THE IMPACT OF POPULATION GROWTH ON WATER RESOURCES AVAILABILITY IN WESTERN DISTRICT, ZANZIBAR

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2019

CERTIFICATION

The Undersigned certifies that she has read and hereby recommends for acceptance by the Open University of Tanzania a dissertation titled: "***The Impact of Population Growth on Water Resources Availability in Western District, Zanzibar"*** in partial fulfillment of the requirements for the degree of Master of Arts in Natural Resources Assessment and Management of the Open University of Tanzania.

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Dr. Magreth S. Bushesha

(Supervisor)

……..

Date

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DECLARATION

I, **Salma Yahya Ayoub,** do hereby declare that, this dissertation entitled "**The Impact of Population Growth on Water Resources Availability in Western District, Zanzibar"** is my original work, and that it has not been presented and will not be presented to any other University or Higher learning Institution.

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Signature

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Date

DEDICATION

This dissertation is dedicated to my husband Hamdan J Rajab and my children Rahma Hamdan, Abdulrahim Hamdan and Nadeem Hamdan who supported me morally and materially during the entire period of this study. I also dedicate them for their love, prayers and patience.

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ABSTRACT

This study focuses on the impact of population growth on water resources availability in Western District, Zanzibar. It aimed to determine changes in domestic water resources from 1995 to 2015, examine the effects of population growth on domestic water resources and assess the effects of population growth on domestic water infrastructure. A field survey was conducted in three Shehias namely Chukwani, Kiembesamaki and Tomondo to collect data. Further, key informants were contacted to gather qualitative data. IBM-SPSS statistical analysis was used to analyze numerical data while content analysis was used to analyze qualitative data. The finding revealed that in Western District 78.8% of the households face domestic water scarcity because of rapid increase of population. Also, 79.3% of household's composition and age structure contribute on increasing demand for water. While 51.6% claimed that construction of new roads and expansion of the existing ones destroy water infrastructure, 51.3% viewed the destruction of water infrastructure being a result of ignorance of the community. The study findings showed that a water supply bill is needed for repairmen and maintenance of water resource infrastructure to cope with increased population. The study concluded that rapid population growth in Western District leads to the scarcity of domestic water. Finally, the study suggested the provision of education, involvement of local people in order to increase awareness on freshwater management at household level, capacity building and implementation of laws to improve water resources management in the study area. Furthermore, the study recommended further research to be undertaken for assessment of the impact of climate change on water resources.

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LIST OF ABREVIATIONS

DESA	Department of Economic and Social Affair
DWD	Department of Water Development
GIZ	Gesellschaftfür Internationale Zusammenarbeit
IBM-SPSS	International Business Machine-Scientific Package for Social Scientists
KIST	Karume Institute of Science and Technology
MDG	Millennium Development Goal
MENA	Middle East and North America
NGOs	Non-Governmental Organizations
PAI	Population Action International
PHC	Population and Housing Census
ULF	Ultra-Low-Flush
USA	United States of America
WHO	World Health Organization
ZAWA	Zanzibar Water Authority
ZPRP	Zanzibar Poverty Reduction Plan
ZSGRP	Zanzibar Strategy for Growth and Reduction of Poverty

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Water is a key element of life on Earth. As the world's population grows, the demand for water mounts and pressure on finite water resources intensifies. Climate change, which is also closely tied to population growth, also leads to greater pressures on the availability of water resources. The exact number of people living on Earth in the coming decades is uncertain, but we do know that the population will continue growing, and this will impact water availability. Investing in efforts that slow the rates of population growth through increasing access to voluntary family planning services, can help ensure that ample water is available for global food production, ecosystem health, and political and social stability.

1.2 Background of the Study

Though Zanzibar receives reasonably adequate rainfall, there are several phenomena that have been making water scarcity an increasingly pressing issue. Along with an influx of in migrants from Tanzania mainland, Zanzibar's population has steadily been growing by 3% annually (Hansson, 2010). This increase in consumers has led to an overuse of wells, which can lead to salt contamination if not properly managed.

Human population growth at global level has been in a continuous increase since the late seventeenth and early eighteenth centuries. The twentieth century witnessed an extraordinary growth of the world population from 1.6 billion to 6.1 billion people, an increase of 80 percent (DESA, 2001).

Max (2015) divided the World history into three periods, distinct trends in population growth. The first period (pre-modernity) was a very long age of slow population growth. The second period, beginning with the onset of modernity, was characterized by rising standards of living and improved health services, and lasted until 1962, and had an increasing rate of population growth. Now that period is over, and the third part of the history has begun: the population growth rate is falling and will continue to fall, leading to an end of growth before the end of this century **(**Max, 2015). The world population is currently growing at a rate of around 1.13% per year. The average population change is currently estimated at around 80 million per year.

2.2.1 Population and Water in Zanzibar

The rapid increase and growth of population in Zanzibar especially urban area contribute to the increasing demand for more service, especially water. Due to this situation Zanzibar has improved and expanded water supply service by the establishment of water authority in Zanzibar (PHC, 2002).

But the history of water sector in Zanzibar dates back to the beginning of the 20th century, when a system supply water from Bububu and Mtoni springs to the Stone town of Zanzibar town was built. After 1960's the demand increased rapidly, due to the increasing number of population in Zanzibar. To cope with the situation, the water department developed new water sources, the number of bore holes in Unguja and Pemba today is more than 150. By 1990 ten boreholes, seven springs and one cave, were used as urban water supply intakes in the two islands (Mabumba, 1997). The government aimed at achieving universal access to clean and safe drinking water, they viewed clean and safe water as a basic need and fundamental right to every citizen.

It is generally acceptable that, the difficulties Zanzibar faced in fulfilling the goal of water sector together with other related development which started in 1980's may have been related partly from short comings in management, administration and resource constraints but much more Significantly the failure reflected on the fundamental economic setback which resulted from global recession, tremendous increase in price of fuel and the decline of world market demand of cloves (Mabumba, 1997).

The old aged machinery and equipment, frequent break down of machines and lack of spare parts are major problems affecting water, all of which are a function of inadequate financial resources, both local and foreign exchange. Nowadays the management of water resources fails due to urban population expansion which is more pronounced in developing countries and Zanzibar in particular, as a result of immigration from rural to urban area.

The urban water supply of Zanzibar shifted from direct ministry and agency control under the DWD to the Zanzibar Water Authority (ZAWA), which became a public corporation in August 2006. In line with that shift, institutions are now being developed to establish a system for collecting water charges. However, since no water charges have thus far never been collected from ordinary households, the country faces such challenges as switching to an organizational culture oriented toward customer service, establishing a practical system for collecting water charges, stepping up the management aspect of the water supply business, and motivating residents to pay the charges.

Saltwater intrusion problems are widespread where there are over pumping of groundwater from coastal aquifers. Water samples were collected from production boreholes in Zanzibar municipality and analyzed for salinity indication parameters comprising of chloride, electrical conductivity, total dissolved salts and percentage salinity levels.

1.3 Statement of the Research Problem

Growth in populations means mounting demand and competition for water for domestic, industrial, and municipal uses. Water is also needed for agriculture and industrial use, and for the evacuation of waste materials. Water management and population growth have been a great concern in Tanzania in general and Zanzibar in particular, and have received a great attention from both the government and individuals.

On the bases of these concerns many related policies including National Water Policy for Zanzibar which aims to improve the social wellbeing of the population and enhance the performance of the economy by ensuring equitable provision of adequate and reliable water and sanitation services, the Zanzibar Development Vision 2020 and Zanzibar Poverty Reduction Plan 2002 Policy Frame Works which aim to reduce poverty and improve living standards through sustainable development, including investment in basic economic and social infrastructure, such as water and sanitation facilities that is to ensure efficient, affordable and high quality water supply and services provision reveal the problem of water demand is not being met and some sources are contaminated, while access to water for Zanzibar's population has increased, the supply is still low in certain districts so the path of future population

growth and its impact to water availability and scarcity will largely depend on size of families and the family planning services, urbanization or rapid urban expansion. Because the growing population requires more food, more water will be needed for agricultural productivity and that will put more pressure on water resource. This indicates that, the number of population in Zanzibar is a hindrance to sustainable water resources management in the Islands. Yet the available literature is short of information regarding the extent to which population growth in Zanzibar is impacting water resources management in the Island; this is the reason why the researcher proposes a conduct of this research work.

1.4 Research Objectives

1.4.1 General Objective

The main objective of this research is to assess the impact of population growth on water resources availability.

1.4.2 Specific Objectives

(i) To examine the changes in domestic water sources since 1995 to 2015 for

(ii) Western district.

(iii) To examine the effects of population growth on domestic water resources.

(iv) To investigate the effects of population growth on domestic water infrastructure.

1.5 Research Questions

This research answered the following questions

(i) What are the changes in domestic water sources since 1995 to 2015 in Western District?

(ii) What is the effect of population growth on domestic water resources?

(iii) What are the effects of population growth on domestic water infrastructure?

1.6 Significance of the Study

The accomplishment of this study is expected to be useful to environment managers and conservers by expanding an understanding on the conservation strategies. The result is expected to provide more insight on the impact of population growth and water management and therefore may not only be useful for various environmental decision makers but also to other related stakeholders for sustainable development. The research will also help to keep awareness to all people, politicians, policy makers, non-governmental organization, on proper way to protect water sources for future generation. The research also will propose solutions on recommendation that could be used to reduce the effect of population growth to water resource. Above all, this study will expand the body of knowledge that already exists in the issue of water in Zanzibar, and therefore it can be taken as a primary or supplement reference on the future research studies.

1.7 Limitation of the Study

The research process possibly suffered from various setbacks that hindered the whole process of data collection. Some of the limitations were:

Poor responses, especially those who were the primary source of data. This happened when the time of data collection was not well considered. For example, lunch time

was not proper time for data collection. So to ensure the availability of good responses, time was checked.

1.8 Organization of the Study

This dissertation is organized into five chapters. The introduction chapter presents the background to the research problem, the statement of the research problem as well as research objectives and questions. Literature review is presented in chapter two where different studies were reviewed with a focus on the impact of population growth on water resources availability in general and Western District in particular. Chapter three focuses on research methodology used in this study. Chapter four presents the findings obtained from the field and discussion related to the specific objectives. Finally, chapter five presents conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the review of literature related to this study. The chapter is divided into three parts. The first part presents definition of the concepts, while the second part presents the literature review of the theory and the empirical literature review together with review of policies. The last part gives the conceptual framework and research gaps in the reviewed literatures to mark the rationale for conducting this study.

2.2 Definition of the Concepts and Terms

Some of the key concepts that are involved in this literature review include the following**:**

2.2.1 Population

Population refers to the total number of human inhabitants of a particular area, such as city, village, country or continent at a given time (URT, 2012). In statistics and other areas of mathematics, population is a discrete group of people, animals or things that can be recognized by at least one common characteristic for the intention of data collection and analysis (Microsoft Encarta Encyclopedia, 2009).

2.2.2 Population in Tanzania

The United Republic of Tanzania is a union of Tanganyika (Tanzania Mainland) and Zanzibar (Tanzania Zanzibar). According to the National Population Policy of 1992, in 1995, the population of Tanzania was estimated to be 28.9 million. The population

has more than doubled since 1967 when it was 12.3 million. Comparable figures for the 1978 and 1988 census were 17.5 million and 23.1 million, respectively. At the national level, population growth is mainly due to natural increase that is the differences between births and deaths. The decline of the national rate of population growth is supported by findings of the Tanzania Demographic and Health Survey (1991/92) and the Tanzania Knowledge, Attitude and Practices Survey (1994).

The 2012 Population and Housing Census (PHC) revealed that, the population of Tanzania has grown from 12,313,469 persons in the 1967 Census to 44,928,923 persons counted in 2012. The population of Tanzania has more than tripled from 12.3 million in 1967 to 44.9 million in 2012.

The National Bureau of Statistics, Tanzania reported that, the total population in Tanzania was last recorded at 47.4 million people in 2014, with 947,300 square kilometers of land; Tanzania is the 23rd largest country in the world and the 13th largest in Africa. This, in combination with the total population, equates to a population density of approximately 62 people per square kilometer. The population is now estimated at over 58.01 million, as Tanzania has one of the highest birth rates in the world and more than 44% of the population is under the age of 15. The total fertility rate is 5.01 children born per woman, which is the 17th highest of any country, (World population Prospect 2019).

2.2.3 Population of Zanzibar

It is composed of the Zanzibar Archipelago in the Indian Ocean, 25–50 kilometers (16–31 mi) off the coast of the mainland, and consists of many small islands and two

large ones: Unguja (the main island, referred to informally as Zanzibar) and Pemba. The capital is Zanzibar City, located on the island of Unguja. Its historic center is Stone Town, which is a World Heritage Site. According to the Population and Housing Census (2012), the population of Zanzibar has grown from 1967 (0.4 million) to 2012 (1.3 million).

In Tanzania Zanzibar, there are five regions in Zanzibar (two in Pemba and three in Unguja) the region with the largest population was Urban West (593,678) which accounts for 46 percent of the total population of Tanzania Zanzibar and covers an area of 88.8 mi^2. The region with the smallest population was South Unguja with a population of 115,588 and the highest population number is recorded in urban west region 593,678 (PHC, 2012).

The average annual growth rate for Zanzibar were 2.7% for 1967-1978, 3.0% for 1978 – 1988 and 3.1% for 1988 – 2002, and the number of people per square kilometer of the land area differs from region to region (PAI, 2011). Zanzibar West District is one of the two districts of the Zanzibar Urban/West Region of Tanzania. It is bordered to the north by the Zanzibar North Region, to the east by the Zanzibar Central/South Region, to the south by Kiwani Bay, and to the west by the Zanzibar Urban District. As of 2002, the population of the Zanzibar Western District was 184,710 (PHC, 2002).

For parliamentary elections, Tanzania is divided into constituencies. As of the 2010 elections the area for Zanzibar Western District had nine of the nineteen constituencies in the region: Bububu, Dimani, Dole, Fuoni, KiembeSamaki,

Magogoni, Mfenesini, Mtoni and Mwanakwerekwe Constituencies. As of 2002, Zanzibar Western District was administratively divided into twenty-nine wards.

