ENVIRONMENTAL HEALTH IMPLICATIONS OF WATER SCARCITY IN BEITBRIDGE TOWN, MATEBELELAND SOUTH PROVINCE, ZIMBABWE

A Mini Dissertation submitted in partial fulfilment of the degree of Masters of Public Health, University of Venda, Thohoyandou, South Africa.

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Abstract

Water scarcity is a critical environmental health issue. Its shortage results in deterioration of health and sanitation, particularly domestic water which is a fundamental basic for daily living. This study was focused on assessing the extent to which water scarcity at household level and the associated environmental health impacts on people in Beitbridge town of Zimbabwe. Empirical evidence was gathered using the questionnaire survey method targeting three residential sites of the town. Questionnaires were administered to a sample of households. The Statistical Package for Social Sciences (SPSS) was used to analyse the data. A relationship was drawn between water scarcity and environmental health implications using the binary logistic regression model. The study's results provide compelling scientific information that will act as a guideline on the extent to which water supply affects people's health.

KEYWORDS: water scarcity, health, sanitation, domestic water, environmental health.

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List of acronyms and abbreviations

WHO – World Health Organisation

UNICEF – United Nations Children Fund

UNDP – United Nations Development Programme

UN – United Nations

MDGs – Millennium Development Goals

CDC – Centers for Disease Control and Prevention

WRMSS- Water Resource Management, Supply and sanitation

NGO- Non Governmental Organisation

CHAPTER 1 INTRODUCTION

1.1 Introduction and Background to the Study

Globally it is estimated that 1.1 billion people have no access to improved water supply, and 2.4 billion people having no access to any improved sanitation facilities. Every year nearly 2 million people die due to related to sanitary and water diseases such as diarrhoeal and the most vulnerable group are children below the age of five. The problems are more pronounced in developing countries. (World Health Organisation, (WHO)/ United Nations Children's Fund (UNICEF), 2012). Everyone has the right to water and this right is internationally recognised (United Nations Development Programme (UNDP), 2006; WHO/UNICEF, 2008; World Bank, 2013). According to the UN report, the 21st century challenges might not be war, hunger, civic disorder or disease but the lack of fresh water.

Water and its environmental challenges have been identified by Goal 7.C of the Millennium Development Goals (MDGs). Its target was to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation. So far this target has been met ahead of the schedule. Two billion people have gained access to improved drinking water between 1990 and 2010. Currently 11% (783 million) of the people in the world lack improved drinking water and 40% of these people without improved drinking water are from Sub Saharan Africa (United Nations (UN), 2012).

While approximately three quarters of the earth is covered with water (70%), only a small fraction (1%) of it is available as fresh water for consumption (Vorosmarty, 2005)). As a result of rapid urbanisation, increased farming, and climate change, WHO has highlighted a severe water crisis especially for fresh water in some of the African and Asian countries. According to the UN (2012) about one fifth of the world lives in countries which do not have enough water supplies for their use (UN 2012; Centers for Disease Control and Prevention (CDC), 2007). Population growth, climate change, and pollution which is estimated to be at 12.000 cubic metre of waste water, the capacity which is far beyond the carrying capacity of the 10 world's largest river basins at any given point in time severely affects the supply of fresh water (McCarthy, 2003).

Since the year 2000, there has been virtually no investment in the service delivery for the past decade. Water provision was on the peak since the country won its Independence in 1980 until up to around late 1990s, which was followed by a sharp contrast in the decline of service provision in the millennium era.

The year 2000 has been Zimbabwe's turning point in the provision of water resources to both the urban and rural communities. Zimbabwe fell into arrears with the international community and this led to the closure of the much needed assistance from the donor community in financing the provision of water and sanitation to the entire country. The millennium decade has witnessed a sharp decline in the quality of water services provided (Water Resource Management, Supply and Sanitation, Zimbabwe Report (WRMSS), 2009). The full picture of deterioration became so clear in August 2008 when cholera epidemic hit more than 100,000 cases and with 4,300 deaths all related to water and sanitation conditions (WRMSS, 2009).The study will focus only on domestic water supply, which primarily impacts on health and productivity. This implies that the study will concentrate on the environmental health implications of water scarcity.

1.2 Problem Statement

Beitbridge is a growing border town in Zimbabwe that has witnessed a high influx of people from various parts across the country in a bid to capitalise on business and employment opportunities being anticipated by many from the cross border notion. However the town council's inability to expand on the water reservoirs and persistent drought within the province has led to acute water shortage in the town thereby affecting environmental sanitation and the health of its residents. According to an article by Mashudu (2013), the Beitbridge Town Secretary Dr Sipho Singo indicated that, "*The town needs at least 15 000 m3 of water per day, although the local authority is able to supply only a third of the daily requirement. The border town has 4 000 houses and is home to more than 40 000 people, and thousands of travellers pass through it every day*".

Failure to expand the existing water infrastructure to meet the increase in population and travellers passing through the Beitbridge border post has adversely compromised the health and sanitation of residents and travellers. While many studies have been done on environmental health and water scarcity across the globe (Montgomery & Elimelech, 2007;

Prüss, Kay, Fewtrell & Bartram, 2002; UNDP, 2006; WHO/UNICEF, 2008; World Bank, 2013), literature is scarce when it comes to Beitbridge's water scarcity and the environmental health challenges it presents. Therefore this study seeks to fill in that knowledge gap.

1.3 Rationale for the study

Water scarcity is a significant global problem affecting man and his environment. The study seeks to provide valuable insight into the issues surrounding water scarcity and the associated health effects. The area of focus is Beitbridge Town that frequently suffers from water shortages which have gone unaddressed for a couple of years mostly due to economic woes that Zimbabwe suffered in the past ten years. Water scarcity in Beitbridge, (border town), has serious effects which can be easily spread through the transmission of water related diseases between the two countries which share the border. Therefore this study is meant to highlight the need for an action to improve the water and sanitation conditions to promote and protect public health.

1.4 Significance of the study

By understanding community vulnerability to water scarcity, water supply and health, the research seeks to enhance knowledge on water and health issues. Findings from this study will help government and health officials in decision making to prioritise efforts to prevent rather than cure environmental disease outbreaks such as cholera. Government spending will be directed towards improving water and sanitation conditions rather than on curing victims of environmental related diseases.

The research will generate a great deal of interest to the environmental sanitarians and the Beitbridge community at large by increasing their knowledge base and awareness about water, sanitation and health, thereby improving public health.

1.5 Aim and Objectives

1.5.1 Aim

The research seeks to investigate environmental health implications of water scarcity in the Beitbridge border town of Zimbabwe.

1.5.2 Objectives

- To analyse the causes of water scarcity in Beitbridge.
- Analyse domestic water demand and supply in Beitbridge Town.
- To assess the impact of water scarcity on health and sanitation.

1.6 Definition of terms

Terms used in this study have been conceptually defined.

Environmental health- is the study of the physical, chemical, and biological factors external to a person, and the control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments (WHO, 2013).

Water Scarcity- is defined as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied (UN, 2007).Water Scarcity is gauged in cubic metres, when available fresh water falls below 1,700 cubic metres per person annually.

1.7 Organisation of the dissertation

This dissertation has five chapters, thus:

Chapter 1: Introduction of the study. Included in this chapter are the background and rationale of the study, statement of the research problem, justification and rationale of the study, objectives and operational definitions of key concepts and terms.

Chapter 2: Review of related literature. This chapter links the water scarcity to environmental health. Central to this are issues pertaining to water supply situation, sanitation conditions and disease outbreaks. A conceptual framework is employed to explain the scenario presented by the water-supply situation . At the end of this chapter, a summary of the review of literature is presented.

Chapter 3: Research methodology. It includes a description of the study area, research design, sampling procedures as well as data collection and analysis methods and techniques used.

Chapter 4: Research findings of the study. Results are presented in this section using tables , pie charts and graphs.

Chapter 5: Discussion of research findings, conclusions and recommendations. Firstly, is discussion of the research findings, followed by conclusion and lastly recommendations are presented in this chapter.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This section is divided into two parts namely: data based literature and conceptual based literature. The study examines Global, African and Zimbabwean context in relation to water, health and sanitation issues. The epidemiological triad was used as the conceptual framework to this study. The researcher argued that there is a close relationship between the ever recurring water borne disease and the water supply situation in Beitbridge.

2.2 Global situation on water scarcity

Every year on March 22, the world takes a reflection on water issues as they continue to pose a threat on livelihoods (UN, 2014). Water scarcity affects the socio-economic sectors and impinges on the sustainability of natural resources. Varying opinions have been put forward by different experts as to whether there is water crisis in the world or not. However in mid-November 2006 there were media reports about water shortages in parts of Australia, Botswana, Canada, China, Kuwait, Malawi, Liberia, Uganda, United Arab Emirates, Philippines and South Africa (UN, 2007). Water scarcity is both natural and man-made , with some experts arguing that there is enough fresh water on the planet to cater for the six billion people. However, the problem lies in the uneven distribution of the water and wastage by others through pollution and unsustainable management of the resources (UN, 2007).

In a study done by Chatres and Williams (2006), China ranks sixth in the world in terms of water resources, with approximately (2.8 trillion m^3) water reserves and an annual per capita of renewable fresh water is 2300m3. Water scarcity in China is mainly a result of the country's huge population and climate change. Like many other nations, China suffers from the same problem of having too much water in the wrong place. The northern part of China has a human population of 33% and 7.7% of the national water resources, whereas the southern part has 21.3% of the water resources, a region with less human population and industrial activities.

Furthermore they said Australia, like China is faced with a situation whereby water is in abundance in the northern part of the country where a few people live and relatively scarce in

the southern part where the majority lives. Climatic conditions and decline in rainfall is cited as a contributing factor to water scarcity. Although Australia has enough water resources, its heavy extraction in the agricultural sector can compromise the environmental sustainability, hence care has to be made to balance environmental sustainability of water for the future and agriculture production.

