and Kinzhingezhinge. Actually, it was found that most of the households in the low-density area such as the Teacher's compound (see Figure 5.4) experienced water shortages through out the year. (Table 5.2). The water problems in these areas may partly be attributed to the inefficient water distribution line servicing the areas. The constant break down of the High-lift pump affected the supply of water particularly in the low-density, Kizhingezhinge and Muselepete areas.

Even though water supplied to Kasempa Township comes from the same source, it was not well distributed. The distribution of water in Kasempa was not effective enough to supply adequate water to all the households in the different residential areas. As was described above, the old water distribution line supplying the low-density areas was the most ineffective in-terms of delivering water. It was found out that one of the factors contributing to the ineffectiveness of the distribution system was the continuous breaking down of *the High-lift pumps.*

5.6 Adequacy of Water Supplied

Even though all households in Kasempa Township had access to piped water, not all of them could say that the amount of water, which they were supplied with, was adequate to meet their domestic demand for water. This fact is illustrated in the findings presented in Figure 5.3 below.



	LD	MD	HD
No Taps	0	0	13
Inadequate	15.2	2.2	32.6
Adequate	0	13	23.9

Percentage of total Sample

Fig 5.3 Adequacy of water supplied each residential area

From figure 5.3, it can be seen that all the households in the low-density area did not have an adequate supply of water. In the high-density area 47 percent of the households (making up 32.6 % of sample) were not supplied with adequate amounts of water to meet their domestic water demands. Some (18.8 %) of the residents in the high-density area (usually those who used communal water facilities) did not have taps. These were vandalized and hence the residents could not state at the time as to whether they had an adequate water supply or not. The medium density area seemed to be the least affected by the poor supply of water. 85.7 percent of the households in the medium-density areas indicated that the amount of water they were supplied with was adequate. These represented only 13 percent of the total sample. All in all, the study showed that only 50 percent of the sample could say that the amount of water supply was adequate for their domestic uses. The rest did not have enough water for their household uses.

The Kasempa District Council only manages to supply a total of 1 million litres of treated water per day to the 8,615 people living in Kasempa Township. It means that on average the amount of water available per capita was only 116 litters per day. Figures on the actual rate of consumption could not be provided since all houses in the Township were not metered. However, studies by Jayarajan (1985) show that the average rate of consumption for Townships like Kasempa was 200 litres per person per day. This is still way below the government recommended consumption rate of 310 litres per person per day. Using the recommended amount of water for each person (GRZ,1994$_a$) the amount of water that is required for the entire Kasempa Township should not be less than 2,670,650 litres per day (310 litres x 8,615,population of Kasempa Township). However, KDC manages to supply only 37 percent of this amount is supplied to the Township. Thus on government standards, the amount of water supplied to households in Kasempa Township is not adequate. Of course, this should not be taken as a blanket statement since the distribution of the water is not uniform. Some areas receive more water than was receive in other residential area such as the Teacher's compound at Kasempa Secondary School.

As the problem of inadequate water supply persisted, residents of Kasempa had to find ways in which they could overcome part of the problem. Some of the coping strategies included acquiring supplementary sources of water and adjusting the way they used their water. Their responses could also be seen in the attitude that some had developed towards the settling water bills.

5.7 People's Attitude

The most common attitude people adopt in response to lack of an adequate water supply is the unwillingness to settle water bills. Residents were asked as to how often they settled their water bills. The results are presented in Table 5.5 below.

Table 5.5 Settling of Water Bills

Response				
Always Pays	Sometimes	Never	*Other	Total
23	11	7	5	46
50.0%	23.9%	15.2%	10.9%	100.0%

* Bills settled by employers.

There was a small group of people (representing 11 % Of the sample) who indicated that they saw no need in paying for the water, which they were not getting. These people were mainly from the Teacher's compound. Some indicated that they did not always settle their bills because of other commitments. However the majority of the resident settled their bills.

On the question of establishing commercial water utilities, 93.5 percent of the residents favoured the idea. They believed that a private company would be more efficient in delivering water than the council.

5.8 Supplementary Sources of Water

The Kasempa District Council (KDC) supplied piped water to the entire Kasempa Township. The water supplied to the township was abstracted from the Lufupa River.

It was found that even though all the respondents had access to piped water, some (45.2 %) had other sources of water in addition to the piped water supply. This was to supplement the water that they got from the District Council. Table 5.4 below shows the responses when residents were asked if they had any other source of water apart from the piped water supply.