2.2.4 Population Growth

Population Growth refers to the change in population over time and can be quantified as the change in the number of individuals in a population using "per unit time" for measurement (NBS, 2012). According to Kamili (2009), population growth is the growth in size of the population. Population is dynamic phenomena which experience changes all the time; it includes change in number, distribution, structure and movement. It is calculated by taking into account the birth rates and death rates. Hence it can be calculated as natural population growth (difference between birth and death rate) or numerical population growth (the actual increase of the number of people in an area within a given period, calculated by getting the difference between two consecutive censuses).

2.2.5 Water

The Book of Population Science, Vol. 2 (1972) defines water as compound of H_2O combining two atoms of hydrogen with one of oxygen. It takes the form of solid, liquid or gases, atmospheric pressure of 14.7 pounds per square inch; it solidifies when cooled to 32^0F and boils at 212^0F. Water is the liquid that descends from the clouds as rain, forms streams, lakes, and seas, and is a major constituent of all living matter and that when pure is an odorless, tasteless, very slightly compressible liquid oxide of hydrogen H_2O which appears bluish in thick layers, freezes at 0°C and boils at 100°C, has a maximum density at 4°C and a high specific heat, is feebly ionized to

hydrogen and hydroxyl ions, and is a poor conductor of electricity and a good solvent. (Merriam-Webster, 2015).

2.3 Theoretical Literature Review

2.3.1 Karl Marx's Theory

Karl Marx’s theory states that, population growth is a symptom rather than a cause of poverty, resource depletion, pollution and other social problems. He believed that social exploitation and oppression of the less privileged people lead to poverty, overcrowding, unemployment, and environmental degradation that in turn, cause over population. He observed that starvation was caused by imbalanced allocation of wealth and its growth by capitalists. In relation to population, Karl Marx commented that population depends on social and economic organization. According to him, the problem of overpopulation and limits to resources as enunciated by Robert Malthus, are natural and predictable features connected with the capitalist system of production (Dupree, 1977).

Karl Marxs theory has tried to show that, many problems toward natural resources such as starvation, poverty, unemployment, resources depletion and pollution are caused by the imbalanced distribution of the wealth and its accumulation by capitalists. However, this theory forgets the implication of overpopulation on natural resources which lead overutilization of the resources, hence affects the availability of resources such as water resource.

2.3.2 Ester Boserup's Theory

This theory considered population growth as a catalyst for agricultural intensification and development of more sustainable ways of resource management. Boserup drew

the knowledge of farming in the developing countries where the populations were growing rapidly. The model illustrated that, the threat of hunger and the challenge of feeding more mouths motivate people to improve their farming methods and invent new technologies in order to produce more food. She also suggested that population growth and resulting increased population density induce technological changes, such as the use of plough or fertilizer, which allow food production to keep pace with population growth. Thus, population could actually stimulate agricultural intensification. Boserup's theory seemed to provide a model for continuous population growth, as modern environmentalists, scientists and politicians debated the future of the world's climate and resources. Her observation was of significance.

The amount of resources available such as land was fixed, and did not make allowance for other responses to increased population growth such as trade, migration of people and conquest. The environment has a limit that restricts population. It has limits, which could be changed using technologies. Population growth was generated for innovation to allow food supply to increase.

However, this model fails to elucidate the impacts of innovation applied due to population increase, which depleted resources overly. Also, did not cover the impacts of population growth on water resource availability especially in western district. It is with this view this study comes into disclose such a gap.

2.3.3 Malthusian Theory

The Malthusian theory comes in connection to the study by explaining the relationship between the growth in food supply (resources) and in population. It states that

population increases faster than food supply and if unchecked leads to vice or misery. According to the model, there is a natural sex instinct in human beings to increase at a fast rate. As a result, population increases in geometrical progression and if unchecked doubles itself every 25 years. Thus starting from 1, population in successive periods of 25 years will be 1, 2, 4, 8, 16, 32, 64, 128, and 256 (after 200 years) (Smith & Knill, 2008). On the other hand, the food supply (resources) increases in a slow arithmetical progression due to the operation of the law of diminishing returns based on the supposition that the supply of land is constant. Thus the food supply in successive similar periods will be 1, 2, 3, 4, 5, 6, 7, 8, 9 (after 200 years).

Therefore, since population increases in geometrical progression and the natural resources like food supply, land and water increases in arithmetical progression, population tends to outrun food supply (resources). Thus, as the rapid population growth reaches a serious point and exceeds the carrying capacity resulted in depletion of natural resources, which leads to scarcity of resources due to over-population (Smith & Knill, 2008).

The Malthusian theory evidenced that, rapid increase in population pose severe impacts on the natural resources. However, the link between population growth and natural resources is too general and model fails to explain on how population growth affects natural resources particularly water resource availability. Similarly, the theory did not touch the situation of western district, therefore, this study intend to expose the real situation by instigating the impacts of population growth on water resource availability in western district.

2.4 Empirical Literature Review

Empirical literature review encompassed the existing performance of water supply; from this part, there are water supplies in the world, Africa, Tanzania and historical water supply policy of Zanzibar and how it influenced water supply. There is also the current water supply policy of Zanzibar.

2.4.1 Water Supply in the World

Nagle, (2003), demonstrates that, water supply depends on several factors in the water cycle. Currently, the quantity of water used for all purposes exceeds 3700km^3 per year. The world's available fresh water supply is not distributed evenly around the globe, either seasonally or from year to year. About three quarters of annual rainfall occurs in areas containing less than one third of the world's population, as where two-thirds of the world's population live in the areas receiving only one quarter of the world's annual rainfall.

For instance about 20% of the global average runoff each year is accounted for by the Amazon basin, a vast region with fewer than 10 millions people. Similarly, the Congo Basin account for about 30% of Africa's annual runoff, but less than 10% of its population (Nagle, 2003). The major challenges that face water supplies in the world is Population growth and Climate Change. Around fifty years ago, the common perception was that, water was an infinitive resource.

At that time, there were fewer than half the current number of people on the planet. Today, the competition for water resource is much more intense. This is because there are now 7 billion on the planet, their consumption of water rising and there is

increasing competition for water for industry, urbanization, bio fuel crops, and water reliant food items. Thus water demand will increase unless there are corresponding increase in water conservation and recycling of this vital resource.

Climate change could have significant impacts on water resources around the world, because of the close connections between the climate and hydrological cycle. Rising temperature will increase evaporation and lead to increase precipitation, though there will be regional variation in rainfall. Overall, the global supply of fresh water will increase. Both drought and floods may become more frequent in different regions at different times and dramatic change in snowfall and snow melt are expected in mountainous areas. Higher temperature will also affect water quality in ways that are not well understood. Climatic change could also mean an increase in demand for farm irrigation, garden sprinklers and perhaps even swimming pools. There is now ample evidences that increased hydrologic variability and change in climate has and will continue have a profound impact on the water sector.

2.4.2 Water as a Natural Resource

Water is the most abundant environmental resource covering more than 70 percent of the earth surface. Most of this (more than 97%) is salt water (ChapMan & Maher 1995). Water is also a finite resource and of the huge global volume less than 8 percent is readily accessible, the rest is stored in saline oceans or deep below the land surface or in the polar ice caps (Bishop & Prosser 1995). In broad sense water is a renewable resource, because it is continuously delivered to the land by the hydrological cycle, which refers to the movement of water between atmosphere, lithosphere and biosphere. Water moves through this cycle in all its three forms solid,

liquid and gases. The majority of fresh water forms its arrival as a precipitation such as rain, snow, hail until its departure back into atmosphere or into the oceans. This journey may cost a few minutes or thousands of years, this means, although water is a finite resource, it is also a renewable resource, (Bishop & Prosser 1995).

Much of the water which falls on the earth surface is stored as ground water. Reservoirs of ground water are naturally filled by seepage from the surface and underground flows at the rates, which depend on the permeability of the country rock and soil. It takes many thousands of years for the equator to be filled with underground water, which sounds a warming that, the use of underground water should be taken with great precautions. According to the Gale Encyclopedia of Science (2008), it has been estimated that the global groundwater resource is equivalent to about 34 times the volume of all surface waters (i.e., rivers and lakes) of the world. This resource is present nearly everywhere and has the additional advantages of typically needing no storage or treatment. Utilization does require the construction of a well, sometimes presenting a problem in the neediest locations.

When the rate of withdrawal of ground water exceeds the rate of recharge over a period of time, the water table falls. Water consumption varies greatly among regions due to differences in economic development. The Gale Encyclopedia of Science (2008) reveals that, the average municipal use in the United States is about 150 gal (568 l) per person per day, though the rate can be higher than 350 gal (1324 l) in some locations. This includes home use for bathing, waste disposal, and gardening, as well as institutional and commercial usage. Per capita (per person) water usage in Asia is only 22 gal (85 l) per day, and just 12 gal (47 l) in Africa. This may raise the cost of

drilling wells and pumping water. It may become totally uneconomical if the water table is too far below the surface. In such instances water becomes a non-renewable resource because it cannot be mined easily (Mnobile, 2000).

2.4.3 Water Supply

From Gardner (1931) water supply is the provision of water by public utilities, commercial organizations, community endeavors or by individuals, usually via a system of pumps and pipes Water supply systems get water from a variety of locations, including groundwater (aquifers), surface water (lakes and rivers), conservation and the sea through desalination. The water is then, in most cases, purified, disinfected through chlorination and sometimes fluoridated. Treated water then either flows by gravity or is pumped to reservoirs, which can be elevated such as water towers or on the ground (for indicators related to the efficiency of drinking water distribution. Once water is used, wastewater is typically discharged in a sewer system and treated in a sewage treatment plant before being discharged into a river, lake or the sea or reused for landscaping, irrigation or industrial use.

2.4.4 Population and Resource

Resources are features in the environment that are needed and used by people. The term usually is applied to natural features that occur in the air, water or on land. Although some time it is widened to include human resource, i.e. people, (Gardner & Waugh, 1999). Population and resource are so interrelated since they both affect each other. Human life depends on the ability of the resource to sustain it, and human has some impacts on the existence of sustainability of the resource. So the number of people, distribution, the structure of population, the ability of the resource to sustain it

and the techniques of production used are so important aspects when considering the population and resource relationship. On this bases the area can be said to be having optimum population (number of people is in balance with available resources), or under population (too few people compared to the available resources) or over population (too many people in relation to resources and technology available), (Kamili 2009). This depends on the extent to which the resources are used and the way in which they are used.

2.4.5 Water Resource Management

Water resource management is the activity of planning, developing, distributing and managing the optimum use of water resource. It is a subset of water cycle management. Ideally water resource management planning has regard to all the competing demands for water and seeks to allocate water on an equitable basis to satisfy all use and demands. As with other resources management, this is really possible in practice, (Arizona Department of Water Resource).

2.4.6 Relationship between Population Growth and Water Resource

Growth in population means mounting demand and competition for water for domestic, industrial and municipal uses. Water is also needed for agriculture and industrial uses and for the evacuation of waste materials. Population growth is a major contributor to water scarcity. The most water scarce or stressed areas are typically those with few water resource, high population densities and high population growth rate.

Warren Viessman (n.d) clarifies that, Population is highly correlated with public water supply, about 56 percent of which is allocated for domestic (household) purposes.

According to the U.S.A Geological Survey, the average per_capita public water use in the United States in 1995 was about 179 gallons per capita per day (gpcd) and that for domestic_water use was about 101 gpcd. An average per capita figure for all water uses in the United States in 1995 (municipal, industrial, agricultural, etc.) was estimated to be about 1,280 gpcd. The U.S. population in 2000 was about 275.6 million.

Projections by the Population Research Bureau indicate a 2025 population of 373.8 million and a 2050 population of 403.7 million. The bureau also reported that the doubling time from the year 2000 for the population of the United States, at its current rate of growth, is about 120 years, for the world 51 years, and for the less developed countries, including China, 36 years. The importance of these estimates can be seen when one notes that about 81 percent of the world's current population resides in less-developed countries.

2.4.7 Impact of Population Growth to Water Resource Management

Population growth limits the amount of water available per person, drives people to marginal regions which are already water stressed and also into cities. For instance most of the countries in the Middle East and North America (MENA) region cannot meet their current water demand. Seven of the world’s 10 water scarce countries are in the MENA region. The path of future population growth will impact water stress and scarcity. This path will largely depend on the choices that men and woman make today about the size of their families and the family planning services that are available to them as they make these choices.

A growing population requires more food. More water is needed to produce that food. Agricultural productivity and hunger are closely interrelated. Population growth along with development, will double global food demand by 2050. This will require increased agricultural production and put increased pressure on water resource. Urbanization leads to increased pressure on water sources as individual become more concentrated in one area.

Further increases in per capita water consumption, driven by development, intensify water demand and strain local water capacity. Although the water withdrawal of domestic and municipal uses globally accounts for a modest part of total water use, they are going rapidly, especially as a result of population growth in urban areas of developing countries. Demand for water for industrial use is increasing with rapid industrialization to meet the many needs of a growing population and the destruction of water plants occurs due to construction of industries etc. At the household level, demand for water is determined by demographic factors including household size, composition and age structure. Population growth leads directly to increase in an overall water demand.

2.4.8 Contamination of Water

The majority of human require fresh water, but water faces a big problem of pollution. According to Mzezele & Kibuuka (2009). Water pollution refers to the introduction of harmful substances into water bodies. Water pollution is one of the main concerns of world today. The government of the numerous countries has striven to find solution to reduce this problem. Many pollutants threaten water supplies, but the most widespread, especially in developing countries, is the discharge of raw sewage into

natural water. This method of sewage disposal is the most common method in underdeveloped countries. The main sources of water pollution as demonstrated by Mzezele & Kubuuka 2009, are industrial wastes, domestic waste, agricultural chemicals, oil spills and extensive construction.