In the Arabic world studies were also done by Postel (2000) who highlighted that there is a massive water shortage due to sparse rainfall distribution in the Arab nations. Jordan is ranked among the top five countries that face severe water shortages. Limited resources, population growth, refugees and water disputes with Israel are cited as some of the challenges affecting Jordan water supply. In the year 2010, Jordan's water demands exceeded its supply by 200%. Ground water aquifers were overexploited. Jordan river, which used to be the major source of water, was diverted by the countries which share the river and such countries like Israel benefit most while downstream countries like Jordan receive less.

2.3 African situation on water scarcity

In Africa, the threat from water uncertainty is said to be higher compared to other continents. Falkenmark (1989) highlighted that in Africa population increase is consuming the future water potential. He predicted that countries in Northern Africa which depend heavily on Agriculture will have arrived at absolute water scarcity. The problem of water in Africa is a combination of the natural dryness of the region, climate change and frequent years of drought (Falkenmark,1989).

According to studies done by Awuah, Nyarko & Owusu (2009) in Accra, the capital city of Ghana approximately 25% of the residents have 24hour water supply while 30% have an average of 12hour water ration per day for five days a week. Another 35% has water for 2 days per week and the remaining 10% hardly has access to piped water supplies. Ground water is the major supply of water in the rural areas, despite the presence of heavy metals in the water which are far above the WHO recommended standards for safe drinking water. Financial constraints have been cited as the major obstacle preventing Ghana from meeting the MDGs such as the provision of safe water for all.

A study in Nigeria revealed that more than 90% of rural areas and 60% of urban areas are threatened with water related diseases. The majority of people particularly in rural areas face water shortages. The daily per capita water consumption in Nigeria ranges between 10-27 litres, a figure which is far less than the internationally recommended standard of 115 litres per person. Benue State in Nigeria has an ever recurring challenge of water supply and 95% of the residents lack access to water supply facilities (Utsev and Aho, 2012).

A vulnerability assessment on water resources done in the Eastern Nile Basin covering three countries, namely Ethiopia, Egypt and Sudan found out that the vulnerability to water resources is highest in Sudan, followed by Ethiopia and then Egypt (Hamouda, El-Din,& Moursy, 2009).) The study revealed that in Egypt vulnerability is mainly a result of hydro physical factors, in Ethiopia and Sudan vulnerability is closely linked to poverty and underdevelopment. Water stresses in Egypt are caused by the huge withdrawals mainly meant for agriculture, whereas in Ethiopia and Sudan water stresses result from mal-distribution and the deteriorating water quality coupled with governance, politics and poor management.

Water scarcity is a relative term which can be caused by many circumstances. Distance and time taken to access water and its availability are other issues considered. Infrastructure to make water available can be there but its accessibility to social groups can also vary thereby straining the already scarce resource. In Botswana, a study conducted to assess the accessibility of water by HIV/AIDS care centres revealed that, although infrastructure to deliver water was available, the water was not constantly supplied to the caregivers (Ngwenya and Kgathi, 2006). Cited amongst the reasons for such unreliable water supply was the issue of breakdown of the water pump, and shortage of diesel.

2.4 Policy framework for water and sanitation in Zimbabwe

Zimbabwe is a semi-arid country reliant on regular rains. Early 1980 just after the country won its independence; it launched several programs to develop its water and sanitation facilities through the country's national water authority which was Zimbabwe water Authority (ZIWA) by then. Around 1994, the government renamed this authority to Zimbabwe National Water Authority (ZINWA) to oversee the management of water as a resource in the country. The Water Act of 1998 sought to reform the country's water

resources to ensure a more equitable distribution of water resources and community involvement in its management. Water rights were replaced by water permits. This meant that water was no longer privately owned. Water was to be treated as an economic good and the principles of polluter pays were adopted (WRMSS, 2009).

Institutions for water and sanitation were organised and laws and policies constituted for this service provision. Four categories were identified as follows:

- Water resource management
- Urban water supply and sanitation
- Rural water supply and sanitation
- Irrigation

Below is a diagrammatic illustration of the institutional arrangements in water management in Zimbabwe.

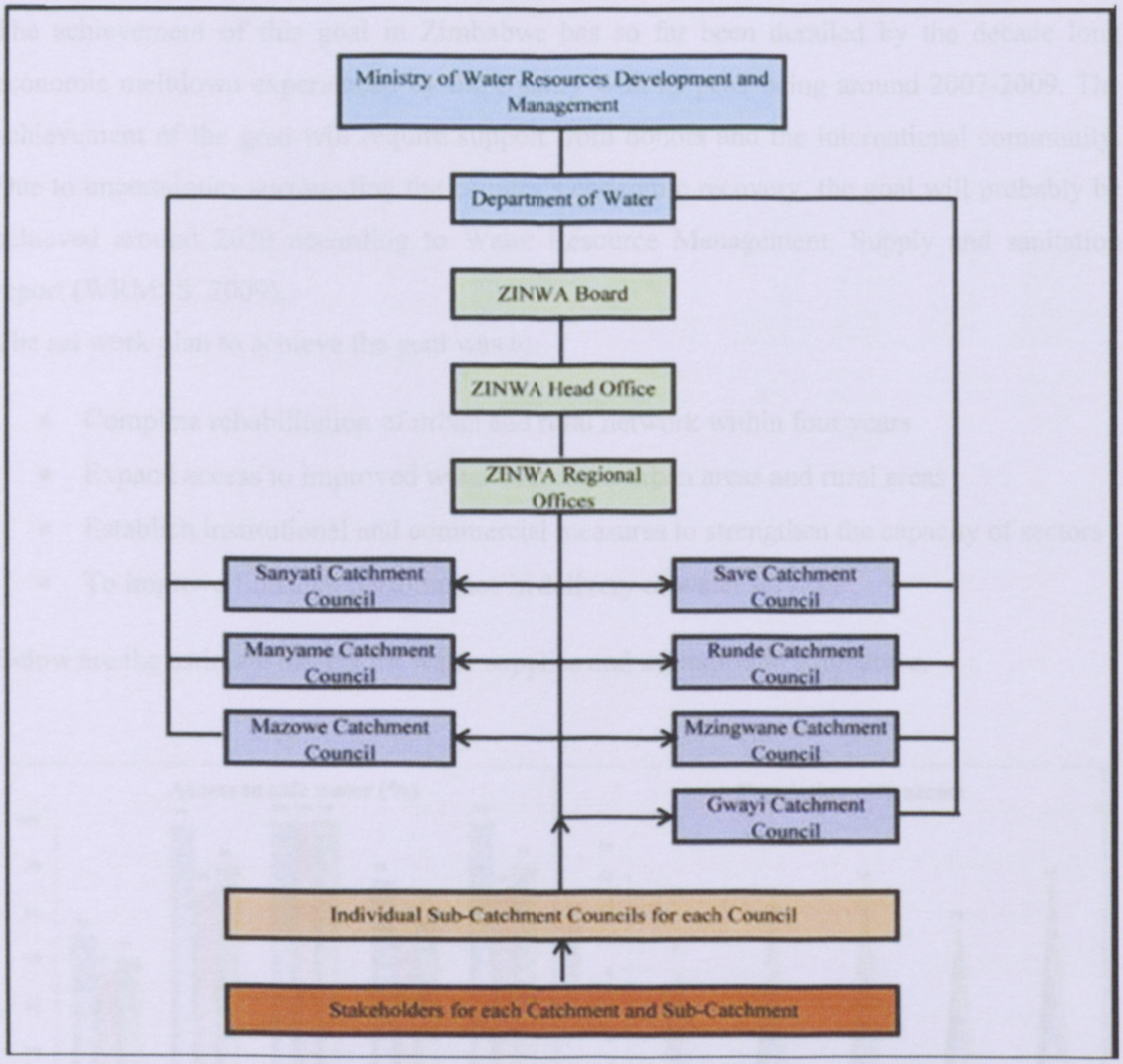


Figure 2.1: Institutional Water Management. *Source: WRMSS (2009), pg 3.*

2.5 Zimbabwe: Towards the millennium development goal 7.

The Millennium Development Goals (MDGs) were a resolution made at the 55th session of the UN General Assembly in September 2000 in New York (UN, 2012). Targets to improve livelihoods were set to be achieved over a 25 year period from 1990 – 2015. Zimbabwe embraced the targets and incorporated them into the framework for water and sanitation sector by 2015. The overall objective was to achieve a 100 percent access to water and

sanitation in both urban and rural communities. Goal 7.C of the MDG pertains to reducing the population without access to drinking water and sanitation by half by the year 2015.

The achievement of this goal in Zimbabwe has so far been derailed by the decade long economic meltdown experienced by the country with its peak being around 2007-2009. The achievement of the goal will require support from donors and the international community. Due to uncertainties surrounding the country's economic recovery, the goal will probably be achieved around 2020 according to Water Resource Management, Supply and sanitation report (WRMSS, 2009).

The set work plan to achieve the goal was to:

- Complete rehabilitation of urban and rural network within four years
- Expand access to improved water sources in urban areas and rural areas
- Establish institutional and commercial measures to strengthen the capacity of sectors
- To improve financial performance in delivery of water services

Below are the estimate targets for water supplies and sanitation in Zimbabwe.