Table 5.4 Other Sources of Water (as percentages of the Total sample)

Source	**Residential Area**			**Total**
	LD	**MD**	**HD**	
Spring	8.7	2.2	4.3	15.2
River	4.3	0	11.0	15.3
Borehole	2.2	0	0	2.2
*Well	0	0	13.0	13.0
None	0	13.0	41.8	54.8
Subtotal	**15.2**	**15.2**	**70.1**	**100.5**

Note: * indicated that the shallow wells were not necessarily a supplementary source but the only source of water. They were found only in Kizhingezhinge and Muselepete which where initially serviced by the council but the (communal) taps were vandalized at the time, hence the use of wells.

Fifteen percent of the residents collected water from the near by rivers such as the Lamadamba, Kamusangolwa, the Lufupa and its tributaries. The residents in the high-density residential areas were the ones who mostly collected water from rivers because rivers were the nearest supplementary source of water for them. Most of the residents in the low-density area collected water from a spring located within the Township (see Figure 5.4), these represented 8.7 percent of the total sample. All of the respondents in the high-cost residential area had extra sources of water because they were the most affected by the inadequate and erratic water supply. The spring behind the local magistrate court was the second most popular supplementary source of water especially for those in the police camp and from some parts of the low-density area. There was only one borehole that was still operational in Kasempa Township. This was found at Kasempa Basic School and only 2.2 percent of the residents used it. The other borehole at Kasempa Secondary School had not been operational for a long time. Slightly over half of the residents did not supplement their water supply. These were mainly from the medium-density area and from the Roads department compound. As indicated in section 5.4 above, over 80% of the residents in the medium-density area received an adequate supply of water hence they did not need any supplementary source of water.

People in Kasempa Township had other sources of domestic water because of the inadequate supply in the area. Where this problem was prevalent, the residents had to consistently make trips to fetch water from their different sources. However, apart from having supplementary sources of water, some of the residents had other strategies that helped them cope with the water problem. These could be looked at as water conservation measures aimed at serving the little amounts of water that might be flowing from the taps.

5.9 People's Coping Strategies

One of the strategies the people adopted was the use of largely 20 litre containers to collect and store water. None of the residents in Kasempa had sunk any borehole in Kasempa Township. A good number of people could be seen with yellow 20 litre containers tripping to and from the spring, rivers or where ever they collected portable water.

The water situation was so bad in certain area that some residents had constructed Pit latrines even within the high-cost residential area. Six Pit latrines were found in the low-density area and in the police camp, but they were mostly common in Kizhingezhinge and Muselepete largely because of the fact that some parts of these areas did not have Taps while the water and sewerage systems were completely dilapidated.

From the data presented above, it can be seen first of all that the falling level of water in the Lufupa River contributes to the poor supply of water during the dry season. Human activities and other factor may be the major cause of the low water levels in the river since it was proven in section 5.2 that rainfall variations had minimal effect on the fluctuations in the levels of water in the Lufupa River. This is probably were this study did not do well. A good picture on how the level of water in the Lufupa affects the supply of water would have been given relating the mean monthly volumes of water supplied or consumed and the water levels. Unfortunately lack of information on the amount of water supplied and consumed did not facilitate for such an analysis.

Secondly, the distribution system is does not supply water equally to the different residential area thereby leading to the situation were the low-density area is poorly supplied with water than the medium and some parts of the high-density area. The people of Kasempa Township have been socially affected by the inadequate supply of water.

The problem of Lack of sufficient water supply in Kasempa can be divided into two major components. The engineering aspect, which refers to the pumping and distribution of the water and the environmental aspect, which are the problems on the Lufupa River as a waster resource. As was discussed in chapter two, the Kasempa district council only looks at the engineering aspect and the environmental aspect of the problem falls under other government institutions. This means that the KDC can only deal with part (the engineering aspect) of the problem leaving out the other environmental aspect. It is possible that with this diffuse form of water resource management, the problem in Kasempa may not be eliminated completely unless a holistic approach is taken.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The information collected all point to the fact that the amount of water supplied to Kasempa Township varies for each residential area. However, on the whole, it can be concluded that the amount of water that is supplied to Kasempa Township is not adequate for domestic uses. The areas that suffer most from the inadequate supply of water include the Low-density area, Police camp, Kizhingezhinge and Muselepete compounds.