2.4.9 Contamination and Population Growth

For the past two thousand years, the human population has exhibited a J-shaped pattern of growth (Southwick, 159). This exponential population proliferation has been coupled with the growth of cities and industrialization. Together, these trends have posed increasing difficulties of water quality control. The causes of water pollution range from all corners of industrial sectors and continue to be amplified by the dense populations concentrated in urban centers.

2.4.10 Domestic and Municipal Pollution: The Overpopulation Problem

Part of the water pollution problem stems from high population growth and the consequent need for expanded food production. In order to increase crop yields, farmers rely on use of insecticides, herbicides, and fertilizers. Most insecticides, such as chlorinated hydrocarbon DDT, are non-biodegradable. These materials adhere strongly to the soil, and most water contamination is due to the soil being eroded and washed into the surface bodies of water (Morton, 1976). Through the process of bioaccumulation, the fat-soluble chemicals accumulate in the fat of many organisms (such as fish), and can have damaging ecological effects. The growing demand for food also affects the livestock industry and presents the problem of animal wastes. Farm animal wastes are forms of organic matter, and runoff into a receiving body of water can overload it with nutrients. The abundant nutrient promotes the rapid growth

of algae and weed species, causing the depletion of oxygen resources of a lake or stream (Morton, 1976).

Another cause of water pollution is the continuous growth of cities, which has become a pattern of the population growth trend. A “disproportionate share” of population growth occurs in the world’s cities (Southwick 1996), which are “parasitic” to the surrounding landscape. If cities were covered by giant plastic domes, they would suffocate in a matter of days from their own toxic products (Southwick, 1996). A growth in population, especially that of a city, increases the volume of used water carried by the urban drainage systems, which are frequently discharged into the nearest river or lakes without complete sewage treatment (United Nations, 2). A 1976 statistic reported that of the raw domestic sewage that enters the municipal sewage treatment plant, about 99.9 percent consisted of water and only 0.1 percent consisted of impurities (Morton, 1976).

Though this statistic is outdated, it is still relevant and applicable based on our unchanged ways of life. It is common practice to let the water run, for instance, to rinse a glass before we fill a drink with it and after that we take the drink. Our daily showers, which first require to let the cold water out before it is heated, are followed by lengthy relaxation in the shower after we are already clean. This diluted sewage makes it more difficult to remove pollutants than if the impurities were present in a small volume of water, as most treatment processes depend on differences in concentration, temperature, pressure, or density for their operation. As a result, the water that leaves the sewage treatment plant is not as effectively or thoroughly removed of contaminants. In addition, city sewers are unequipped to handle both

storm runoffs and sanitary wastes during the rainy season. This causes the two to mix and overflow into the nearest lake, stream, or ocean without being treated (Morton, 1976).

Non-point pollution is also a major contributor to the contamination of water sources, and can be attributed to urban runoff due to city landscape and living as well as landfill sites. Urban runoff consists of residues, wastes, and natural products that are washed from the streets and lawns by rain into storm drains. It includes everything from dirt, dust, leaves, fertilizer and soil from lawns, pet wastes, automobile oil and grease, to salt from the salting of roads in the winter which causes a spike in salt level in surface waters.

These potentially hazardous pollutants are emptied into a receiving body of water without being properly neutralized. Another prominent source of non-point pollution are solid waste land disposal sites. Precipitation falling on a site can become runoff, and the percolation of water through the pile of refuse and waste can generate leachates (Miller, 1980, 147-149,). Leachates from landfills are usually acidic with a high concentration of metal ions and can pollute open bodies of water as well as ground water sources. The potential for water pollution through urban runoff is proportional to population growth as both increase in conjunction with one another. As population numbers rise, so do the number of people inhabiting cities. This inevitably corresponds to a rise in the total number of cars, pets, lawns with fertilizer, and detergent used (just to name a few)- all of which contribute to the increased presence of pollutants.

2.4.11 Industrial Pollution: The Industrialization Problem

In addition to J-shaped population growth, another trend is growing industrialization. Southwick points out that the most industrialized countries (such as Japan, the United States, and those in western Europe) have reduced birth rates and show population growth rates of 0.6 percent or less (Southwick, 163); however on a global scale, both total population size and total industrialization exhibit an upward growth. Since the Industrial Revolution, industrialization has only grown and become more prominent in modern global society. The mechanization of industries and technological innovations have become fixtures in our culture, but at the price of higher pollution levels. The pollution of streams, rivers, and the seas is increasing, owing mainly to the development of industry, which uses water in its production processes (United Nations, 1). Because of this extensive industrialization, every good and material made comes with a waste product, which in some cases literally outweigh the amount of good produced (ENVS, 2007).

2.4.12 Effects of Water Pollution

It has been suggested that water pollution is the leading worldwide cause of deaths and diseases and that it counts for the deaths of more than 14,000 people daily. In addition to the acute problems of water pollution in developing countries, developed countries also continue to struggle against pollution problem, all because of the increasing number of people which continue to occur worldwide.

2.4.13 Future Population Levels.

Population in the world is currently (2019-2020) growing at a rate of around 1.08% per year (down from 1.10% in 2018, 1.12% in 2017 and 1.14% in 2016). The current

average population increase is estimated at 82 million people per year. (World Population Prospects. 2019 Revision).

According to the World Population Prospects (2019 Revision) annual growth rate reached its peak in the late 1960s, when it was at around 2%. The rate of increase has nearly halved since then, and will continue to decline in the coming years. World population will therefore continue to grow in the 21st century, but at a much slower rate compared to the recent past. World population has doubled (100% increase) in 40 years from 1959 (3 billion) to 1999 (6 billion). It is now estimated that it will take another nearly 40 years to increase by another 50% to become 9 billion by 2037.

If population projections prove to be reliable, many regions of planet Earth will be facing significant water_shortages within the next 50 years. If the 1995 figure of 1,280 gpcd for all water uses in the United States is multiplied by the bureau's estimate of population in 2025, a rough estimate of water use in that year would be about 508 billion gallons per day. Although uncertainty exists in the population forecast, and technological changes and conservation practices could likely reduce the overall per capita water use in the future, significant increases are expected in population related water use. However, in the United States, large increases in water use may not be possible or sustainable unless water is imported or brackish or saline waters are desalinized.

2.4.14 Future of Water Resource

One of the biggest concerns for our water based resource in the future is the sustainability of the current and even future water resource allocation. As water

become scarce, the importance of how it is managed grows vastly. Finding a balance between what is needed by human and what is needed in the environment is an important step in the sustainability of water resource.

The field of water resource management will have to continue to adapt to the current and future issues facing the allocation of water, with the growing uncertainties of global climate change and long term impact of management actions, the decision making will be even more difficult. It is likely that ongoing climatic change will lead to situations that have not been uncounted. As a result new management strategies will have to be implemented in order to avoid setbacks in the allocation of water resources.

2.4.15 Population Impacts on Future Water Sources

The impacts of population on the quantitative water needs of a locality are related to population density (that is, how the population is distributed geographically), and to the rate of increase or decrease in population growth. Because population changes affect such variables as the economy, the environment, natural resources, the labor force, energy requirements, infrastructure needs, and food supply, they also affect the availability and quality of the water sources that can be drawn upon for use.

The impact of population on the ability of water sources to meet the demands placed on them by society is paralleled by the effects of population on the quality of water resources. People alter the properties of water as they use it, often degrading the quality with each successive use. Water used in households for drinking, bathing, and cooking becomes contaminated by various chemicals and other constituents

introduced during its use. Drainage from water applied in agricultural irrigation carries away chemicals that have been applied to crops to enhance their growth and control weeds and pests. Industries introduce chemicals needed for the manufacture of their products.

As a result of human intervention, waters that have been used for a variety of purposes may contain harmful constituents, including sewage, that pose threats to the environment and to the public health. Their removal can be expensive and difficult. Issues of water quantity and water quality are inseparable. If the quality of a water source is so degraded that restoring its quality for further use is not feasible, then the source is lost for all practical purposes. Remedial actions are costly, and prevention rather than remediation should be the goal. To achieve it, the public, industries, governments, agencies, and a variety of organizations must all play a positive role.

2.4.16 Reducing Population Impacts

The impacts of future populations on the amount and quality of water resources available for use can be lessened by modifying the local rate of population increase, by modifying the per capita use of water, and by a combination of the two approaches. A reduction in the per capita use rate for public water has already been demonstrated in the United States. Per capita use decreased from 184 gaped in 1990 to 179 gaped in 1995 even though the nation's population increased by 7 percent during that period. Education can play a major role in bringing about such changes.

Water-stressed regions should seek to slow their population growth and reduce their per capita water use to help alleviate their water supply problems. In general,

developing nations are growing faster than industrialized nations. Between 2000 and 2050, most all of the world's population growth is projected to take place in developing nations. A reduction of population growth rate in these nations could significantly enhance the likelihood of achieving sustainability for their water supplies.

2.4.17 Water Supply in Africa

Africa faces huge challenges with multiple issues that adversely affect public health. One major challenge is the ability for both rural and urban Africans to access a clean water supply. According to the WHO (2006), only 59% of the world's population had access to adequate sanitation systems, and efforts to achieve the Millennium Development Goal, which is aiming for 75% by the year 2015, will fall short by nearly half a billion people.

The situation of access to clean water and sanitation in rural Africa is even more dismal than the previous statistics imply. The WHO (2006) stated that, in 2004, only 16% of people in sub-Saharan Africa had access to drinking water through a household connection (an indoor tap or a tap in the yard). Not only is there poor access to readily accessible drinking water, even when water is available in these small towns, there are risks of contamination due to several factors. When wells are built and water sanitation facilities are developed, they are improperly maintained due to limited financial resources. Water quality testing is not performed as often as is necessary, and lack of education among the people utilizing the water source leads them to believe that as long as they are getting water from a well, it is safe. Once a

source of water has been provided, quantity of the water is often given more attention than its quality of water (Awuah et al., 2009).

There are limited sources of water available to provide clean drinking water to the entire population of Africa. Surface water sources are often highly polluted, and infrastructure to pipe water from fresh, clean sources to arid areas is too costly of an endeavor. Groundwater is the best resource to tap to provide clean water to the majority of areas in Africa, especially rural Africa, and groundwater has the benefit of being naturally protected from bacterial contamination and is a reliable source during droughts.

However, the high costs associated with drilling for water, and the technical challenges in finding sources that are large enough to serve the population in need, present challenges that limit tapping the resource. Groundwater is not a fail-safe resource, either, when it comes to providing clean water. There may be contamination of the water with heavy metals, and bacteria may be introduced by leaking septic systems or contaminated wells. For these reasons, it is important that groundwater be monitored frequently, which is costly and requires technical abilities that may not be present in rural areas (Awuah, et al., 2009).

The implications of lack of clean water and access to adequate sanitation are widespread. Young children die from dehydration and malnutrition, results of suffering from diarrheal illnesses that could be prevented by clean water and good hygiene (Metwally et al., 2006). Diseases such as cholera are spread rampantly during the wet season. Women and young girls, who are the major role-players in accessing

and carrying water, are prevented from doing income-generating work or attending school, as the majority of their day is often spent walking miles for their daily water needs. They are also at an increased risk for violence since they travel such great distances from their villages on a daily basis, and are even at risk when they must go to the edge of the village to find a private place to relieve themselves.

Urban areas face a whole different host of challenges to providing clean water and sanitation. Rapid growth of urban areas, especially in sub-Saharan Africa, has led to large volumes of water being extracted from existing sources. The influx of water, in addition to the influx in human waste, has outpaced the development of wastewater management systems, which has led to pollution of natural water bodies, unintentional use of wastewater in irrigated agriculture, irregular water supply, and environmental concerns for aquatic life due to the high concentration of pollutants flowing into water bodies (Van et al, 2009, cited in Lori Lewis (n.d).

Overcrowding in urban slums makes it even more difficult to control sanitation issues and disease outbreaks associated with exposure to raw sewage. It has been reported that underprivileged urban populations pay exorbitant amounts of money for water, which is often not even suitable for consumption, while resources allocated to those living in wealthy urban areas are heavily subsidized, meaning the wealthy pay less for cleaner water and better sanitation systems (Fotso *et al*., 2007).

2.4.18 Water Supply in Tanzania

According to WHO/UNICEF, slightly more than half the population of Tanzania is estimated to have access to an improved_water_source, with stark differences between

urban areas (about 79% in 2010) and rural areas (about 44% in 2010). In rural areas, access is defined as households have to travel less than one kilometer to a protected drinking water source in the dry season. Trends in access to water supply are difficult to discern due to conflicting and unreliable data. However, it seems that access increased during the 1990s, particularly in rural areas, but stagnated during the 2000s.

According to data from the Household Budget Surveys 2000/2001 and 2007, access to an improved water source in mainland Tanzania even decreased from 55% in 2000 to 52% in 2007. Using a narrow definition, in 2007 around 34% of households had access to piped water, as opposed to 40% in 2000. However, using a broader definition of access that also includes standpipes and protected springs, there has been a slight increase in the proportion of households reporting a drinking water source within one kilometer.

Estimates from the Joint Monitoring Programmer for Water Supply and Sanitation (JMP) show a different trend. They show a slight decline in access from 55% in 1990 to 53% in 2010. According to these figures, access in rural areas stagnated, while in urban areas it decreased from 94% to 79% over the same period. The JMP estimates rely on extrapolations using, among others, data from the Household Budget Survey 2000/2001 and 2007, the Census of 2002 and the Demographic and Health Surveys of 1999, 2005 and 2010.

2.4.19 Water Supply in Zanzibar

The rapid growth of Zanzibar town and the worsening economic situation have significant strain on all social services and infrastructure. This includes the provision

of water services to the town's inhabitants. The situation of water supply in Zanzibar is very similar to that of other developing countries.

According to Lee (1994) the water services management in Zanzibar situated today is in crises. The situation can be described as an example of the common conflicts within the urban water supply sector in many developing countries.