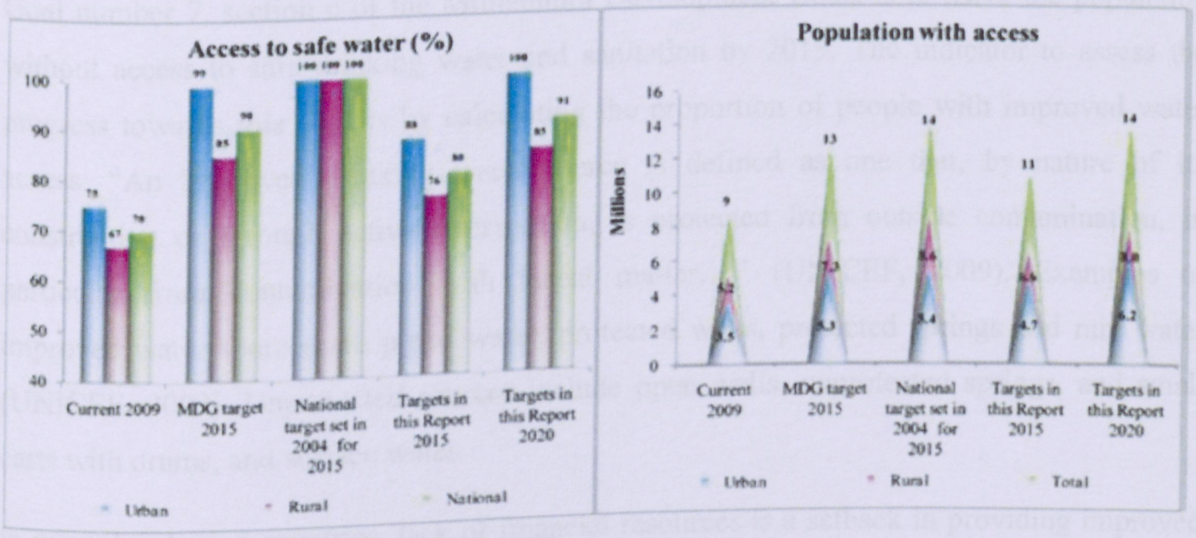


Figure 2.2: Targets to achieve the MDG on Water Supply. *Source: WRMSS (2009), pg 31.*

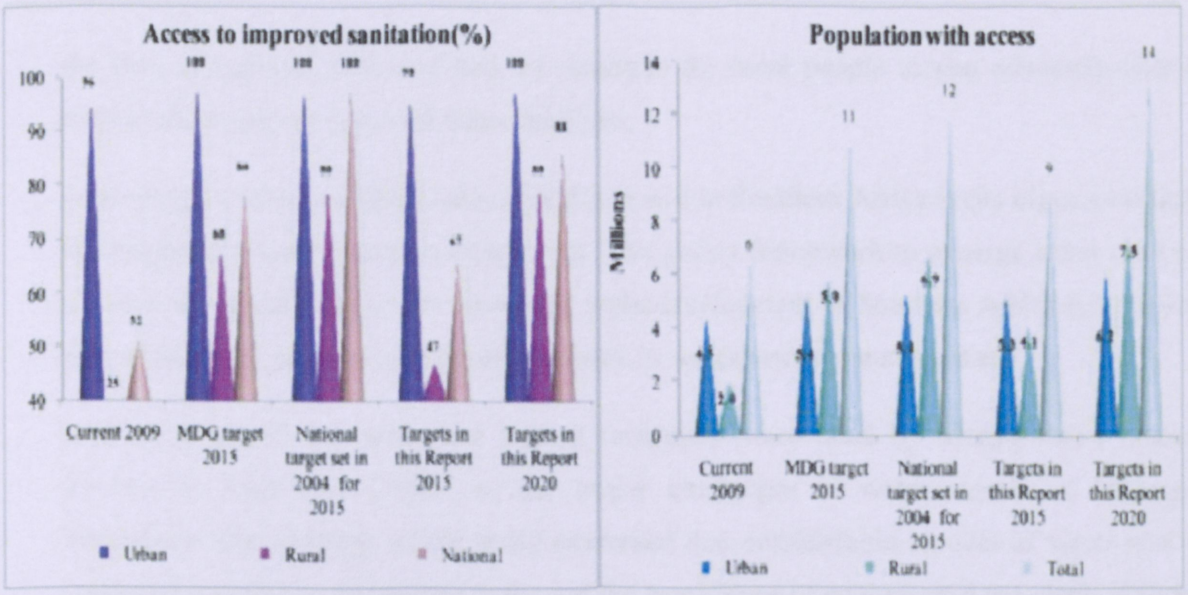


Figure 2.3 Targets to achieve the MDG on Sanitation. *Source: WRMSS (2009), pg38.*

2.6 Obstacles to achieving the Millennium Development Goals

Goal number 7, section c of the Millennium Development Goals is to halve the population without access to safe drinking water and sanitation by 2015. The indicator to assess the progress towards this goal is by calculating the proportion of people with improved water access. "An improved drinking water source is defined as one that, by nature of its construction or through active intervention, is protected from outside contamination, in particular from contamination with faecal matter…'' (UNICEF, 2009). Examples of improved water sources are piped water, protected wells, protected springs and rain water (UNICEF, 2009). Unprotected sources include open wells, unprotected springs, and small carts with drums, and surface water.

In most developing countries, lack of financial resources is a setback in providing improved water. This is coupled with low prioritisation of water and sanitation programs. Corruption, lack of accountability, inefficient management and lack of political will are other factors which have led many African countries fail to provide safe drinking water. This is confirmed by a study carried out in Kenya which observed that, six months after installation of hand pumps, less than 50% mere functioning (Montgomery and Elimelech 2007). This shows how

the lack of political will and lack of incentive for local people to can adversely alter the maintenance and operation of water facilities

According to Swatuk (2008), lack of political will in Southern Africa is the biggest challenge in integrated water resource management. The policy framework to manage water resources is rather too weak. The socio- economic underdevelopment of Southern Africa has created a web of political, social and economic setback in water resource management.

Lack of financial resources and human incapacity were cited by Manyanhaire, Matewa, Svotwa & Munhuwa (2009) as the major challenges in water supply in Mhangura, Zimbabwe. The findings of the study expressed that considerable amount of water was lost along the way due to water pipe leaks and the breakdown of equipment due to lack of finance to upgrade new water systems. The increase in tariffs was also contributed to water problems in the area as the residents resisted the new tariff rates when the cost of producing and delivering a unit of water escalated.

Engineering shortcomings, management and institutional failure, corruption, population growth, rising demands, social factors and competition between water users have been identified as some principal cause of water supply shortages (Butterworth and Soussan, 2001; Gwebu, 2002) Most of the factors reflect some failure in management and policies rather than natural factors and as such improvements can be done to the existing systems. For example competition for water resources between agriculture, industry and domestic uses highlights some aspects of water resource which are fundamental in water priorities.

2.7 Domestic water demand and supply

The Southern African region is characterised by low rainfall and high evapotranspiration rates. Renewable fresh water for the region is around 1400 billion m^3. The water resources are unevenly distributed over time, source and space (Mwendera, Hazelton, Nkhuwa, Robinson, Tjijenda & Chavula 2003). For the past decades, water policies in most African countries focused on increasing water supply by building dams but did not pay attention to demand management. Pollution, inadequate maintenance and costly tariffs are the major problems affecting water supply in Southern Africa. Poor water management policies create

serious water shortages and give a false picture of the actual water demand (Mwendera et al., 2003).

Adequate domestic water supplies contribute largely to environmental sanitation and livelihoods in several ways. The role of domestic water supplies goes beyond just consumption to promoting food security, supporting ecosystems that support livelihoods and household maintenance among others as noted by Butterworth and Soussan (2001). Water is among the most basic human needs for human survival. Table 2.1 below shows the role of domestic water supplies in supporting livelihoods.

An article by Hunter, MacDonald & Carter, (2010) describes a safe, reliable, accessible water supply as a critical component for good health. In most developing countries water supply aims at increasing water availability, changed water uses and water management habits. The table below shows the basic roles of water.

Table 2.1: Roles of domestic water supplies to environmental sanity and livelihoods

Role to Livelihoods	**For example**
Food security	Use of domestic water and waste water recycling in rural communities and urban areas , for example for gardening
Health and Household maintenance	Such uses as washing, cooking, drinking, bathing, watering.
Water based livelihoods	Water use for agriculture, industries, commerce and construction
Ecosystem maintenance	Sanitation facilities and maintenance of equilibrium of the ecosystem.

Source: *Butterworth and Soussan (2001), pg2.*

The UN (2010) through the office for the coordination of Humanitarian Affairs predicted a growing demand of water resources. Water use has been predicted to have grown twice the rate of population growth in the last century. Rapid global population increase has increased

demand for both renewable and non-renewable resources. Estimated predictions on water demand were that the ability to feed everyone in 2050 will require 50 percent more water than what is needed today.

Rapid urbanisation in most African cities has created a challenge to service provision (Gumbo 2004). Demand for water resources has always been on the peak in many African cities. Water demand management has been introduced in many African cities and towns as a solution to water woes in the region. Water demand management's ultimate goal is to achieve water use efficiency.

Dube and Zaag (2003) highlighted that water demand management aims at achieving a desirable demand and a desirable use. With the rise in water demand in most African cities, water demand management has become a better option to ensure water security in the region than simply focusing on the supply side while ignoring the demand side.

In a study carried out in Masvingo by Gumbo and Zaag (2003), most African countries were faced with a serious dilemma on whether to increase the supply aspect by building more dams and other water sources or go for demand management. The study concluded that Masvingo town needed to address both the demand and supply in order to improve on water resources. Domestic water demand has gone up in the town of Masvingo, whereas industrial and commercial demand has gone down due to closure of most industrial sectors as a result of economic hardships.

Another component on water demand was the one that was noted by Arbués, Garcıa-Valiñas, & Martınez-Espiñeira (2003) in which they said that water pricing, per capita income and household composition are critical determinants of residential consumption. He noted that demand is elastic and water pricing can yield water savings if policy-makers can effectively use it to manage demand.

According to Nnaji, Eluwa, & Nwoji (2013) water use is greatly a function of monthly income, cost of water, time spent to collect the water, capacity of storage tanks, household size and the number of refills per months. Such were their the conclusions after carrying out a study in Nsukka metro in Nigeria (year), where the average water consumption is 34.9l/ day, a level far below the daily basic water needs standards set by WHO.

A definition of water demand by Froukh (2001) is stated as the amount of water that is required for various uses. Demand is something that can be controlled if it is divided into various components and be managed. Froukh (2001) noted that several natural and manmade factors aid in increasing water demand.