It is further concluded that the factors contributing to the inadequate supply of water in Kasempa include the following:-

I. The ineffectiveness of the distribution system to distribute water proportionally to the different residential areas in the township. This is coupled with the constant breaking down of the High-lift pump, the Treated Water pump and the Raw Water pump.

II. The low levels of water and the occasional drying up of the Lufupa River during the dry season consequently results in an inadequate supply of water.

The other reason for the inadequate supply of water may be attributed to the occurrence of water shortages in the area. Frequent shortages of water may result in a situation whereby the amount of water that each household is supposed to be supplied with in a unit time may be reduced and thus the supply may not meet each household's domestic demand for water.

6.2 Recommendations

6.2.1 The problem of low water levels in the Lufupa River

This should be looked at as an environmental problem that requires both engineering and environmental solutions.

Proposed Action:

I. **Construction of a weir.**

A weir should be constructed across the Lufupa River just near the new water works to impound part of the water in the river. This will help in rising the level of water in the river at the same time ensure the availability of water in the river during the drought years.

The KDC and the DWA can do this.

II. **Environmental Education and Enforcement of Legislation**

Both the community in the areas along the Lufupa River and all the relevant authorities should be informed on the importance of not cutting trees or cultivation along the banks of the river.

And the necessary regulation preventing cultivation within the Water Protected Area should be enforced.

Such exercises should involve the KDC, DWA officials, Forestry Department, the traditional leaders and the people of Kasempa district.

6.2.2 The Ineffective Distribution System

Proposed Action:-

I. Acquisition of new pumps

There is need for the district council to acquire a new or reconditioned Raw Water pump, Treated Water pump and a High-lift pump to improve on the distribution of water especially to the most affected areas.

II. Shift to the use of Hydroelectric power

The district should be connected to the main power grid so that they can start using hydroelectricity instead of diesel in pumping water. This will prevent the constant water supply interruptions due to diesel shortages and will also allow the KDC to pump water 24 hours a day. The Government in-conjunction with ZESCO can help to do this.

III Rehabilitation of the water reticulation system

The water reticulation system in especially Kizhingezhinge and Muselepete need to be rehabilitated to ensure that all the houses are Supplied with safe drinking water.

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APPENDIX I (a)

Mean Monthly Water Levels in meters

		MONTH											
SEASON		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1994/5	DAILY MAX	0	0.283	0.526	0.633	0.695	0.784	0.784	0.660	0.544	0.520	0.451	0.284
	DAILY MIN	0	0	0.440	0.481	0.569	0.649	0.661	0.554	0.523	0.461	0.322	BG
	MEAN	0	0.137	0.463	0.536	0.632	0.702	0.712	0.618	0.539	0.515	0.479	0.256

		MONTH											
SEASON		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1997/8	DAILY MAX	0.284	0.512	0.669	0.692	0.730	0.872	0.696	0.564	0.535	0.529	0.519	0.505
	DAILY MIN	0	BG	0.544	0.561	0.592	0.718	0.576	0.536	0.529	0.522	0.511	BG
	MEAN	0.179	0.471	0.573	0.628	0.663	0.795	0.635	0.556	0.543	0.524	0.514	0.223

MONTH													
SEASON		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1998/9	DAILY MAX	BG	0.530	0.712	0.813	1.070	1.142	0.894	0.643	0.594	0.581	*0.713	*0.720
	DAILY MIN	0	BG	0.580	0.615	0.894	0.894	0.645	.0595	0.583	0.577	0.525	0.687
	MEAN	0	0.265	0.650	0.786	0.856	0.976	0.768	0.620	0.590	0.582	0.617	0.696

MONTH													
SEASON		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1999/00	DAILY MAX	0.672	0.691	0.719	0.818	0.863	0.913	0.781	0.662	0.642	0.634	0.579	0.503
	DAILY MIN	0.510	0.486	0.684	0.721	0.765	0.785	0.670	0.642	0.637	0.624	0.514	0.462
	MEAN	0.586	0.590	0.700	0.763	0.816	0.849	0.723	0.652	0.641	0.630	0.556	0.488

BG Means Below Gauge

Source: Kasempa District Council

APPENDIX I (b)

Analysis of Variance conducted on water levels for the 1994/5, 97/8, 98/9 and 99/00 seasons.

H_o = There is no significant difference in the mean water levels between seasons and between different months within each season.