The conflicts comprises of financial constraint versus desire for improved infrastructure, the need for cost recovery versus the desire to provide free services. Where the available financial resource are meager the conflicts are manifested in the form of resource allocation, occupation between the needs for system, expansion versus maintenance and operation of the existing system.

Due to high productive rate, there is a high demand for social services such as water. This is because it has a young population with 54 percent of the total population being below 19 years of age (Revolutionary Government of Zanzibar 2004). So water demand for Zanzibar municipality will increase to 30,000m per day in 1995 to 90,000m per day in 2015. (Abdallah. 1994).

2.4.20 Challenges of Water Supply in Zanzibar

According to Thematic Papers of Zanzibar Poverty Reduction on Plan (2002) the Revolutionary Government Zanzibar faces a number of challenges in water supply activities. Low capacity of district officers to assist community in the planning and management of water supply networks and loss of water (up to 30%) in production transmissions, storage and distribution networks. Poor coordination with other sectors and low public awareness and involvement in planning, water uses, management, cost

sharing and participation in the implementation of scheme. Conflict in rural areas between domestic and other users, rapid growth of population and unplanned expansion of urban areas. Other challenges include inadequate funding, lack of wake policy for water management, undemocratic or unfenced boundaries around protected water sources and low private sector involvement with slow implication of local government policy.

2.4.21 Zanzibar Water Authority (ZAWA)

According to ZAWA customer service hand book, ZAWA is a corporate authority established in 2006 following the enactment of the Water Act No: 4 of 2006. It was formed as a follow- up of the recommendations of the Zanzibar National Water Policy of 2004, with the jurisdiction of providing clean reliable and good quality water supplies through the operation and maintenance of water infrastructure and development of new networks in urban and rural area of Unguja and Pemba Islands. ZAWA is also responsible for the management and regulation of water resource and influent discharges in Zanzibar. The water Act gives ZAWA enough power to operate and effectively carry out its mandated functions.

2.4.22 Water Supply Infrastructure

According to ZAWA (2013/18) draws water from boreholes, springs and caves. There are two springs each on Unguja and Pemba and 3 caves in Unguja. There will be 260 production boreholes available in 2014 (Unguja 140; Pemba 115) after the present investment cycle (45 new boreholes), but 20% of existing production boreholes in Unguja (26) and15% in Pemba(12) are not functioning. Pump availability is also reduced due to other factors such as power cuts, voltage variation

and normal off duty periods and short duration failures that can be repaired. The Feasibility Study (2012) into infrastructure investment needs in the urban west area of Unguja, Mjini/Magharib recommended 10 additional boreholes and equipment, while another 30 pump stations should be rehabilitated.

There are many other boreholes that have been abandoned due to a variety of technical reasons while another 78 smaller wells (31 in Unguja; 47 in Pemba) will be available for observation from 2014. All production boreholes are recorded in the asset register, while the observation wells will be captured into the data base in due course. The 78 observation wells are intended for gathering information about the aquifers over the longer term and will be equipped for this as part of the water resources management program. Total length of water pipe network will soon be about 1,850 km, comprising of 1,200 km of existing pipes in Unguja with another 50 km in construction stages; 400 kms of existing networks in Pemba with another 200kms in construction stages. The majority of the older network (about ¾), being old asbestos-cement pipes, is subject to frequent leaks and damage requiring expensive repair works. Many years of under-spending on repair and maintenance of the network has allowed the standard of the network to deteriorate.

Some older pipes will be abandoned as part of the current expansion program (in 2014), while the findings of the Feasibility Study (2012) into infrastructure investment needs in Mjini/Magharibi recommend some more older pipes to be abandoned (7 kms), or reinforced (15 kms), as well as the construction of new pipelines (67kms). This will be confirmed when the detailed design work is done (in 2014) and they should be in service by end 2016. ZAWA will soon have 77 clear water

reservoirs in place, 50 in Unguja with another 4 in construction, and 10 in Pemba with another 13 in construction stages as part of the present 11 investment cycle. More reservoirs may be provided in the next investment cycle, depending on detailed design, although more effective use of existing reservoirs after separating the zones may be sufficient.

Significant infrastructure expansion is in progress already, and ZAWA expect this to continue with another investment phase starting in 2014. But the long hiatus in investment in networks while the population bloomed is another basic cause of the low level of services and coverage. This gap may have been from a lack of in come from consumers to fund services before the introduction by RGOZ of the concept of payment for water services (in 2008). But it is also probable that development banks and other lenders or donors were unwilling to support a financially unsustainable system.

2.4.23 Function of ZAWA

The following are the functions of ZAWA.

To control, manage and protect all catchments areas and shall have mandate to take legal action against any person or body of person in violation of or disturbing or encroaching the catchments areas. Apart from the functions performed by ZAWA, it formulated a vision, mission and motto. (Consult, 1998). The vision of ZAWA is to be the best water and sanitation services provider in East Africa. The mission is to develop and provide portable, adequate, affordable water and in environmentally friendly manner. In this regards ZAWA’s motto states that every drop counts use water wisely.

(i) To develop and maintain water works plan and execute new project for supply of water.

(ii) To advise the government in formulation of policies relating to the development and water conservation.

(iii) To specify standard of water quality and water equipment as specified in the regulation of this act.

(iv) To propose to the board amendments of water tariffs and water services charges offered to the consumer as considered necessary.

2.4.24 Challenges Facing ZAWA

At the moment ZAWA is not fulfilling its role in the Zanzibar society; service coverage is weak in certain areas, the public often complain about sub standard service and the ZAWA has not lived up to the expectation in the transformation from a public water supply service institution into modern RGOZ owned utility generating sufficient income from sale of water to sustain operation. ZAWA still require heavy financial support to maintain an acceptable service to its customers.

Population growth: Increase in population leading to cutting down the trees at water sources because of unplanned expansion of human settlement, is to blame for continuing shortage of water as people mount pressure on government to solve the water blues. ZAWA has the challenge of preserving the water source not to be contaminated by nearby people.

(i) Water sources: ZAWA has no enough sources which can be used to deliver freshwater, it has few resources which depend on ground water. The fewest sources tend to have water scarcity.

(ii) Water leakage: fresh water supplied to consumers is almost lost on the way to consumers owing to water leakage due to the ignorance of the community.

(iii) Poor coordination between ZAWA and the community: people do not pay much attention on maintaining the mains on their areas, the authority remains as a constructor of damages.

(iv) Inadequate funding in the water sector: Sufficient funding has been lacking mainly because of low awareness on the importance of cost sharing in water resource in all sectors, agricultural, industrial, domestic uses etc. due to that ZAWA lacks money to run its activities and initiating new projects.

2.4.25 Problem facing Water Supply

Unfortunately, African cities are burdened with numerous shortages in water supply. The shortage and drop in water supply in Zanzibar town have been caused and aggravated by multiple factors. These include an aged and poorly maintained water supply system, rapid urban expansion, limited natural supply sources and the degradation of water sheds together with the government policy of providing free water services to domestic water consumers and place of workshop.

However over time, one of the main outcomes of the policy has been the deterioration of the quality of the service provided because; the government does not have enough funds to support the efficient management and delivery of water services. Also it is harming rather than helping the very society that it intends to assist.

2.4.26 Water Conservation

Water conservation encompasses the policies, strategies and activities to manage fresh water as a sustainable resource, to protect the water environment and to meet current

and future human demand. Population household size and growth and effluence all affect how much water is used. Factors such as climatic change will increase pressure on natural water resources especially in manufacturing and agricultural irrigation.

The Gale Encyclopedia of Science (2008), claims that of all the freshwater used directly by humans, agricultural irrigation accounts for about 70% of the total. The remainder is used for industrial and domestic purposes. However, these proportions vary widely due to the climatic and economic conditions of a particular locality. Within this century, one-third of the countries situated in areas of water scarcity may encounter severe water shortages. By 2025, two thirds of the world's population is likely to live in areas of moderate or severe water shortage. The need for more effective conservation of the limited supplies of water that are available for use by people and required by natural ecosystems will intensify as water stress grows.

Because about 70% of water spent on irrigation system (as population increases and production expands so more water is needed for irrigation). Subsurface irrigation is an emerging technology with high water-utilization efficiency. Subsurface irrigation uses a drip-irrigation tubing buried 6 to 8 in (15 to 20 cm) underground, with a spacing of 12 to 24 in (30 to 60 cm) between parallel lines. The tubing contains drip outlets that deliver water and nutrients within the root zone at a desired rate. In addition to water conservation, subsurface irrigation has other advantages that overhead sprinklers do not: minimal over watering, fewer disease and aeration problems, less runoff and erosion, fewer weeds, and better protection from vandalism. In California, subsurface irrigation has been used on fruit trees, field crops, and lawns, and has achieved water-use savings of about 50%. Though these systems are currently used primarily on

large-scale applications, development of economic models for the small-scale user is underway.

Water conservation can also be advanced by improving other domestic uses of water. One simple conservation practice is to install ultra-low-flush (ULF) toilets and low-flow showerheads in homes and other buildings. A ULF toilet uses only 1.6 gal (6.1 l) per flush, compared to 5 to 7 gal by a standard toilet. Replacing a standard toilet with an ULF saves about 30 to 40 gal (114 to 151 l) of water per day, equivalent to 10,000 to 16,000 gal (37,850 to 60,560 l) per year. More recently, advanced toilets and urinals requiring no water have been developed and are beginning to be utilized on a limited basis, (The Gale Encyclopedia of Science, 2008).

Another way to conserve the freshwater supply is to desalinize seawater. Desalinization is the removal of salts and other impurities from seawater by either distillation or reverse osmosis (RO), and this method is being increasingly used to provide high-quality water for drinking, cooking, and other domestic uses. The Gale Encyclopedia of Science (2008). demonstrates that, world production of desalinated water was produced in Saudi Arabia and other nations of the Gulf of Arabia, where energy costs are relatively low (the cost of desalinated water is highly sensitive to the cost of energy). The largest desalination plant in the world (Shoaiba Desalination Plant) is located in Saudi Arabia, and it uses reverse osmosis to produce half of its country's drinking water. Saudi Arabia is the largest producer of desalinated water in the world with desalination providing 70% of the country's drinking water. Desalinization is also practiced in California and Florida, where the cost is about three dollars per thousand gallons, which is four to five times the cost paid for domestic

water by typical urban consumers in the United States, and more than 100 times the cost paid by farmers for water for irrigation. The process is also gaining popularity in Spain, Australia, and China.

Widespread recognition of the importance of reusing water has begun to change traditional water use methods. One of the first of these reuse applications was the irrigation of golf courses and landscaping. In many areas, treated waste-water is diverted from its normal disposal path to be reused in irrigation. This has gained popularity and is also utilized in small artificial ponds for decorative purposes. Gray water systems capture water that drains from sinks, tubs, laundry, and dishwashers for reuse in irrigation. Gray water systems do not incorporate toilet wastes because of the potential health threat, The Gale Encyclopedia of Science (2008).

Using water wisely will reduce pollution and health risks, lower water cost and extend the useful life of existing supply and waste treatment facilities (BPS, 1972).

Water efficiency initiative currently being undertaken can be grouped under four principal categories, namely structural, operational, economic and socio-political conservation. Most of these conservation activities fall within the jurisdiction of institutional or public utilities.

2.5 Policy Frameworks

2.5.1 Zanzibar Strategy for Growth and Reduction of Poverty (ZSGRP)

According Zanzibar Strategy for Growth and Reduction of Poverty (2007), the quantity and quality of water supplies in Zanzibar is one of the top priorities. This is because the water demand is not being met and some sources are contaminated.

However, while access to water for Zanzibar's population has increased, the supply is still low in certain districts. It is estimated that 75 percent of urban residents and 51percent of rural residents currently have access to clean and safe water within 400 meters. Water in many areas is not good for peoples' health and plans to address this problem are urgently needed.

So, the Zanzibar Strategy for Growth and Reduction of Poverty (ZSGRP), policy calls for an increase access to clean safe and affordable water by setting out targets that ZAWA should meet. The first target was to increase water supply in urban areas from 75% from 2005 to 90% in 2010 and rural areas from 51% to 65% in the same year. This policy also calls for the promotion of community based management of water supply in order to ensure long term water supply.

2.5.2 Zanzibar Poverty Reduction Plan 2002 (ZPRP)

Policy framework emphasizes the importance of effective water and sanitation services to combat poverty in achieving the Millennium Development Goal (MDG). It acknowledges that poverty is not only lack of income, but also lack of accessibility to the basic needs of the people and proposes for an improvement of living condition through better access to basic physical and social services. ZPRP calls for establishment of a decentralized approach to the provision of water supply system and enhancement of community awareness to observe hygienic and sanitation requirement and to develop water supply and sanitation system capable of supplying rural and urban community with portable water. It says that the protection of the quality of water resource is necessary to ensure sustainability of the nation's water resource in the interest of all water users.

2.5.3 The Zanzibar Development Vision 2020 Policy

It is revolutionary as it calls for involvement of private sector and community participation in the water resource management and promoting community ownership and the right to water supply. The policy vision on water supply and management is to ensure adequate, affordable and economically accessible and sustained water supply to all people and sectors, (Vision, 2020). It also calls for the development and promotion of efficient water supply and management system that will ensure reliable water supply for all purposes at a reasonable cost. The vision also advocates for the development of rain water harvesting. It calls ZAWA to institute and maintain an efficient and effective water tariff and timely revenue collection system for all water users.

2.5.4 Cost Sharing in Water Supply

The cost of supplying water consists to a very large extent of fixed cost, and only to a small extent of variable cost that depends on the amount of water consumed. Throughout the world only part of this cost is usually billed to consumers, the remainder being financed through direct or indirect subsidies from local, regional or national governments. Beside subsides, water supply investments are financed through internally generated revenue as well as through dept. Due to the different challenges and policy failure (Konsult, 1999) demonstrate that, water sector in Zanzibar is unsustainable and that, the goal of free water for all is not possible. Therefore, domestic consumers must participate in maintaining and sustaining the operation of the water supply system by contributing the necessary financial resources for the services sector, as well as institutions, commercial, agricultural. ZAWA

management has prepared tariffs and approved by ZAWA Board of Directors and has been submitted to the minister for consent and subsequent gaze-ting by the Government. The revenue- and revenue collection project was made and the approved tariff has started to be collected since August 2008.