In Tanzania, Maganga, Butterworth & Moriarty (2002) highlighted that water supplies in Tanzania are greatly impacted by:

- Conflicts over water resources like debate on the use of mixed irrigation system or the traditional furrows
- Pollution risks, for example water from Dar es Salam is heavily polluted by siltation and chemicals mostly due to commercial agriculture.
- Sanitation challenges, the use of ground water and shallow wells with increasing risk of water contamination from pit latrines.

2.8 State of health and sanitation in face of water scarcity

Safe, reliable, affordable and accessible source of water is the key to good health. The World Health Organisation defines Health as a state of complete physical, social and mental well-being not merely the absence of disease and infirmity (Üstün & Jakob 2005). Below is a table which shows the amount of water required for good health?

Table 2.2 Basic water needs for good health

Drinking and food (water intake)	**2.5-3L per day**	**Depends on climate and individual physiology**
Basic hygiene practices	2-6 L per day	Depends on social and cultural norms
Basic cooking needs	3-6 L per day	Depends on food type, social and cultural norms
Total basic water needs	7.5-15 L per day	

Source*: Üstün & Jakob (2005), pg 5.*

Sanitation is defined by WHO (2012) as the provision of facilities and services for the safe disposal of human urine and faeces. It also refers to maintenance of hygienic conditions through the provision of such services as garbage and waste water disposal. Poor sanitary conditions are associated with health problems. Poor hygiene is usually caused by lack of adequate quantities of water supply to meet the domestic needs (Adeoye, 2001) .Without

adequate supplies of water, basic sanitary conditions essential for promoting good health cannot be met. In order to determine if water supply can meet the health standards, six parameters were considered (Hunter et al. 2010), and these are:

- The quality of water- the chemical and biological components of water;
- The quantity of water- volume of water required for everyday use;
- Access to water- usually refers to distance and time spent to access the water;
- Reliability - both for urban dwellers with improved water supplies and rural with unimproved water supply. Disruptions in piped water may affect the reliability of water and also unimproved water sources usually in rural areas, like wells may dry up affecting reliability;
- Cost of the water- utility bills for water affect its availability;
- Ease of management for end user- end users of water only pays the bills of water and is not directly involved in management, maintenance and operations.

Table 2.3: Relationship between the service level and the level of health concern

Service level	Access measure	Needs met	Level of Health Concern
No access (Quantity collected is below 5 I/cd)	More than 1000m or 30 minutes time spent to collect water	Consumption is not assured Hygiene not possible unless done at source	Very high
Basic access (average quantity not likely to exceed 20 I/c/d)	Between 100 &1000m or 5 to 30 minutes spent to collect water	Consumption can be assured. Hygiene, hand washing and basic food hygiene can be done Laundry and bathing can be difficulty unless done at source	High
Intermediate access (average quantity around 50 I/c/d)	Water delivered through one tap on a plot 100m or 5 minutes to collect water	Consumption is guaranteed. Hygiene assured even laundry and bathing	Low
Optimal access (average quantity 100/c/d and above)	Water continuously supplied through household taps	All needs met and all hygiene needs met	Very low

Source: *WHO/SDE, Howard and Bartram (2003), pg 3.*

The table above shows the estimated quantities of water required for optimal health conditions. If basic access to water supply has been achieved, hygiene can be assured. Access to improved water supplies from protected water sources coupled with behaviour, notably of face and hand washing increases gains in public health. On the other hand, reduced water supplies will increase the chances of intake of contaminated water.

From the table above the groups with no access to water are said to have no water security. The second category is the group with basic water supply which has partial household water security. The last group comprises those with optimal access and above. The group is said to have a sustained water security (Howard and Bartram, 2003).

Gleick (2002) estimated that 80% of diseases in the world are connected to unsafe water and poor hygiene. Four classes of water related diseases have been identified in Bradley's classification as waterborne diseases, these are; water washed or water scarce disease, water based disease and water- related insect disease. In his classification the relationship between water supply and disease is clearly spelt out. These diseases are associated with lack of improved domestic water supply and sanitary conditions.

Global estimation on the burden of diseases from water and sanitation was done by Prüss et al and was estimated to be at 4.0 % of all death and 5.7% of the total disease burden. Diseases taken into account were ascariasis, diarrhoeal disease, drancunculiasis, hookworm, infection, schistomiasis, and trachoma. If it can be a priority for public health, such a global burden can be reduced to minimal level. Improving water supplies greatly increases health gains in societies (Gleick 1996). From the estimation of the global burden it was revealed that water related and sanitation diseases affect the poor members of the society more than the affluent.

2.9 Diarrhoeal morbidity and mortality cases in Zimbabwe

The latest severe case of cholera outbreak in Zimbabwe was in 2008. A Country Analysis Report of 2010 reported that Cholera affected all the 10 provinces of the country. This outbreak affected 60 out of 62 districts of the country. The cumulative cases were 98 000 and 4 300 deaths were reported, with a crude case fatality of 4.3 percent. Out of all death, 62% occurred at home. In 2010 more than 4 000 cases of typhoid were recorded in Harare alone (Country Analysis Report, 2010).

It further stated that people with safe drinking water in rural areas decreased from 70% in 1999 to 61% in 2009 with 35 % of the water points were broken down.

Beitbridge, which is located at the border with the Republic of South Africa, was one of the worst affected towns, accounting for 26% of the nationally recorded cholera cases (World Bank Group, 2013).The cholera outbreak spread between Zimbabwe and South Africa. In South Africa, Limpopo province was mostly affected as can be seen from the table below.

Table 2.4: Epidemiological Data on Musina Cholera Outbreak

	Limpopo	Gauteng	Mpumalanga	KZN	North West	Eastern Cape	Northern Cape	West Cape	Free State	Total
Cumulative no. Of cases	1754	144	2	6	4	1	1	5	1	1918
Cumulative no. Of death	9	4	1	1	0	0	0	0	0	15
Cumulative no. of lab confirmed cases	110	29	2	2	4	1	1	5	1	155
Patients in the ward	158									158
New cases of the day	67									67

Source: *National Outbreak Committee Situational Report. 11 January 2009: 2*

2.10 Benefits of improved water supply (quantity and quality)

Adequate supply of good quality water is the basis for promoting hygiene and protecting the health of people. The quantity of water that people use depends on accessibility to it. If water is delivered at every household people will use more quantities for consumption and hygiene,

while consumption decreases if people are to travel some few kilometres to reach the water source. Waterborne diseases are usually transmitted through drinking contaminated water; hence improved water supply will significantly reduce the morbidity and mortality rate of water related diseases. Cholera is a disease that can be easily prevented by improving water supplies (WHO, 2012). The table below shows how improvement in water supplies can reduce morbidity levels.

Table 2.5: Impact of improved water supply and sanitation to health

Disease	**Projected reduction in morbidity (%)**
Cholera, typhoid	80-100
Diarrhoeal disease, dysenteries, gastroenteritis	40-50
Drancunculiasis	100
Schistomiasis	60-70

Source:*Esrey et al (1990), pg 86*

Health gains from improved water supply are derived if the challenge to basic water access has been overcome. Lack of basic access to water is usually a result of the distance and time involved in collecting the adequate volumes of water which are needed to support life and hygiene. Gains in water accessibility result when water can be delivered at household level to reduce the time spent on accessing water which in most cases result in reduced water consumption, both for drinking and hygienic purposes. Apart from these, huge gains in health will be realised when the quality of the supplied water is improved (Howard and Bartram 2003).

Mara, Lane, Scott, & Trouba (2010) highlighted the impact of improved water supply on diarrhoeal disease, ascariasis, drancunculiasis, schistosomiasis, and trachoma and hook infection. The evidence provided showed that diarrhoea morbidity reduced by 26%, 27% for trachoma, 29% for ascariasis, 77% for schistomiasis and 78% for dranculiasis. Reduction in such diseases was linked to improved water supply and sanitation. In their analysis they also noted that improvements in water quantities to promote good hygienic practices had greater impacts than improvements in the water quality.

Okun (1988) summarised the benefits of improved water supply and sanitation as follows:

- Prevention of diseases;
- Improved primary health care;
- Improvements in nutritional status;
- Improved services to health centres, clinics and schools;
- Time released for women, time spent in carrying water home is substantial;
- Household Irrigation and Animal watering;
- Promotion of commercial activities;
- Strengthening community organisation;
- Support for other sectors;
- Improved quality of life.

Okun (1988) noted that water supply and sanitation programs if implemented with community participation and accompanied by health hygiene education, can show their efficacy in diarrhoea prevention

2.11 Alternative water sources in urban areas

According to a study conducted by Nyemba, Manzungu, Masango & Musasiwa (2010) in Bulawayo, Zimbabwe citizens have resorted to alternative water supplies other than relying on tap water which is highly unreliable. Boreholes, wells and bowsers are the common alternative sources of water in urban residential areas in Zimbabwe. In Khumalo residential area, 88% of the population had access to improved alternative source of water. Alternatively, residents fetched water from borehole as their alternative water sources, which are over a kilometre away thus resulting in low water consumption. Additional 10 boreholes were drilled by the council to supplement erratic pipe borne water supplies.

In South Africa, taking reference from Kahinda, Taigbenu & Boroto (2007) highlighted that rain water has become a major water supply especially in the rainy season, commonly practiced in Kwazulu Natal and Eastern Cape Province. This is a common practice in rural and peri-urban areas. The advantage of rainwater harvesting is that it provides water directly to households. The quantities of water delivered are an important aspect of public hygiene and sanitation. However, the quality component remains an issue with rainwater. The quality of rainwater becomes of concern and its health implications and the possibilities of insect

vectors breeding in the water storage tanks with the possible health outcomes. Though some argue that rain water is safe for drinking the issue here lies with its storage and possibilities of contamination.