H_1 = There is a significant difference in the mean water levels between seasons and between different months within each Season.

Formulas used:

$$S_w^2 = \frac{\sum\sum(x_{ij} - \bar{x}_{ij})^2}{n-k} \qquad S_b^2 = \frac{\sum n(\bar{x}_{ij} - \bar{x}_G)}{k-1} \qquad S_{tot}^2 = \sum(\sum x^2) - T^2/n$$

where, S_w^2= within group variance, S_b^2 = Between group variance, S_{tot}^2 = Total sum of squares
n= number of values, k= number of groups

$\bar{x}_G$ = group variance, x_{ij} =individual values with a group
$\bar{x}_{ij}$ =within mean group

$T_1 = \sum(x_1 - \bar{x}_1) = 5.589$, $T_2 = \sum(x_2 - \bar{x}_2) = 7.4060$, $T_3 = \sum(x_3 - \bar{x}_3) = 6.3040$, $T_4 = \sum(x_4 - \bar{x}_4)$, $T = T_1 + T_2 + T_3 + T_4$

$$S_w^2 = \frac{-0.0005-0.0004+0.3811-0.00004}{48-4} = 0.0086$$

$$S_b^2 = \frac{12(0.4658)+12(0.6172)+12(0.5352)+12(0.6662)}{4-1} = 9.1376$$

$$S_{tot}^2 = 17.5714-3.9527 = 13.6188$$

Sources of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F_{obs}
Between Variance	(K-1) 4-1=3	11.8581	3.9527	98.7838
Within Variance	(n-k) 48-4= 44	1.7606	0.04	
Total	(n-1) 48-1=47	13.6188		

$F_{0.5}$ =26.43 $F_{obs} > F_{crit}$ Ho was rejected.

APPENDIX II (a)

ANNUAL RAINFALL TOTALS IN MM

Station : Kasempa 01 KASEMPA MET 005

Year	Total	Valid Months	Valid Days
1950	1186.2	12	365
1951	1176.5	12	365
1952	1301.8	12	366
1953	1252.0	12	365
1954	987.0	12	365
1955	1134.9	12	365
1956	1482.3	12	366
1957	1149.6	12	365
1958	1174.0	12	365
1959	697.5	12	365
1960	1106.4	12	366
1961	1376.7	12	365
1962	1453.1	12	365
1963	1220.0	12	365
1964	987.3	12	366
1965	872.7	12	365
1966	1059.9	12	365
1967	1261.4	12	365
1968	1025.9	12	366
1969	1553.0	12	365
1970	1173.7	12	365
1971	1338.6	12	365
1972	767.8	12	366
1973	756.7	12	365
1974	1022.3	12	365
1975	1337.0	12	365
1976	1427.6	12	366
1977	1496.6	12	365
1978	1517.9	12	365
1979	1277.8	12	365
1980	1111.5	12	366
1981	911.0	12	365
1982	1018.1	12	365
1983	807.5	12	365
1984	928.1	12	366
1985	1095.7	12	365
1986	1231.0	12	365
1987	998.9	12	365
1988	1207.4	12	366
1989	1121.3	12	365
1990	1216.2	12	365
1991	1087.1	12	365
1992	1281.1	12	366
1993	1350.4	12	365
1994	678.4	12	365
1995	855.4	12	365
1996	1188.5	12	366
1997	1186.1	12	365
1998	1243.5	12	365
1999	1022.6	12	365

APPENDIX II (b)

AVERAGE MONTHLY RAINFALL TOTALS (IN MM)

STATION : Kasempa 01 Kasempa MET 005

Actual Number of Years: 50 Seasonal Mean: 1146.5

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Mean & Standard Deviation											
255.0	233.0	176.3	40.0	3.1	0.2	0	0.7	4.5	43.8	143.5	256.2
73.4	71.4	84.3	45.9	8.3	1.1	0	4.0	12.0	35.3	55.7	83.4
Highest Monthly (Value, Year)											
401.5	362.2	377.7	191.0	50.3	6.0	0	27.2	68.6	141.4	273.0	439.2
1989	1962	1969	1990	1976	1988	1950	1966	1958	1982	1971	1962
Lowest Monthly (Value, Year)											
102.6	98.3	22.8	0	0	0	0	0	0	0	24.1	83.9
1980	1972	1982	1954	1952	1951	1950	1950	1950	1956	1994	1981