2.6 Conceptual Framework

The study impacts of population growth on water resource availability is conceptualized in accordance to the explanations given by the already explained theories and empirical literature review of impacts of population growth on water resource. The framework shows the relationship between independent variable, the intermediate variables and dependents variables.

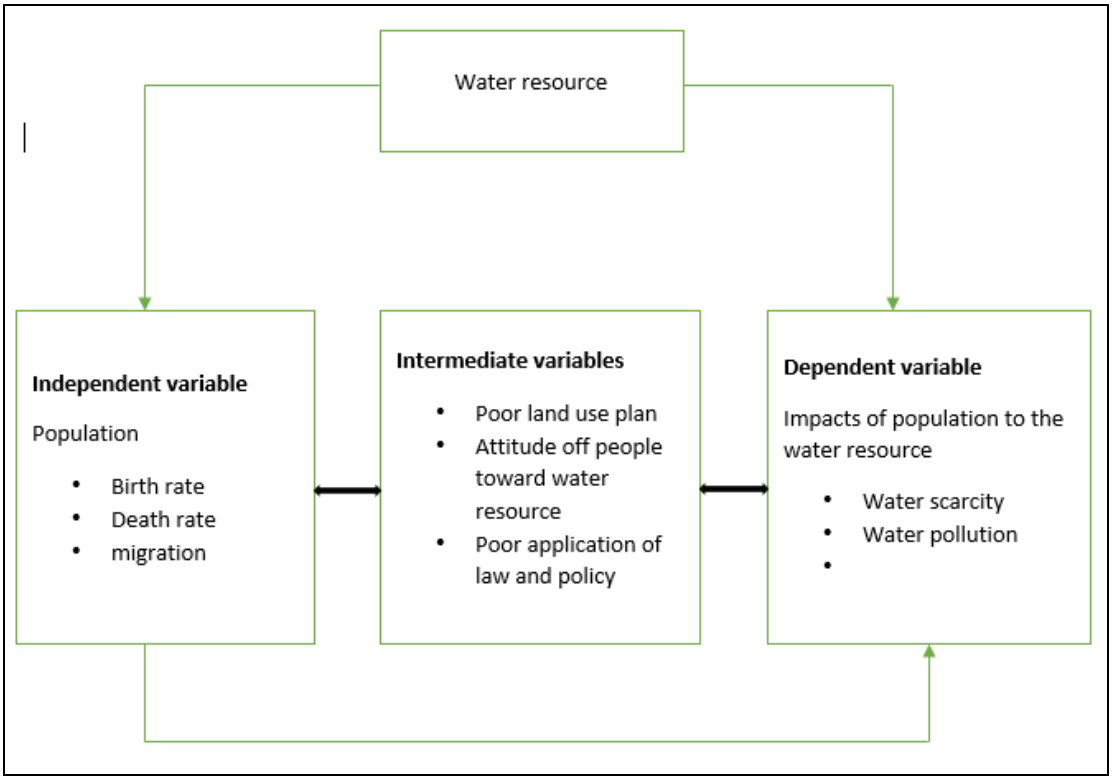

Figure 2.1: Conceptual Framework for the Study

Source: Author's conceptualization

The dependent variables of this study (include water scarcity and water pollution) are conceptualized as a function of the independent variables, which are the impacts caused by population growth. However, in causing impacts on water resource availability, it depends on how the population impacts directly and/or indirectly influence the intermediate variables. The extraneous (intermediate) variables, which include: lack of legal protection, poor land use plan, attitude of people toward water resource was controlled by holding these factors constant. Thus, the water resource availability is determined by a set of connection and interaction of the population impact and their respective influence of extraneous variables. Therefore, the researcher considers this conceptual framework relevant and potential in maintaining focus in answering the research questions on the assessing impacts of population growth on water resource availability in Western District.

2.7 Research Gap

A number of studies have been done throughout the world concerning water resource. The scenario has also been conducted at the regional level and local level in Tanzania Zanzibar; the studies have looked on Causes and Consequences of Groundwater Use on a Tropical Island (Gossling and Johnstone, 1999). Another scenario has been done in Chwaka, Zanzibar, assessing the viability of desalination for rural water supply.(Yu and Packard, 2012). Also management of water supply provision in the informal settlement of stone town Zanzibar is done by Mwehe (2011). However the above studies talk about the water, they fail to address the availability of fresh water resource in relation to population growth. Thus this study is going to access the impact of population growth in freshwater resource availability.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

According to Moutton (2001), research methodology indicates how the researcher conducted the fieldwork. Therefore, this chapter devotes to methodological aspect of the study. It specifically outlines the research approach, research design, study area, administrative setting, research population, sample size and sampling frame as well as sampling procedure. The chapter further presents the research tools, data collection methods, validity and reliability of the research instruments and methods of data analysis. The chapter winds up with ethical consideration, data analysis and summary of the chapter.

3.2 Research Approach

This study deployed qualitative research approach which is apprehensive with subjective attitudes, behaviors and opinions of the respondents (Kothari, 2004). The study further preferred qualitative approach to acquire interview understanding of the key informants' view about the study in question.

3.3 Research Design

Research design is an activity-based plan; based on the research objective and it guides the selection of source and types of information. Koda (2006) defines research design as an arrangement of conditions for collecting and analysing data in a manner that it aims to combine relevance of the research purpose with economy in procedures. Corlien (2003) adjoins that research design is not related

to any particular method of collecting data or any particular type of data. Any research design can, in principle, use any type of data collection method and can use either quantitative or qualitative data.

This study used descriptive survey. Corlien (2003) depicts that descriptive survey involves gathering data that describe events and then organizes, tabulates, depicts, and describes the data, using both quantitative and qualitative data. It also used description as a tool to organize data into patterns that emerge during analysis. The design had been used since data was collected at one point in time from a sample selected to represent a larger population. The author adds three other characteristic features of descriptive survey; first it has the ability to reach a large number of people across a wide geographical area within a short time, second it provides ease and low cost of distribution, and third it often uses visual aids such as graphs and charts to aid the reader (Corlien, 2003).

3.4 Study Area

Zanzibar is made up of two main islands, Unguja and Pemba, about 40 km off the eastern coast of The United Republic of Tanzania (Slade, et al. 2012). Field research for the study was conducted on the island of Unguja, which has a surface area of 2,577 square kilometers (Slade, *et al*., 2012). Unguja is composed of coral rag terrain, made up of fossilized coral and limestone which is porous and hydraulically connected to the ocean (Slade, *et al.,* 2012). The Island of Zanzibar is situated between latitudes 5º 40’ and 6º 30’ and longitude 39º east. It is about 85km (53 miles) long and at its broadest point it is 39 km (24 miles) wide. Its area is about 1660 km^2

(640 square miles) (Slade, et al. 2012). The study selected Western District because it has the highest population of all Urban Western Region. Moreover, the study selected the three wards namely Chukwani, Kiembesamaki and Tomondo because they are mostly occupied by people of different economic characteristics.

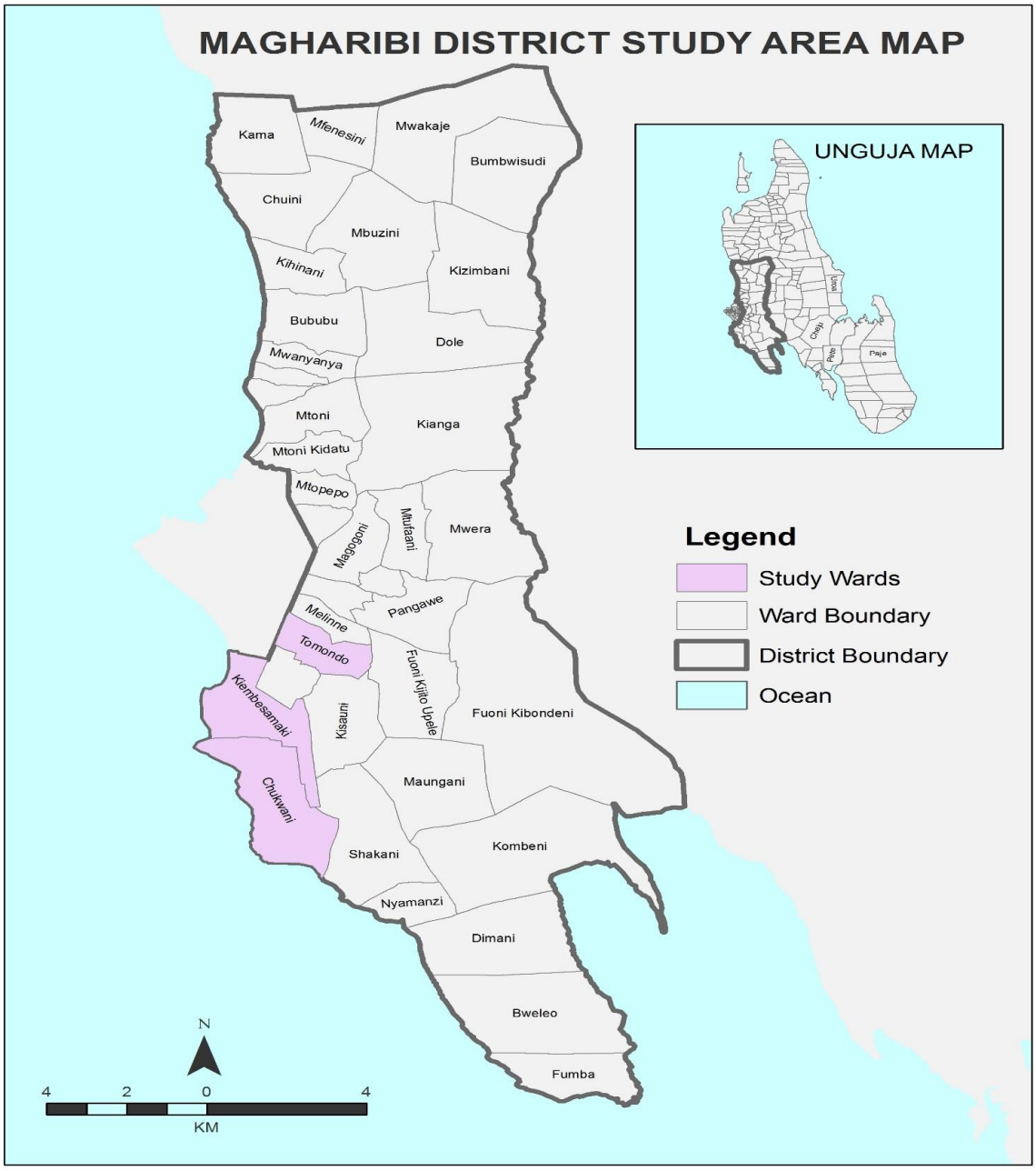

Figure 3.1: A Map Showing Study Wards of Western District

Source: ArcGIS

3.4.1 Administrative Setting

Administratively, Zanzibar is subdivided into three regions: North, South and Urban-West. This study was conducted in Zanzibar West district, which is in the Urban-West Region. The district is further subdivided into Shehias. Three wards/shehias are surveyed which are KiembeSamaki, Tomondo and Chukwani. The reason for choosing these is due to the increasing number of dwellers identified in these areas and the scarcity of water that faces the area. Above all west district becomes a representative sample of other regions of Zanzibar and was deliberately selected to be case study because, it is the center of many activities.

3.5 Research Population

According to Bryman (2003), Population basically is the universe of units from which the sample is to be selected. The term ‘units’ is employed because it is not necessarily people who are being sampled-the researcher may want to sample from a universe of nations, cities, regions, firms, etc. Thus, population has much broader meaning than the everyday use of the term, whereby it tends to be associated with a nation’s entire population. The targeted population for this study were members of households, especially heads of households, ZAWA staffs and Manager Chief Government Statistician.

3.6 Sample size and Frame

The sample size calculated is based on Yamane’s formula (Israel, Glenn D. 1992)

$$n = \frac{N}{1 + N(e)^2}$$

Where,

n= the sample size

N = the size of population

e= the error of 5 percentage points.

3.6.1 Sample Size Computation

$$n = \frac{N}{1+N(e)^2}$$

$$\frac{43312}{1+43312(0.5)}$$

= 401

Total sample size obtained was 401

3.6.2 Sample Size Calculation in each Shehia

Kiembe Samaki $= \frac{11760}{43312} \times 401 = 109$

Chukwani $= \frac{11760}{43312} \times 401 = 77$

Tomondo $= \frac{23254}{43312} \times 401 = 215$

If I interviewed all those 401 people, then it would be worse.

Then I only chose a sample to interview that is 40% of the people (82 people) in the selected areas which is (p=0.4), precision /error level of 10% which is equal to (e=0.1), confidential level of 0.05 equal to 1.96 (95% confidential level deemed acceptable).

Therefore

(i) n = sample size

(ii) N = total population size

(iii) e = confidential level

(iv) P = estimated population proportion

(v) ∂ = confidential level

$$n = \frac{Z\partial^2.p(1-p)N}{Z\partial^2.p(1-p)+Ne^2}$$

$$n = \frac{1.96^2 \times 0.4 \times 0.6 \times 401}{1.96 \times 0.4 \times 0.6 \times 401 \times 0.1^2}$$

$$\frac{370}{4.4804} = 82$$

Therefore from the 43312 population composing three wards (Kiembe Samaki, Tomondo and Chukwani), only 82 samples were selected under the sampling frame mentioned above.

3.7 Sampling Procedure

According to Cohen, at al: (2001), a sample is a representative group drawn from the population in such a way that the findings from the sample can be generalised on the population. Kombo and Tromp (2006) defined sample as the analysis of a large population where bias is minimized and the chance of inclusion of every member is not possible.