Studies done in Botswana in Ngamiland residential area revealed that residents have resorted to bowsed water, rain water harvesting, wells, boreholes and rivers for alternative water sources due to the unreliable water supply in the area. This was revealed by Ngwenya and Kgathi (2006), who further noted that chronic supply distractions have increased the use of poor quality water as well as other unhygienic practices

In Accra, the capital of Ghana, 10% of the residents lack access to piped water and these have resorted to hand dug wells, boreholes and water vendors. The population relying on such alternatives pay a high tariff per m^3 of water. However, in rural areas ground water remains the most reliable source of water (Awuah, Nyarko, & Owusu, 2009). Inadequate water resources have resulted in the inability of the population to access water through household taps.

2.12 Conceptual Framework

In articles by the Centers for Disease control and Prevention, an epidemiologic triangle is a scientific model that has been developed in studying health problems. In this study the epidemiologic triangle will be employed to explain the spread and transmission of water borne diseases.

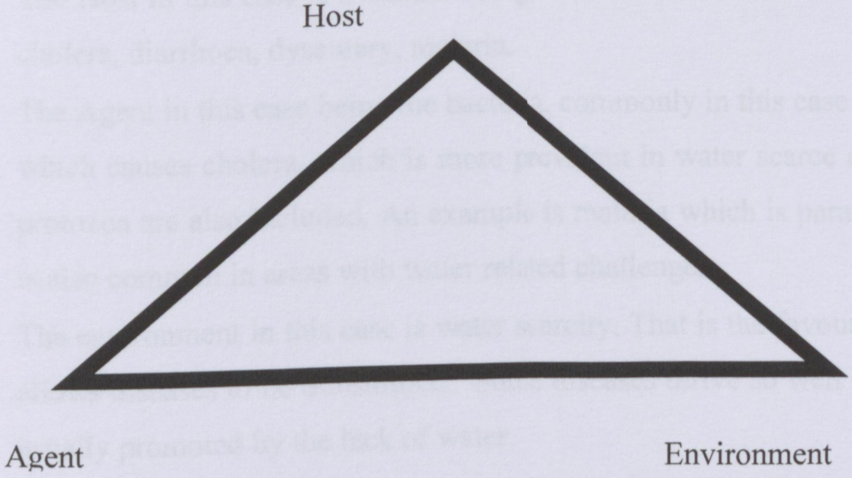


Figure 2.4: Epidemiological triangle, *Source : Centers for Disease Control and Prevention, (2010)*

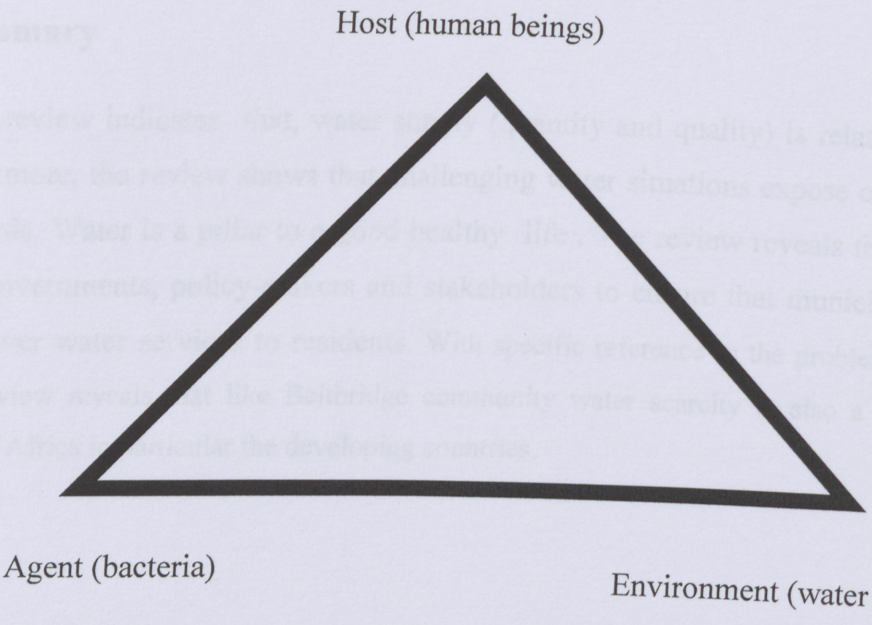
The triangle has three components which are :

Agent: the microbe that causes diseases (the "what" of the triangle)

Host: organism harbouring the disease (the "who" of the triangle)

Environment: external factors that cause or allow disease transmission (the "where" of the triangle). The goal of an epidemiologist is to break at least one side of the triangle, disrupting the connection that exists between the host, agent and the environment, hence cutting off the disease.

In this case the triangle below shows the relationship between water scarcity and disease outbreaks



- The Host in this case is a human being, who harbours such water related disease like cholera, diarrhoea, dysentery, malaria.
- The Agent in this case being the bacteria, commonly in this case is the vibrio-cholerea which causes cholera, which is more prevalent in water scarce conditions. Fungi and protozoa are also included. An example is malaria which is parasitic protozoan which is also common in areas with water related challenges.
- The environment in this case is water scarcity. That is the favourable condition which allows diseases to be transmitted. Some diseases thrive so well in dirty environments usually promoted by the lack of water.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

This research assessed the environmental health implications of water scarcity in Beitbridge town in Zimbabwe. The findings of this research are meant to raise some public awareness on the nature and magnitude of water scarcity on health and sanitation. This chapter presents the study area and its geographic setting. This is followed by the description of the population and sampling procedure. Data collection tools, data analysis techniques and ethical considerations for this research are also outlined in this chapter. A summary closes the chapter.

3.2 Study design

The study adopted a cross sectional research design and used quantitative research approach. A cross sectional study design according to Bryman, Bell, Hirschsohn, Dos Santos, Du Toit, Masenge, Van Aardt & Wagner (2014) involves the collection of data on more than one case at a single point in time. This design usually enables the collection of quantifiable data in relation with two or more variables. The above characteristics made it the appropriate research design for this study.

3.2 Study setting

The study was conducted in Beitbridge town in Zimbabwe. Beitbridge is a Zimbabwean town on the border between South Africa and Zimbabwe. It is located in the province of Matabeleland South, 583km from Harare (Zimbabwe) and 20km from Musina (South Africa). The town has a population of about 40,000 and is dominated by the local Venda people. Currently the town has one water treatment plant which is located just a few metres away from the Limpopo river. The source of water for the town is Limpopo River. The town needs at least 15 000 cubic metres of water per day although only a third of this amount is supplied daily. Due to water shortage residents resort to fetching water from the 33 boreholes dotted across the town.

Figure 3.1: Beitbridge Map. Source (www.maphill.com › Africa › Zimbabwe › Matabeleland South)

3.3 Study population and sampling

The study was conducted at Beitbridge Town which has a total population of 40 000, and a total of 4 000 households. A household was used as the sampling unit of analysis in this study with the target population being an adult member of the household.

Households in Beitbridge are divided into 3 sections, which are: low density, medium density and high density suburbs.

Table 3.1: Households clusters in Beitbridge

RESIDENTS	NO. OF HOUSEHOLDS
Low density	654
Medium density	1236
High density	2110
Total households	**4000**

The sample size was calculated using Cochran (1977) formula below, where N is the total number of households, n is the sample size and e is the accepted level of error, which in this case is 0.05.

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

$$n = \frac{4000}{1 + 4000 \times (0.05)^2}$$

$$= 363$$

Sample size (n) = 363 households

The numbers of households who participated in this study were drawn from all the 3 residential sites. Each site acted as strata and the households to participate were drawn in proportion to the total population in order to achieve some degree of representation.

Systematic sampling was used to select households from each stratum to participate. The total number of households in Beitbridge were divided by the sample size, which is 4000/363 = 11. This means that every eleventh household was selected for the study.

This means the numbers of households to be interviewed per each cluster are as follows:

Table 3.2: Sampling technique per cluster

RESIDENCE	Total Households	Percentage of household representation (%)	No. Of Households per residence
Low	654	16.4	60
Medium	1236	31	112
High	2110	52.6	191
Total	**4000**	**100**	**363**

3.4 Measurement instrument

To generate the much needed information a questionnaire was self-administered to the adult member of the households. The questionnaire was divided into five sections as follows: demographic profile of participants, water availability, water demand and supply, water amenities, sanitation and health

3.4.1 Validity

Validity is the degree to which an instrument measures what it is supposed to measure (Kazi and Khalid, 2012). Content validity, criterion validity and construct validity were ensured. To ensure content validity, the instrument for this study was designed in line with the already existing questionnaires that have been used for similar studies based on literature reviewed. For criterion and construct validity the questionnaire was reviewed by the supervisors, experts in the Department of Public Health, and environmental health practioners for assessment.

3.4.2 Reliability of the instrument

A pre-test was carried out to ensure reliability of instrument to this particular study. The questionnaire was administered to a sample approximately 10% of study sample before being administered to the total sample population. The 10 % sample was a representative from all the three residential sites. The questionnaire was pre-tested prior to the actual data collection

to check its ability to gather the required information. The pre-test was done on three residential locations. The pre-test identified some disparities and adjustments were done basing on the suggestions and recommendations from the pre-test.

3.5 Data collection

Data was collected using a questionnaire which was administered to adult members of the households. Structured and semi structured questions were asked. See Appendix A. Data collection lasted for 10 days as the researcher was moving from one household to another.

3.6 Data analysis

After data collection, the responses from the questionnaire were inspected to establish whether proper and complete data had been acquired. Data was entered in the Statistical Package for Social Science (SPSS v 21) .After coding; descriptive and analytic statistics were used to analyse the data. The results of the analysis were presented in form of tables and graphs. Cleaning of the data collected was done to prevent missing data, frequency tables were obtained and used to examine data for accuracy.