Mean Monthly Rainfall

Season: 1994/5											
Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0	29.7	140.8	126.0	250.0	82.7	0	0	0	0	0	0
Season: 1997/8											
0	166.9	231.7	399.0	223.0	228.8	0	0	0	0	0	0
Season: 1998/9											
0	178.8	213.9	310.4	161.4	101.9	40.0	0	0	0	0	0
Season: 1999/00											
12.2	86.7	202.5	238.9	204.3	186.7	0	0	0	0	0	0

Source: Zambia Meteorological Department, Lusaka and Kasempa

APPENDIX III

PRODUCT MOMENT CORRELATION COEFICIENT
ON WATER LEVELS AND RAINFALL

A Product- moment coefficient was conducted the mean monthly water levels (on Appendix I) as the dependent variables and the mean monthly rainfall (on Appendix II (B) as the independent variables for the 1994/5,97/8, 98/9 and 99/00 seasons.

H_o = Water levels in the Lufupa rise and fall with the amount of rainfall received in the area.

H_I = Water levels in the Lufupa rivers do rise and fall with the amount rainfall received in the area.

Formulae used:

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\{ n(\Sigma x^2)-(\Sigma x)^2][n(\Sigma y^2)-(\Sigma y)^2]\}^{0.5}}$$

Where n = number of individual values, y= water levels, x= Rainfall
R= regression coefficient

Σx= 27.2930, $\Sigma x2$ = 17.5714, Σy=3873.0, Σy^2= 846,401.8, Σxy= 2554.5129, n=48

$$r = \frac{48(2554.5129)-(27.2930)(3873.0)}{\{ [48(17.5714)-(27.2930)^2] [48(846,401.8)-(3873)^2]\}^{0.5}}$$

$$r = \frac{16,910.8302}{50,247.170}$$

regression coefficient, r = 0.3366

coefficient of determination r^2 = 0.1133

APPENDIX IV

The University of Zambia

Geography Department

Domestic water supply in Kasempa

QUESTIONNAIRE FOR THE PUBLIC

Questionnaire Number:............. Residential Area:...................

A PERSONAL HISTORY

1. Sex: Male [ ] Female [ ]
2. Age:.........
3. For how long have you been living in Kasempa Township?.................
4. How large is your household?....................
5. Are you employed?...............................
6. What level of education did you attain?...........................

B. ADEQUACY AND RELIABILITY OF WATER SUPPLY

7. Where do you get your water supply from?
   [ ] Council (Piped) [ ] Own borehole
   [ ] Own well [ ] Other, specify............
8. In terms of water supply what is the level of service at your house?
   [ ] In-house waterborne [ ] Yard tap [ ] External waterborne
   [ ] Communal tap [ ] Aqua privy
9. For how many hours do you have water supply each day?....................
10. Do you experience any water shortages at home? [ ] Yes [ ] No
11. How often do these water shortages occur?
    [ ] Very frequently [ ] Not so often [ ] Not at all [ ] Can't tell
12. At what time of the year is the water supply most erratic?................
13. Is the amount of water supplied to your house adequate enough for all your domestic uses?........................
14. How would you rate the water shortage situation at your house?
    [ ]Severe [ ] Moderate [ ] No water shortages

C. RESPONSE TO WATER SHORTAGES

15. During the time of water shortages, do you have any other source of water?......

16. If so, what is your other source of water?..

17. How far is that other source of water from your house?...............................

18.Does the council impose any water rationing?...........

19. If so, for how long are you supplied with water each day?...............

20. What do you use the water at home for?
[ ]Cooking and bathing [ ]Cooking only
[ ]Watering the lawn [ ]Watering Garden [ ] Other,specify...................

21. When the water supply is to low or erratic, what measures do you put in place to ensure that you conserve the little amount of water available at home?...
....

22. Do you settle your water bills?
[ ] Always [ ] Not always [ ] never

23. If the answer to question 22 is never or not always, why don't you always settle you water bills?

....

D. SOLUTIONS TO THE INSUFFICIENT WATER SUPPLY

24. What do you think of the council's ability to provide adequate water supply for your use?

....
.

25. What should be done to solve this problem of inadequate water supply?

....

26. Do you favour the establishment of a commercial water utility in Kasempa?...........

27. Do you think the creation of a commercial water utility will solve the water supply problems in Kasempa? [ ] Yes [] No
Kindly explain,...
....