Sampling is dependent on many things mostly on the research questions. If the objective of the research is to study and describe a specific situation, then non-probabilistic methods like purposive or convenient sampling is appropriate. However, when the objective is to generalize about the findings, it is necessary and important to apply probabilistic methods. Even in such situations, the choice of a specific method may still be difficult because it may be subjected to a number of factors, such as; geographical location of respondents, cost and time considerations, availability of

sampling frame and size of sample required. Of all those above concerns, the prime requirement is to ensure sufficient representation of the themes under the study.

After harmonizing different consideration, this study employed both probabilistic and probability sampling methods, random sampling technique is applied to obtain sample from ordinary people. And the sample from the department is selected purposely/ deliberately on the belief that they have reliable source of information.

3.8 Research Tools

Cohen, (2000) described research tools as the range of approaches used in gathering information, which were to be used as a basis for inference and interpretation, for explanation and prediction. This research used two different instruments namely: primary and secondary data collection tools. These instruments generated a wide range of data which were both qualitative and quantitative. Primary tool involve Questionnaire which were targeted to the head of the households' members from three shehias; and interview for the staffs of ZAWA and Manager in a chief of governmental statistician, key informants found in west district households, since there were high concentrations of respondents from different socio-economic background. Both provided different dimension of the data on the subject. The instruments can be found on: (Appendix II, Appendix III and Appendix IV).

3.9 Data Collection Methods

Data collection methods fell under two categories. These were those that were used during the field (in the field) and those after the field. Those during the field include structured interviews and observation. While after the field the researcher collected the data through documentation from various libraries and departments.

3.9.1 Questionnaire Survey

This study used both qualitative and quantitative methods of data collection whereby structured interviews were provided to the household heads. The house hold heads were randomly selected and had experience in water management issues. Also, face-to-face interview that was used by the researcher helped to obtain detailed information from the key informants.

3.9.2 Documentary Reviews

Documentary analysis has been considered by many researchers as potential source of data for research (Mason, 1996). Providing the meaning of a document in research context, Bryman (2004) says that, it is any written material that can be read, has not been produced specifically for the purpose of social research, is preserved so that it becomes available for analysis and is relevant to the concerns of a social researcher. In this study, documents have been used to complement other sources of information with the idea that documents corroborate and augment evidence from other sources (Yin, 1994). Various published and unpublished working documents and records from libraries of various departments and higher education institutions were used in collecting secondary data. This helped to obtain various information related to the study.

3.10 Validity and Reliability of the Research Instruments

3.10.1 Validity

Validity refers to the extent to which an account accurately represents the social phenomena to which it refers (Kombo, 2006). Internal Validity in this research was achieved through proper identification of research problem, building a theoretical

perspective on the various motivation programs, as well as using secondary information.

External Validity was achieved through proper identification of the research problem, following the scientific research process, and the use of different research methods. Constructs validity will be concerned with the validity of relationships between theoretical constructs variables operationalization and conclusion to be drawn (Kothari, 2005). In order to achieve it, a systematic research process will be adopted from designing the research problem, and undertaking the research process.

3.10.2 Reliability

Reliability means the consistency with which repeated measures produce the same result across time and across observers. It denotes how consistent a research producer or instrument is Reliability also concerns with the question of whether the results of a study are repeatable. Therefore, it implies stability or dependability of an instrument or procedure in order to obtain information. However, proper study has to regard to reliability, consistency, stability and predictability (synonyms for reliability), whether the result is replicable (Bryman, 2001). Furthermore, the stability and equivalence aspect of reliability of this research study was achieved by carefully replicating the research methods. This was conducted by pre-testing of different data collection methods such as questionnaire and interview.

3.11 Ethical Consideration

Ethical issues include critical aspects of not harming the respondents. Permission to conduct the research was obtained from relevant authorities including the Director of

Postgraduate Studies' office at the Open University of Tanzania and the District Executive Director of Western District. The researcher prepared questionnaires, instruments for data collection and made actual visits. The researcher also made introduction and a brief description about the study to the respondents. Before being requested to participate, the respondents were assured of confidentiality and questionnaires were handled and administered confidentially. Also, numbers were deployed instead of names to ensure privacy and the participants were insisted not to write their names. Eventually, data from relevant sources were coded and analyzed.

3.12 Data Methods Analysis

Data methods analysis refers to the process of editing, coding, classification and tabulation (Kothari, 2004). Even though this study is qualitative in nature, it became necessary that the methods of data analysis contained both qualitative as well as quantitative forms of data. Also, data was analysed and processed through editing, coding, tabulation and pictorial presentation. It was done by using IBM-SPPSS and cross-tabulation was done to find out frequencies of respondents regarding the respective research objectives. However, the study applied a variety of techniques to analyze and describe numerical, maps, tables and figures to report the trends population growth in relation to water resource management in Zanzibar.

CHAPTER FOUR

FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study, data analysis and discussion of the findings. The findings are presented using simple statistical methods including pie charts, graphs and tables. It was the intention of this study to use Malthusian Theory to assess the impact of population growth in water resources availability in Western District, Zanzibar. However, Malthusian Theory was set for the intention to assess how the population growth affects natural resources and how they are tied to a series of questions related to their respective objectives.

4.2 Changes in Domestic Water Sources from 1995 to 2015

The study aimed to determine changes in domestic water sources since 1995 to 2015 in three informal settlement study areas. Malthusian Theory was determined through different ways. These include increasing of population and domestic water scarcity due to the increase of population. The results' scenario was illustrated under various phenomena.

4.2.1 Population Change over time in Shehias

The respondents were asked to give an answer if population is increasing in their respective areas. As it is revealed on Figure 4.1, the respondents showed that 56% strongly agreed on that statement. They were followed by 31% who agreed, 9% were neutral while 4% strongly disagreed. The findings revealed that the majority of the respondents accepted that population is increasing in the study area. Also, the findings

in this Figure 4.1 are consistent with those of the National Bureau of Statistics (NBS, 1988: 2002 and 2012). It shows that the total population of Zanzibar in 1988 was 640,675. In 2002 the population was 981,754 while in 2012 it was 1,303,569.

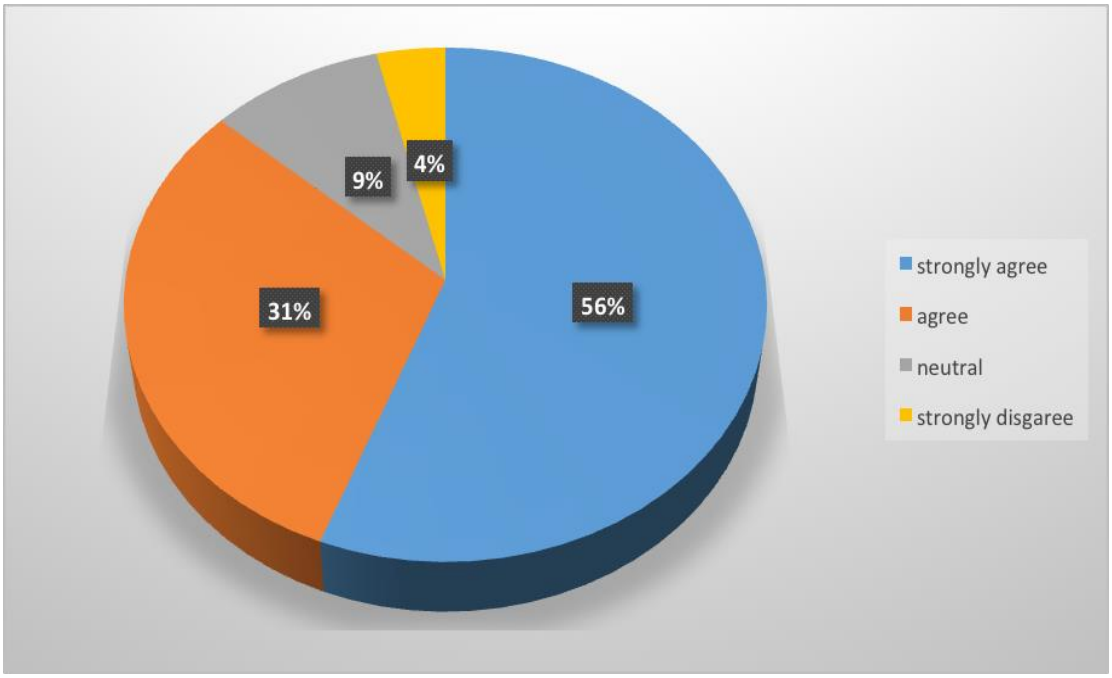

Figure 4.1: Summary of Population Increase in the Study Area

Source: (Field Survey, 2018)

4.2.2 Domestic Water Scarcity in Shehias because of Population Increase

From Figure 4.2 the respondents were asked if there is domestic water scarcity in their Shehia because of population increase. The results showed that 44.2% strongly agreed, 34.6 agreed followed by 15.4% were neutral, 2% disagreed and 3.8% strongly disagreed.

These results implied that the majority agreed that there is water scarcity in their Shehias due to the increase of population. Therefore, this can be conditioned that high population growth caused shortage of water resource in the study area.

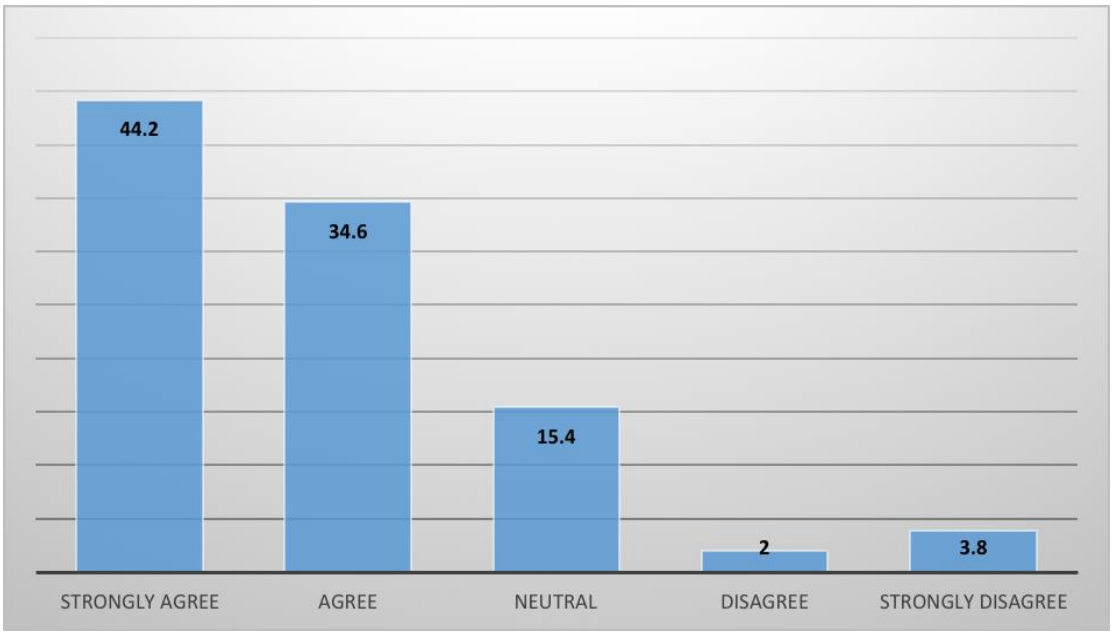

Figure 4.2: Summary of Water Scarcity in the Study Area
Source: Field Survey, 2018

4.2.3 Population Growth leads directly to increase an Overall Water Demand

The respondents were asked to give their views on the statement that stated that population growth leads directly to increase an overall water demand. The results on Figure 4.3 showed that 59.6% strongly agreed with the statement, 32.7% agreed.

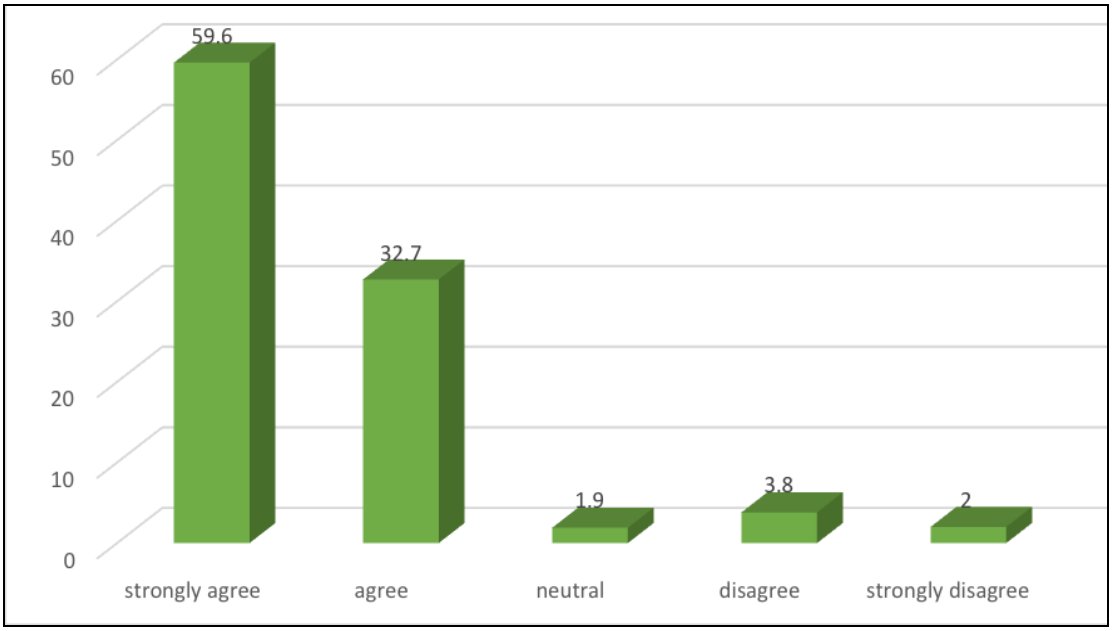

Figure 4.3: Summary of Population Growth against Water Demand
Source: Field Survey, 2018

Meanwhile, 1.9% was neutral, 2% strongly disagreed and 3.8% disagreed. The findings in this reveal that the majority of the respondents accepted that population growth lead directly to an increase an overall water demand in the study area.