3.6.1 Analysis of associations

An association between environmental health implications and water scarcity was discerned using the Binary Logistic Regression Model. The regression model was carried out to statistically validate the results. The Binary Logistic Regression Model is a statistical method for analysing one or more explanatory (independent) variables that determine an outcome (dependent variable) which is binary or dichotomous (has two possible outcomes) (MedCalc, 2011). The goal was to find the best fitting model to describe the relationship between water scarcity and environmental health problems

The model assumes the following formula

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots\cdots + \beta_n x_n + ui$$

Where

Y = Is the dependent variable (i.e., the probability that a household has witnessed sickness related to water and sanitation problems in the last 4 years)

X_1 = Water Scarcity index for each residential area

X_2 = Age of affected household member(s)

X_3 = Wealth Status (as defined by income level)

X_4 = Gender of affected household member(s)

X_5 = Household Locality (i.e. whether household resides in high density, low density or medium density residential area)

X_6 = Highest educational level

ui = error component

k= constant

The choice of explanatory variables was made on the basis of the review of literature on water scarcity and environmental health implications.

3.6.2 Model evaluation

Parameters in the model were estimated using the maximum likelihood method. The statistical significance of each coefficient was evaluated using the Wald test. The goodness-of-fit test of the regression model in this study was analysed using

- The Omnibus test, which is a likelihood ratio chi-square test that test whether the coefficients of the variables in the model are all jointly equal to zero.
- The Hosmer & Lemeshaw (H-L) goodness-of-fit test, which examines the null hypothesis that the model adjust well to the data and
- The Cox and Snell (1989) and Nagelkerke (1991) – two descriptor measures that reveal the amount of variation in the outcome variable that is explained by the models (Long, 1997; Hosmer and Lemeshaw, 2000).

3.7 Ethical considerations

3.7.1 Ethical clearance

Approval to undertake the study was sought and granted from the University of Venda's Research Ethics Committee (see Appendix B). Permission to conduct the research in Beitbridge was requested from the Beitbridge District Administrator.

3.7.2 Informed consent

The researcher explained to the participants the purpose of the study and informed every participant that their participation in the study was voluntary, and they had a choice to either participate or not. The respondents were informed of the fact that they had the right to withdraw from the study at any time. Doing so would not expose them to any form of prejudice or criticism.This was done in order to uphold research ethics, ensure conformity to the ethical requirements and secure informed consent .Those who agreed to participate after given a brief explanation of the purpose of the study were given consent forms to fill.

3.7.3 Confidentiality

The participants were guaranteed that the information they provided will be treated as private and confidential, and that only the researcher and the supervisors had access to the data, and completed questionnaires were kept in a safe place where no one can access them.

3.7.4 Anonymity

The participants were not requested to indicate their names on the questionnaire, in order to maintain anonymity. In addition, the research was not seeking to identify personal traits of the people hence it was confined to only gender and age within the data collection instrument that was used.

3. 8 Limitations of the study

Due to time and financial constraints, the sample size was small, the study was done in only one community which is not highly populated. Instrument of data collection was a questionnaire .All this constitutes a limitation to the study. Based on the above the findings of the study should be interpreted with caution.

3.9 Dissemination of results

Results will be disseminated through submitting a copy of the thesis to the university library; some copies will be submitted to the Beitbridge town council and other relevant stakeholders. Journals and conference papers will be used as another platform to disseminate information.

3.10 Summary

The research study assessed the environmental, health implications of water scarcity in Beitbridge, Zimbabwe. A systematic sampling technique was adopted, which allowed the researcher to sample all the three residential locations in Beitbridge. The questionnaire was used as the main data collection tool. The respondents were residents of Beitbridge town. Frequency distribution analysis and binary logistic regression were used for data analysis. Strict ethical considerations were adhered to throughout the research process.

CHAPTER 4 RESULTS

4.1 Introduction

This chapter examines the environmental health implications associated with water scarcity in Beitbridge Town. It focuses on data collected using a questionnaire (see Appendix A). The questionnaire was organised in an order which starts with the socio-demographic characteristics of the respondents (Section A). After the socio-demographic profile section, the questionnaire has a section on water availability which addresses the causes of the water scarcity in Beitbridge (Section B). Water demand and supply in Beitbridge were other issues of concern in this study hence the questionnaire had a section on it (Section C). An assessment of water scarcity on health and sanitation was the next section of the questionnaire (Section D) .The above design of the questionnaire was meant to include all the aspects which were considered to have a bearing on the severity of water challenges in the town and how it impacts on health and sanitation.

The researcher used frequency distribution analysis, binary logistics regression, journals and related books to summarise and analyse the data. A summary concludes this chapter.

4.2 Socio demographic profile of respondents

	Frequency	Percentage
Gender		
Males	173	47.7
Females	190	52.3
Age		
15-20	41	11.3
21-30	89	24.5
31-40	122	33.6
41-50	80	22.6
51 and above	31	8.5

Location		
Low	60	16.5
Medium	112	30.9
High	191	52.6
Ownership		
Rent	216	59.5
Own	147	40.5
Education		
Primary	4	1.1
Secondary	125	34.4
Tertiary	234	64.4
Income		
<$100	15	4.1
$101-$200	33	9.1
$201-$300	53	14.6
$301-$400	118	32.5
$401-$500	98	27.0
$500+	46	12.7

Table 4.1: Demography of the research participants, Source*: Author's Data Computation (2014)*

4.2.1 Gender

Results showed that 52.3% females participated in this study and 47.7% were males. The results were independent of location but show overall participants who participated in the research.

4.2.2 Age

Results from the survey shown in Table 4.1, showed that most of the participants were ages between 31- 40, which had 33.6% representation in the study. The least age group which participated in this study were the respondents above the age of 51 which had 8.5% representation in this study. Almost all the age categories were represented which gives a clear situation from across the participants.

4.2.3 Location

Results from the survey as shown on Table 4.2 shows that 16.5% of the households who participated in the survey were from low density, 30.9% households from medium density and 52.6% of the households were from high density suburbs. These are the three location types in Beitbridge thus for this study a survey was carried in all the three locations to determine whether water problems are associated with household location.

4.3 Factors contributing to water scarcity in Beitbridge

This section briefly provides a description of the identified factors contributing to water shortage, and which the respondents provided their own views through practical experience. The problems viewed as causing water problems in Beitbridge were summarised in Table 4.2. Likert scale was used to examine results from the questionnaire survey. The following scale ranges were measured on a Likert scale that is: strongly agree, agree, disagree, strongly disagree and I don't know. A frequency distribution analysis was used to determine the number of households that viewed in a similar way the cause of water scarcity and the percentage contribution for each problem.

Table 4.2: Problems contributing to water shortage

	I don't know %	Strongly disagree %	Disagree %	Agree %	Strongly Agree %	Total %
Municipal Administration	16.5	5.2	5.5	35.5	37.2	100
Lack of maintenance and repair of damaged pipes and tapes	14	6.6	12.4	39.9	27	100
Limited Financial capacity of the municipality	31.7	10.2	21.5	24.5	12.1	100
Wasteful water usage practice by households	22.3	17.4	41	13.8	5.5	100
Worsening weather / climate situation	27.8	13.5	29.5	23.7	5.5	100
Population increase	11.6	9.9	13.8	45.7	19	100

Municipal administration was strongly agreed as the major cause of water scarcity with 37.2%, followed by lack of repairing damaged pipes with 27% and financial capacity of municipality with 12.1%. These are all challenges related to municipal administration. Most residents did not agree and strongly agree to the fact that water challenges are as a result of changing weather or wasteful practices by households.

4.4 Analysis of water demand and supply

Water supply in Beitbridge was assessed by comparing the views of residents regarding water supply they received from the municipality for the past four years. The data collected covered a period of four (4) years, which was from 2011 – 2014. Responses were measured on a Likert scale ranging from 1-5, whereby 5=very good, 4=good, 3=fair, 2=poor, 1= very poor. As shown in Figure 4.1, 33.33% and 36.09% households viewed water supply as fair in the year 2013 and 2014 respectively.

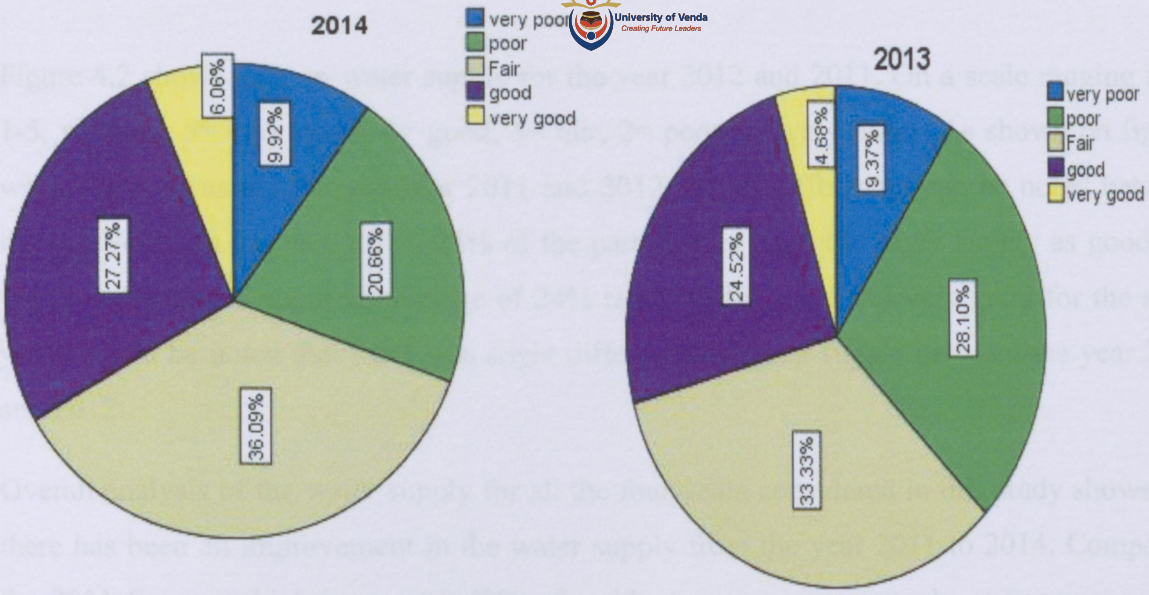


Figure 4.1: Water supply in 2013 and 2014

As shown on fig 4.1, there was a notable improvement in water supply from 2013 through to 2014. About 6.6% of the residents rated their water supply for this year as very good whilist for the year 2013, 4.7% rated it as very good. 27.3% rated the water as good for the year 2014 , whilist 24.5% rated 2013 water supply as good. On the other part, about 9.9% of the residents rated water supply as very poor in 2014, whilst for the year 2013 about 9.4% rated water supply as very poor.