4.2.4 At the Household Level Demand for Water is determined by Household Size

The respondents were asked to comment if the household level demand for water is determined by household size. The respondents on Figure 4.4 indicated that 57.3% strongly agreed, 22% agreed, 7.3% were neutral, 6.1% strongly disagreed and 7.3% disagreed to that statement. This implied that the majority of the respondents had a positive outlook with the statement. This means that the increase of the number of people lead to the increase demand for water.

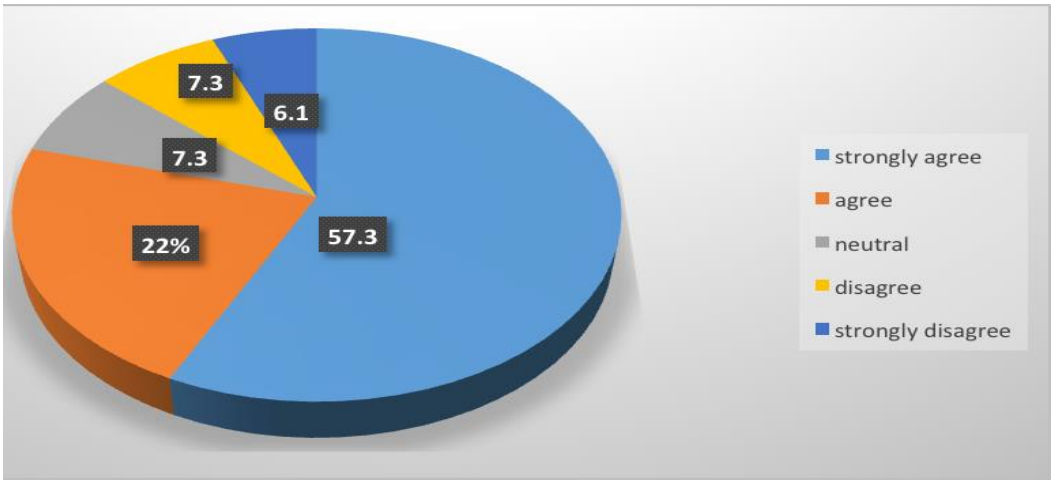

Figure 4.4: Summary of Level of Demand for Water in Household Size
Source: Field Survey, 2018

4.2.5 Diminishing Sources which can be used to Deliver Freshwater to the Increasing Population

The study intended to examine the availability of sources, which can be used to deliver freshwater to the increasing population in their areas. The results showed that

26.8% strongly agreed, 40.2% agreed while 11.0% were neutral, 7.3% strongly disagreed and 14.6% disagreed as it is illustrated in Table 4.3. Thus it can be seen that the majority of the respondents lacked enough sources, which can be used to deliver freshwater to the increasing population.

Table 4.1: Percentage Distribution of Diminishing Sources which can be used to Deliver Freshwater to the Increasing Population

	Respondents	Percent
Strongly agree	22	26.8
Agree	33	40.2
Neutral	9	11.0
Strongly disagree	6	7.3
Disagree	12	14.6
Total	82	100.0

4.3 Effects of Population Growth on Domestic Water Sources

The study wanted to examine the effects of population growth on domestic water sources. Malthusian Theory was examined through various traditions like population growth leads directly to an increase in overall water demand. Others include at the household level demand for water is determined by household size and age structure of households contribute to increasing demand for water.

4.3.1 Composition and Age Structure of the Households Contribute on Increasing Demand for Water

The respondents were asked if the composition and age structure of the households contribute on increasing demand for water. As it is revealed in Table 4.2, the respondents showed that 42.7% strongly agreed and 36.6% agreed. Also, it revealed that 8.5% were neutral, 3.7% strongly disagreed and 8.5% disagreed from these

results it can be inferred that the majority of the respondents had positive insight that both high population and high income of the family lead to high increase demand for water.

Fable 4.2: Percentage Distribution of Composition and Age Structure on Increasing Demand for Water

	Respondents	Percent
Strongly agree	35	42.7
Agree	30	36.6
Neutral	7	8.5
Strongly disagree	3	3.7
Disagree	7	8.5
Total	**82**	**100.0**

Source: Field Survey, 2018

4.3.2 Waking up too Early to Fetch Water

The respondents were asked if they are waking up too early to fetch water in their areas of localities. The results from the respondents showed that 39% of the respondents waked daily, 20.7% woke weekly, 15.9% woke twice a week followed by 20.7% of the respondents who woke monthly and 3.7% were not waking up too early to fetch water as shown in Figure 4.5.

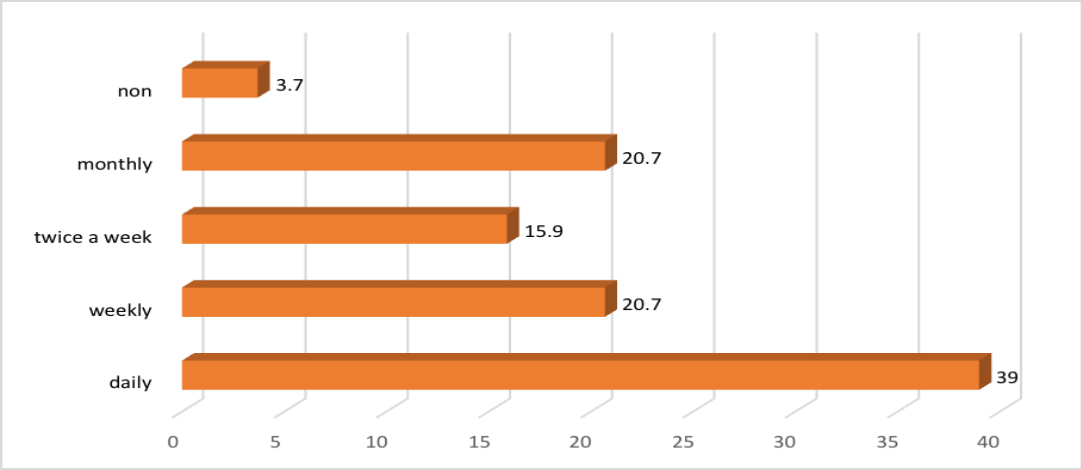

Figure 4.5: Waking up too Early to fetch Water

Source: (Field Survey, 2018)

This implied that only the minority of the respondents are not waking up too early to fetch water while the majority of the respondents are waking up too early to fetch water.

4.3.3 Walking Long Distances in Looking for Water

The respondents were asked to give their views on walking long distances looking for water. As it is revealed on Table 4.4, the respondents showed that 24.4% walked daily and 11.0% walked weekly. They were followed by 3.7% who walked twice a week, 9.8% walked monthly and 51.2% were not. From these results it can be implied that the majority of the respondents were not involved in walking long distances looking for water.

Table 4.3: Percentage Distribution of Walking Long Distances looking for Water

	Frequency	Percent
Daily	20	24.4
Weekly	9	11.0
Twice a week	3	3.7
Monthly	8	9.8
None	42	51.2
Total	82	100.0

4.3.4 Spending Many Hours in Queue During Water Collection

The respondents were asked if they are spending many hours in queue during water collection. The results showed that 5.8% spent twice a week, 11.5% spent weekly, 11.5% spent monthly, 23.1% spent daily and 48.1% none, as shown in Figure 4.6. From these results it can be inferred that the majority of the respondents were spending many hours in queue during water collection while the minority did not.

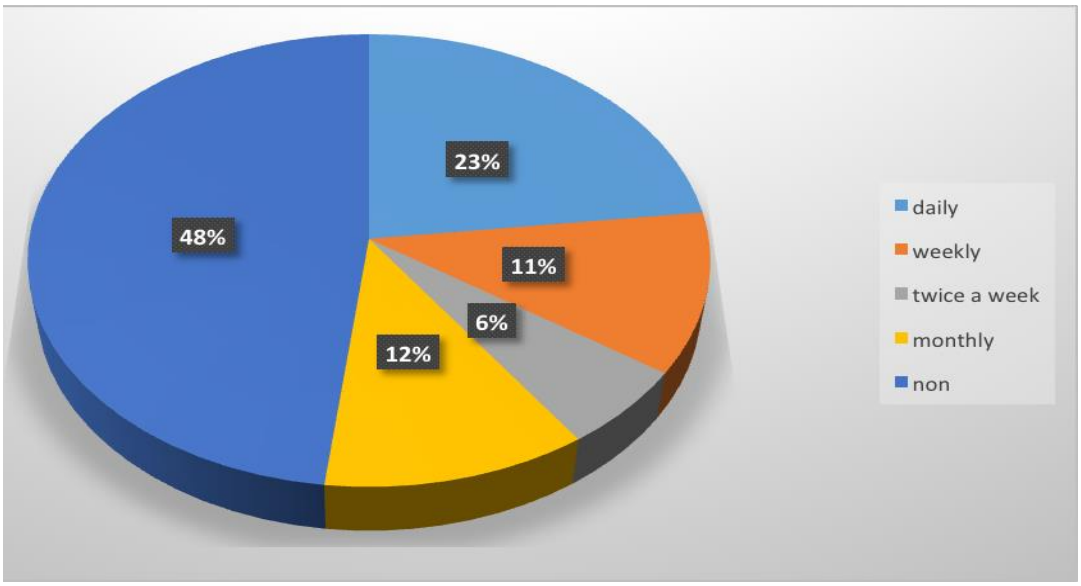

Figure 4.6: Spending many Hours in Queue during Water Collection

Source: Field Survey, (2018)

4.4 Effects of Population Growth on Domestic Water Infrastructure

In assessing the effects of population growth on domestic water infrastructure it include population growth damaging domestic water infrastructure through construction of formal settlement and industries; construction of new roads and expansion of the existing ones destroying water infrastructure. Others include building of schools, hospitals and electricity supply damaging water infrastructure, destruction of water infrastructure is due to ignorance of the community. Lastly, a water supply bill is needed for repairmen and maintenance of water resource infrastructure to cope with increased population.

4.4.1 Population Growth damage Domestic Water Infrastructure through Construction of Formal Settlements and Industries

The respondents were asked to give their views if population growth damage domestic water infrastructure through construction of formal settlements and industries. The results showed that 40.4% strongly agreed and 30.8% agreed on the statement but

9.6% were neutral, 5.8% strongly disagreed and 13.46% disagreed with the statement as it is shown in Figure 4.5. These results implied that the majority of respondents had positive insight with the statement.

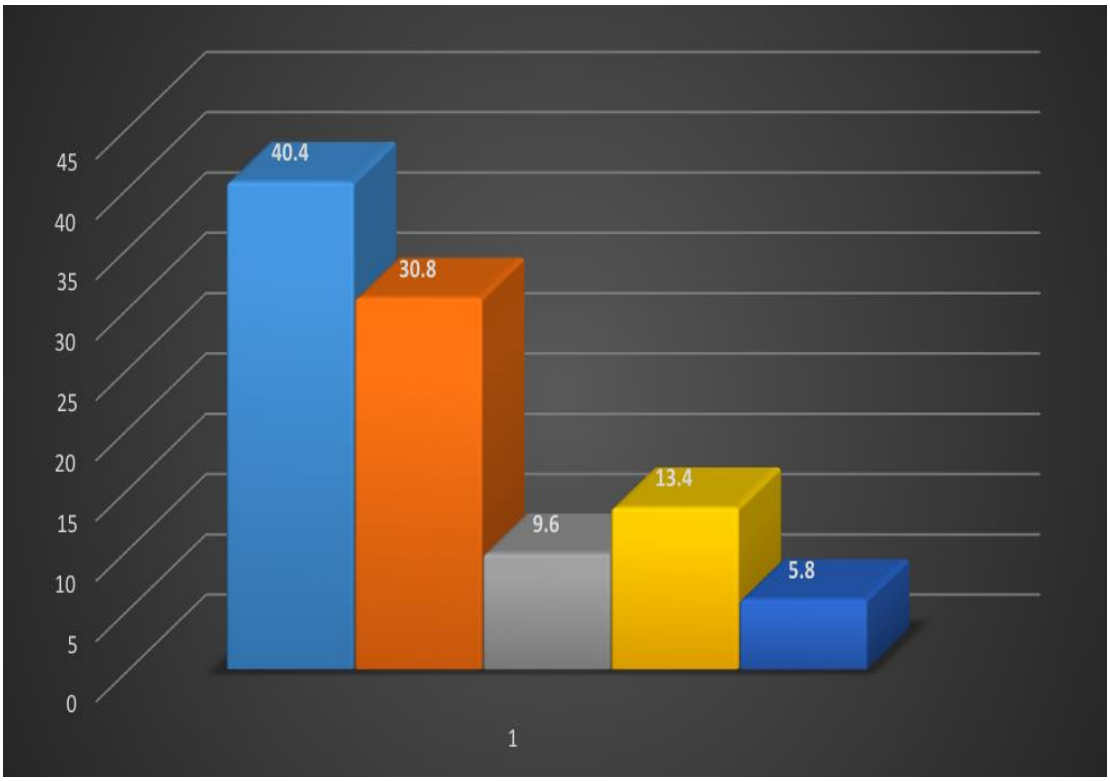

Figure 4.7: Summary of Population Growth damage Domestic Water Infrastructure through Construction of Formal Settlements and Construction.

Source: Field Survey, (2018)

4.4.2 Construction of New Roads and Expansion of the Existing ones Destroy Water Infrastructure

The respondents were asked if the construction of new roads and expansion of the existing ones destroy water infrastructure. As it was discovered in Figure 4.6, the respondents showed that 29.3% strongly agreed, 26.8% agreed, 8.5% were neutral while 13.4% strongly disagreed and 22% disagreed. This implied that the majority of the respondents accepted the statement.

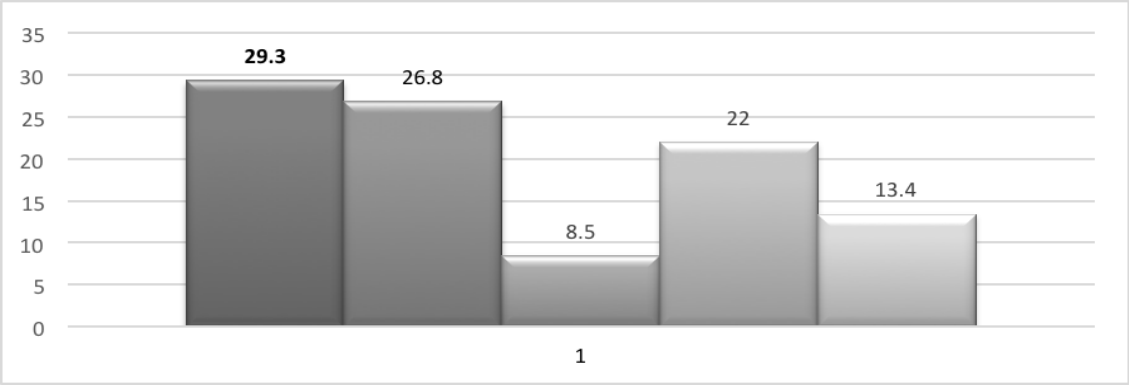

Figure 4.8: Summary of Construction of New Roads and Expansion of Existing Ones Destroy Water Infrastructure

Source: Field Survey, (2018)

4.4.3 Building of Schools, Hospitals and Electricity Supply Damage Water Infrastructure

The respondents were asked if building of schools, hospitals and electricity supply damage water infrastructure in their areas of vicinity. As it is revealed in Figure 4.7, the respondents showed that 7.7% strongly agreed, followed by 19.2% who agreed, 21.2% were neutral, 25% strongly disagreed and 26.9% disagreed. This disguised that the majority of the respondents accepted the statement.

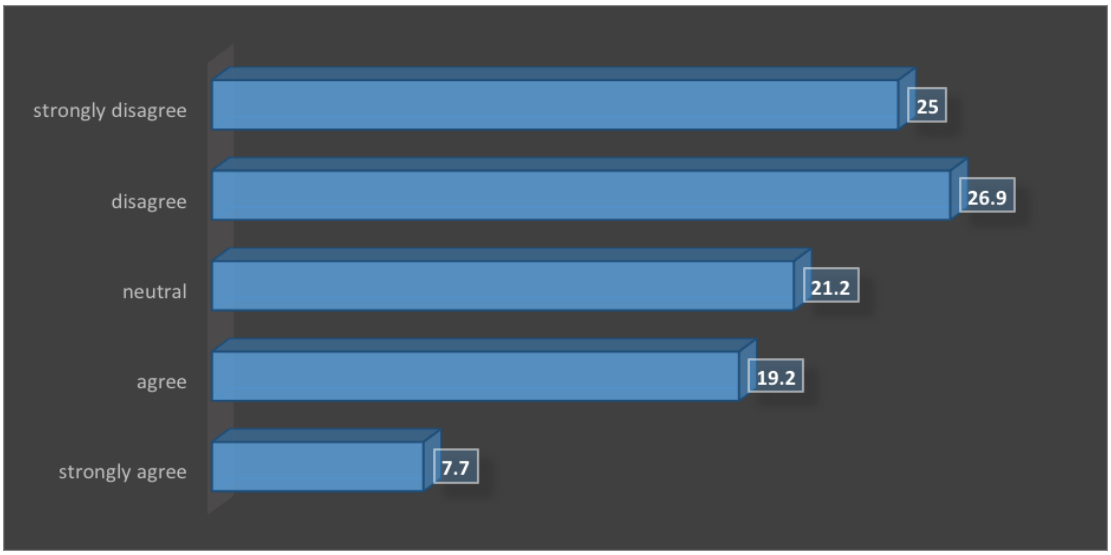

Figure 4.9: Summary of Building of Schools, Hospitals, and Electricity Supply Damage Water Infrastructure

Source: Field Survey, (2018)

4.4.4 Destruction of Water Infrastructure is due to Ignorance of the Community

The study sought to find out if the destruction of water infrastructure is due to ignorance of the community. The findings as suggested in Figure 4.10 shows that 29% of the respondents strongly agreed, 22% agreed, followed by 5% who were neutral, 22% strongly disagreed and 22% disagreed. From these results it implied that the majority of the respondents accepted the statement.

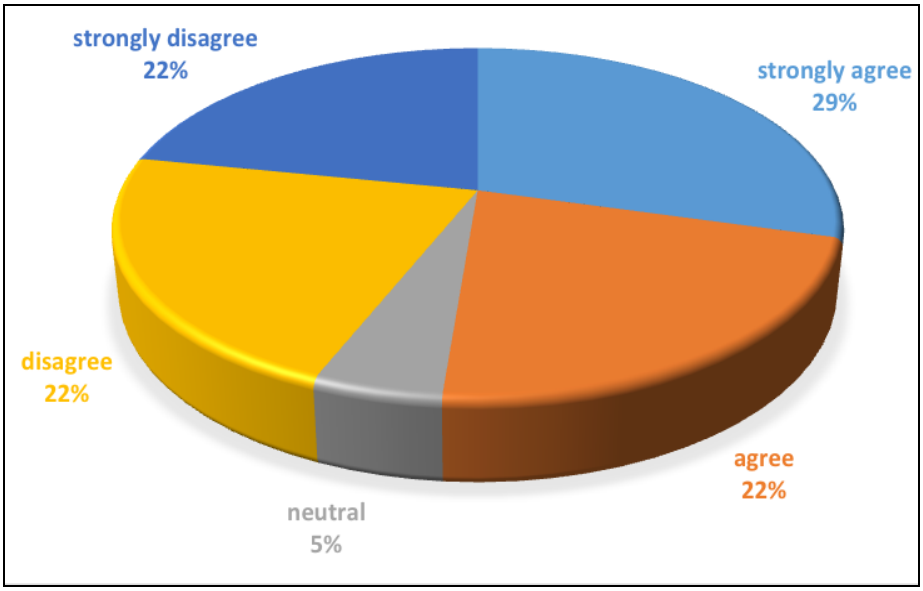

Figure 4.10: Summary on Destruction of Water Infrastructure is due to the Ignorance of the Community

Source: Field Survey, (2018)

4.4.5 A Water Supply Bill is needed for Repairmen and Maintenance of Water Resource Infrastructures to cope with Increased Population

The respondents were asked if a water supply bill is needed for repairmen and maintenance of water resource infrastructure to cope with increased population. As it is presented on Table 4.5, the respondents showed that 41.5% strongly agreed, 40.2 agreed while 6.1% were neutral, another 6.1% strongly disagreed and the rest 6.1%

disagreed. This implies that only the minority of the respondents did not accept the statement.

Table 4.4: Percentage Distribution of Water Supply Bill needed for Repairmen and Maintenance of Water Resource Infrastructures to cope with Increased Population

	Respondents	Percent
Strongly agree	34	41.5
Agree	33	40.2
Neutral	5	6.1
Strongly disagree	5	6.1
Disagree	5	6.1
Total	**82**	**100.0**

Source: Field Survey, (2018)

4.6 Chapter Summary

This chapter has dealt with the study findings, results and discussion. It dwelt on descriptive analysis of sample characteristics and the quantitative of the study variables. The data presentation and analysis paid attention to testing the three research questions to achieve the preferred objectives of the study. The qualitative analysis was used to examine the relationship of the interested variables.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents conclusions of the study findings, results and discussion presented in chapter four. Also, this chapter presents recommendations for administrative actions and recommendations for further study.

5.2 Summary

The study was carried out to assess the impact of population growth on water resource availability in western district Zanzibar. Three shehias namely Chukwani, Tomondo and Kiembe Samaki were studied. Generally findings show that population increase in all shehias affect domestic water sources and domestic water infrastructure leading to domestic water scarcity.

Furthermore the study reveal that there are majority spending more hours to fetch water, staying in a cue during water collection, construction of settlement, school, hospitals, roads contribute to water problem and finally suggest the presence of water bills to cope with increased population.

5.3 Conclusions

The findings of this study revealed that rapid population growth in Zanzibar brings changes in domestic water resources availability. The evidence also showed that the rapid population has effects on domestic water sources. However, the Study found that rapid population growth affects domestic water infrastructure.

The first objective of this study determined changes in domestic water sources since 1995 to 2015 for Western District. The study has shown that population is increasing in Chukwani, Kiembesamaki and Tomondo in Western District. The majority of population is experiencing domestic water scarcity in the study area because of rapid increase of population. The majority of the population commented that population growth leads directly to increase an overall water demand. Also, the majority of the population concluded that at the household level demand for water is determined by household size. However, the study concluded that there are enough sources, which can be used to deliver freshwater to the increasing population.

The basis of objective two was to examine the effects of population growth on domestic water sources in Western District. The findings from this study indicated that rapid population growth of the majority people's composition and age structure of the household contribute on increasing demand for water. Also, the majority concluded that they are waking up too early to fetch water. Further, the findings revealed that the majority of the population is not walking long distance in looking for water. Moreover, the majority of the population is spending many hours in cue during water collection.

Finally, objective three intended to assess the effects of population growth on domestic water infrastructure. The majority's findings concluded that rapid population growth damage domestic water infrastructure through construction of formal settlement and industries. Also, the majority recommended that construction of new roads and expansion of the existing ones destroy water infrastructure. Although the majority of people accepted that building of schools, hospitals and electricity supply

damage water infrastructure, they accepted that the destruction of water infrastructures is due to the ignorance of the community. Furthermore, the majority of people suggested that a water supply bill is needed for repairmen and maintenance of water resource infrastructure to cope with increased population

5.4 Recommendations

The following recommendations were drawn on the basis of this study.

(i) Education as a tool which facilitates raising awareness, exchange of information and communication should be provided on family planning in order to reduce the scarcity of water and increasing pressure on land. Also, education should be provided in order to increase awareness on freshwater management at household level. Moreover, education should be provided in order to raise awareness on destruction of water infrastructure during the establishment of settlements, construction of industries, roads and social services.

(ii) Implementation of government laws, bylaws, regulations and policies related to domestic water management. They should be implemented, supervised and controlled in order to reduce damage, leakage and loss of water. It should also involve discouraging of destruction of water infrastructure due to ignorance of the community. However, water management is not only a matter of supply and availability but also of enforcement, involvement, funding and capacity building instruments.

(iii) The Zanzibar Water Authority (ZAWA) as an exclusive provider of water supply services should distribute pipes. It should also rehabilitate the broken ones and also construct many new pipes to meet the demands. Moreover, it

should increase water supply coverage and reduce loss of water from 30% to 1% so as to improve domestic water supply connections.

(iv) ZAWA should establish and improve other sources of fresh water found near the residencies; and connect pipes in order to enhance domestic water management in the district.

(v) The Revolutionary Government of Zanzibar should integrate with other actors in the Western District Council, Private Sector and Non-Governmental Organizations (NGOs) in order to make coverage to the disadvantaged areas rather than confining to some specific areas.

(vi) Policy makers and planners should consider the adoption of proper planning and management in order to increase domestic piped water supply management.

5.5 Recommendations for Further Studies

The study dealt only with the impact of population growth in water resources availability in Western District, Zanzibar. It is recommended that, further research should be done to investigate the current impacts of climate change on water resources in Zanzibar or other related aspects on water resources management.

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APPENDICES

Appendix 1: Questionnaires

Prepared by: **Salma Yahya Ayoub**

Instructions:

1. This research is for academic purpose only.
2. Answer for the best of your knowledge.
3. Your responses will be confidential.
4. Your cooperation is highly respected.

Name of Shehia …….

Household size: (A) 1-5 (B) 6-10 (C) 11 + ( )

Questionnaire for identifying domestic water availability for the local people of Magharibi District Zanzibar to be filled by heads of households.

Sn	Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree
1	Population is increasing in my shehia.					
2	There is domestic water scarcity in my shehia because of population increase.					
3	Population growth leads directly to increase an overall water demand.					
4	At the household level demand for water is determined by household size.					
5	Composition and age structure of the household contribute on increasing demand for water.					
6	Pipeline is the kind of water I use for household consumption.					
7	Population growth damage domestic water infrastructure					

	through construction of formal settlement and industries.					
8	Construction of new roads and expansion of existing ones destroy water infrastructure.					
9	Building of schools, hospitals, electricity supply damage water infrastructure.					
10	Destruction of water infrastructure is due to ignorance of the community					
11	No enough sources which can be used to deliver freshwater to the increasing population					
12	A water supply bill is needed for repairmen and maintenance of water resource infrastructure to cope with increased population.					

Indicate the frequency of difficulties you face in fetching water

Sn	Statement	Daily	Weekly	Twice a week	Monthly	Non
1	You are supplied with water from public tape					
3	Waking up too early to fetch water					
4	Walking long distance in looking for water					
5	Spending many hours in cue during water collection					
6	Opting to use unsafe water from local wells, dams, streams etc.					

Indicate your consumption for each uses

Sn	Household water use	litters per day	litters per week	litters per month
1	Cooking			
2	Bathing			
3	Drinking			
4	Washing			
5	Other uses			

If population growth is a problem for water availability, what are the mitigation measures for this problem.....?

Appendix II: The research interview for the staffs of Zanzibar Water Authority (ZAWA)

Position holding in this institution …….

Q1. What are the main sources of water in West Region Zanzibar?

Q2. Is there any distraction of water infrastructure caused by increasing population?

Q3. Are there any changes in water source for West District from 1995 to 2015?

Q4. Do you think the sources in Q3 are sufficient to meet the demand of increasing population?

Q5. What are the strategies to be taken to ensure constant availability of water considering the population growth in Zanzibar?

Appendix III: The research interview for the Manager of Chief Government Statistician

Prepared by: Salma Yahya Ayoub

Position holding in this institution…….

Q1. Is the population grows in west district Zanzibar?

Q2. What are the reasons for the answer you provided in (Q1) above?

Q3. Do you have any record that shows water problems relating to population growth in west district?

Q4. What is your opinion in reducing water problem caused by population growth?