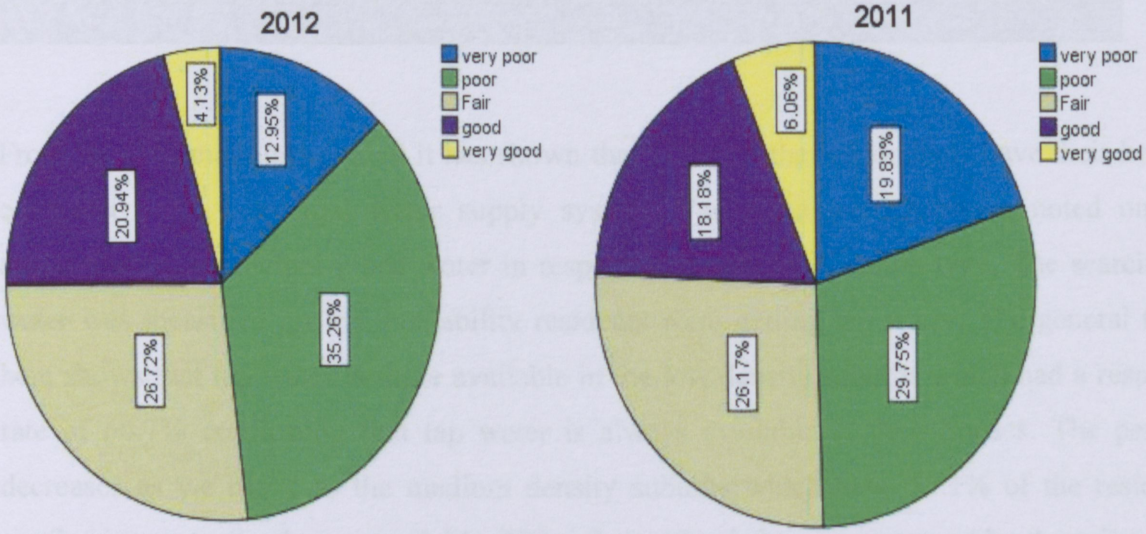


Figure 4.2: Water supply in 2011 and 2012

Figure 4.2 shows data on water supply for the year 2012 and 2011. On a scale ranging from 1-5, whereby 5= very good, 4= good, 3= fair, 2= poor, 1= very poor. As shown on fig 4.2 water supply was poor in the year 2011 and 2012. Slight differences can be noted between the two years. In the year 2012, 25% of the participants rated the water supply as good and very good whereas about an average of 24% rated well it good and very good for the same years. It can be noted that there was slight difference in water supply between the year 2011 and 2012.

Overall analysis of the water supply for all the four years considered in this study shows that there has been an improvement in the water supply from the year 2011 to 2014. Comparing the 2011 figures which have over 48% of residents rating water supply as very poor, only 9.9% of the residents rated the 2014 water supply as very poor.

Variations in water supply were also said to be influenced by residential location, hence table 4.3 below displays cross tabulation of water supply against the location type.

Table 4.3: Water supply and location type

		LOCATION TYPE		
Water availability		LOW (%)	MEDIUM (%)	HIGH (%)
Municipal water	Yes	100	100	100
	No	0	0	0
Water availability	Yes	66.7	57.1	20.4
	No	33.3	42.9	79.6
Enough supply	Yes	73.3	58.9	20.4
	No	26.7	41.1	79.6

From the information provided it has shown that 100% of the respondents have their houses connected with municipal water supply system. Variations were however noted on the availability of municipal piped water in respect to residential location type. The scarcity of water was measured on the availability residents were getting tap water. The general trend here shows that tap water is more available in the low density suburbs which had a response rate of 66.7% confirming that tap water is always available at their houses. The percent decreases as we move to the medium density suburbs which have 57.1% of the residents confirming water as always available. The sad situation is hereby portrayed by those living in

the high density suburbs which have a popu[illegible] of only 20.4 % confirming water as always available compared to nearly 80% of the residents in the same location who face erratic water cuts. Cross tabulating household locality against water supply was done to test whether there are variations between locations in relation to water supply.

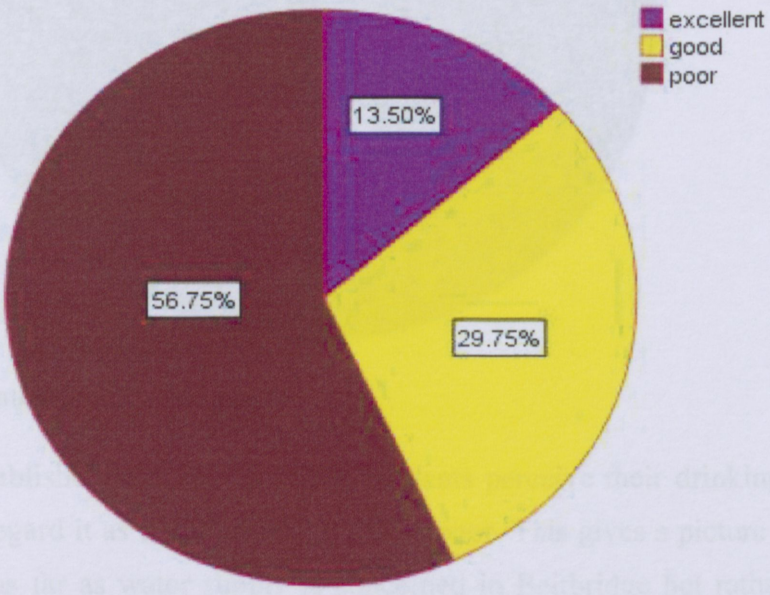


Figure 4.3: Water reliability

The pie chart in Figure 4.3 shows the percentage responses of water reliability in the all the three residential locations that were selected for the survey. On a scale ranging from excellent, good to poor, residents rated their water supply for the year 2011 to 2014. A larger percentage of 56.75% shows that water availability is poor. Only 13% of the households rated the supply as excellent

4.5 Sanitation and Health

In this section, the study addresses the possible outcomes of water scarcity which primarily infringes on health and sanitation of residents. After having obtained data on the quantity of water supply in which a majority viewed their water supplies as low, the questionnaire went on to collect data on the perception of residents regarding water quality. Fig 4.4 shows the perception of residents regarding water quality.

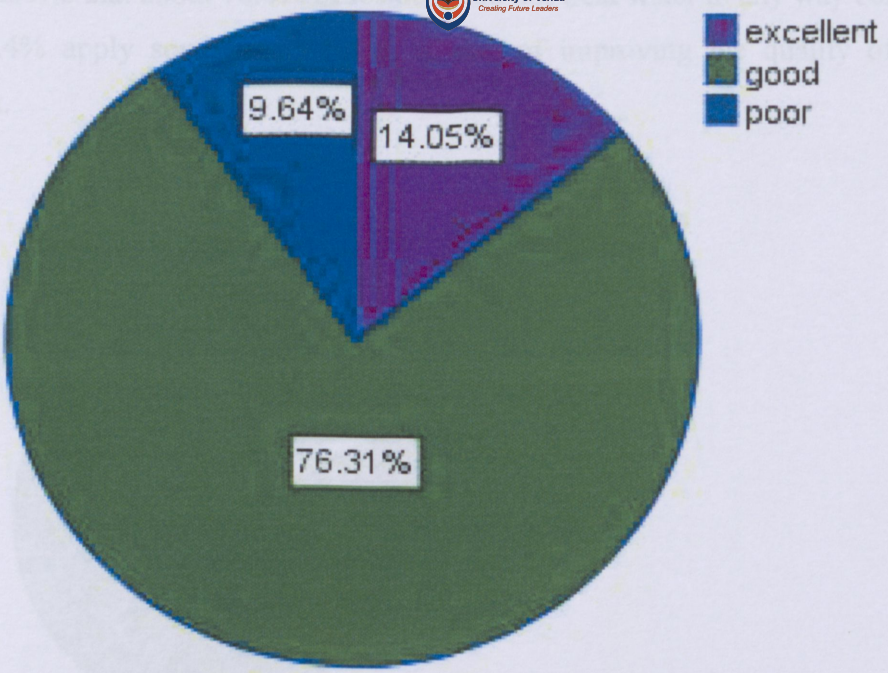


Figure 4.4: Water Quality Perception

The study established that 76.3% of the residents perceive their drinking water to be good, whilst 14 % regard it as excellent and 9.6% as poor. This gives a picture that quality is not a major issues as far as water supply is concerned in Beitbridge but rather the quantity is of concern.

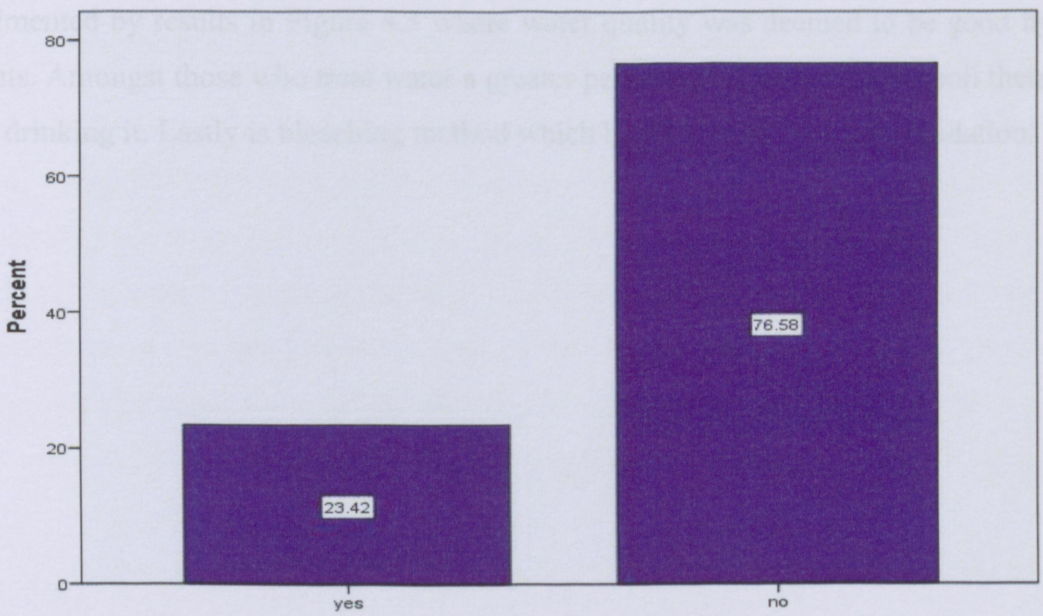


Figure 4.5: Water treatment responses

Statistics shows that about 76.6% of residents do not treat water in any way before drinking it whilst 23.4% apply some treatment as a way of improving the quality of water before drinking it.

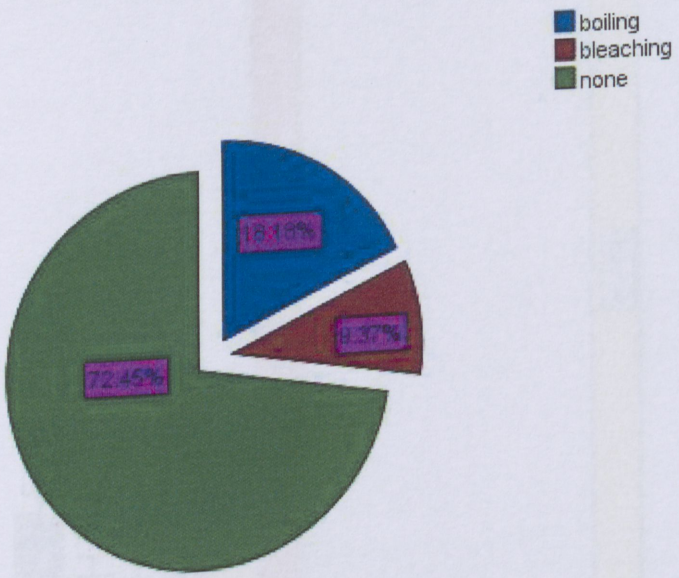


Figure 4.6 Household water treatment methodologies

Results show that 72.45% of residents do not treat water in any way. This is also complimented by results in Figure 4.3 where water quality was deemed to be good by most residents. Amongst those who treat water a greater percentage, that is 18.18% boil their water before drinking it. Lastly is bleaching method which has 9.37% of the total population.

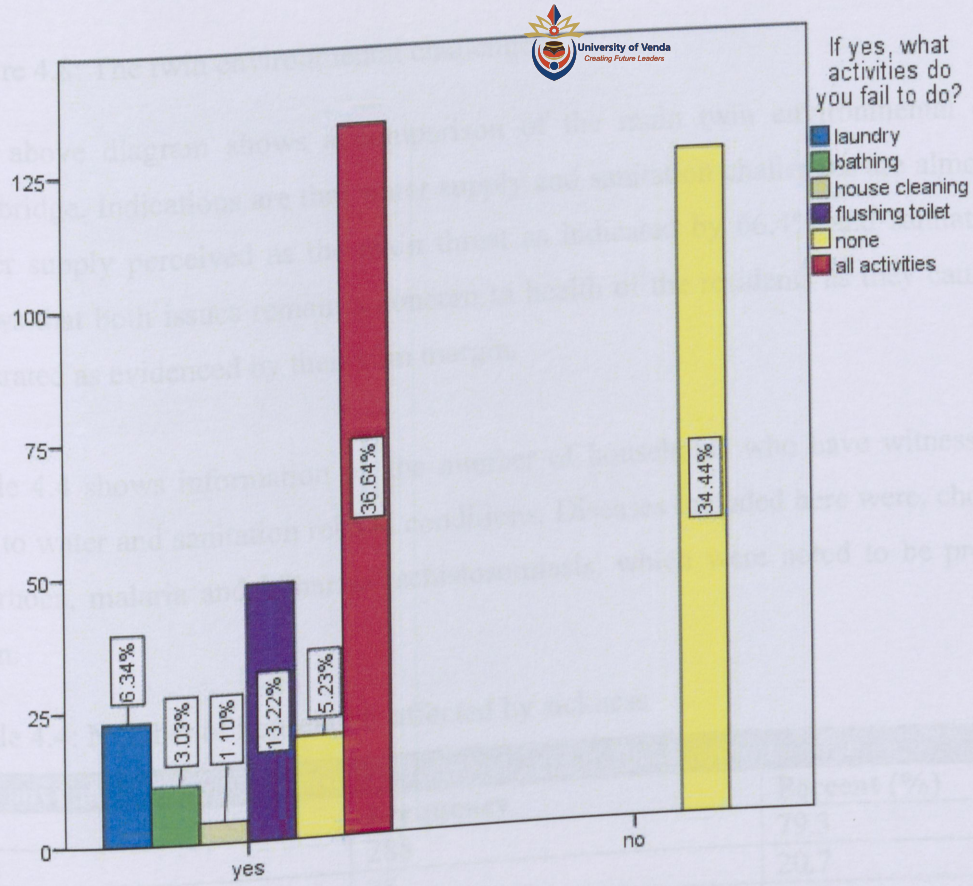


Figure 4.7: Adequacy of water supply and activities affected by water.

The above bar graph (Figure 4.6) analyses whether water shortage affects households and if yes, to see whether residents have missed some basic activities at home due to lack of water. Basic water consuming activities are represented by separate bars.

Fig 4.6, results show that 65.6% of the residents regard water shortage as affecting their hygiene, whilst 34.4% do not have their hygiene affected by water shortage. About 36.6% of the residents have missed at least each of the activities due to water shortage. That is toilet flushing, house cleaning, laundry, bathing. 13.2% have at one point to flush their toilets due to water shortages. Those who have failed at some point to do laundry are 6.3%. It is clear to a great extent that water shortage has affected a greater number of people as witnessed by the figures of households who have failed to do the basic household activities which requires water.

In Beitbridge the two major players in waterborne disease outbreaks is water supply and sanitation. Fig 4.8 shows the impact of the two.

Figure 4.8: The twin environmental challe

The above diagram shows a comparison of the main twin environmental challenges in Beitbridge. Indications are that water supply and sanitation challenges are almost at par with water supply perceived as the main threat as indicated by 66.4% and sanitation 63.4%. It shows that both issues remain a concern to health of the residents as they cannot be clearly separated as evidenced by their slim margin.

Table 4.4 shows information on the number of households who have witnessed sicknesses due to water and sanitation related conditions. Diseases included here were, cholera, typhoid, diarrhoea, malaria and bilharzia/ schistosomiasis, which were noted to be prevalent in the town.

Table 4.4: Number of households affected by sickness

Has any family member Suffered from sickness in the Last four years		
	Frequency	**Percent (%)**
Yes	288	79.3
No	75	20.7
Total	363	100

Statistics above shows that at least 79.3% of the households interviewed have witnessed a water related sickness in their family. Only 20.7% of the residents have not witnessed sickness in the family.

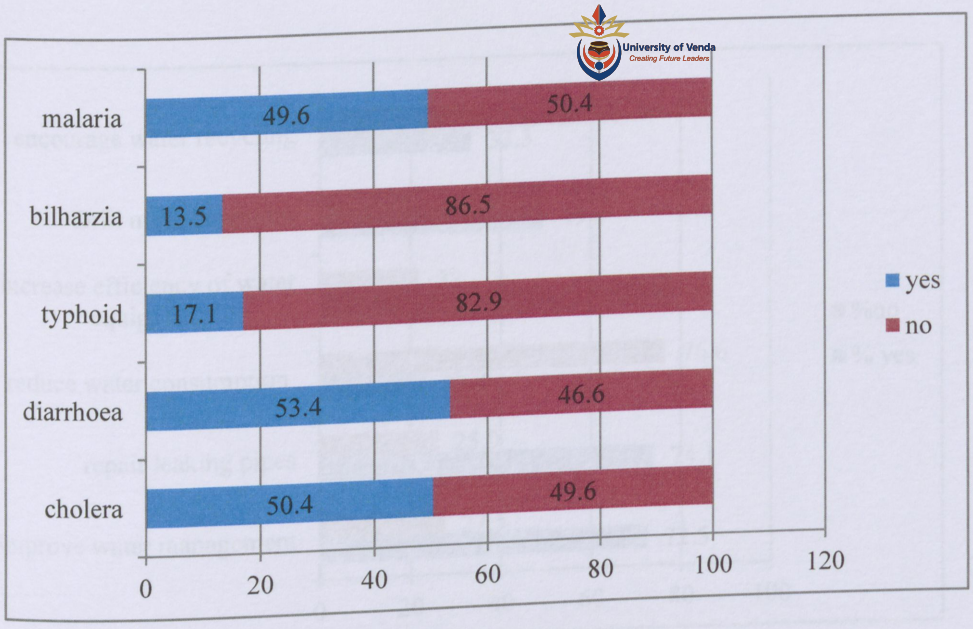


Figure 4.9: Common Water Based diseases

The table above shows a list of common water related diseases in Beitbridge.

As shown on fig 4.9 residents have witnessed diarrhoeal disease more than any other disease. About 53.4 have witnessed diarrhoeal disease, followed by cholera in which 50.4% of the residents have witnessed cholera diseases in their families. Bilharzia has been least experienced in Beitbridge which has 13.5%. About 49.6% have witnessed malaria disease in their family and typhoid with 17.1% having witnessed that type of sickness.

4.6 Interventions

The last part of the questionnaire had a section on the possible intervention measures which can be taken to overcome the water scarcity challenges. Figure 4.9 shows possible solutions which can be employed to mitigate water shortages in Beitbridge.

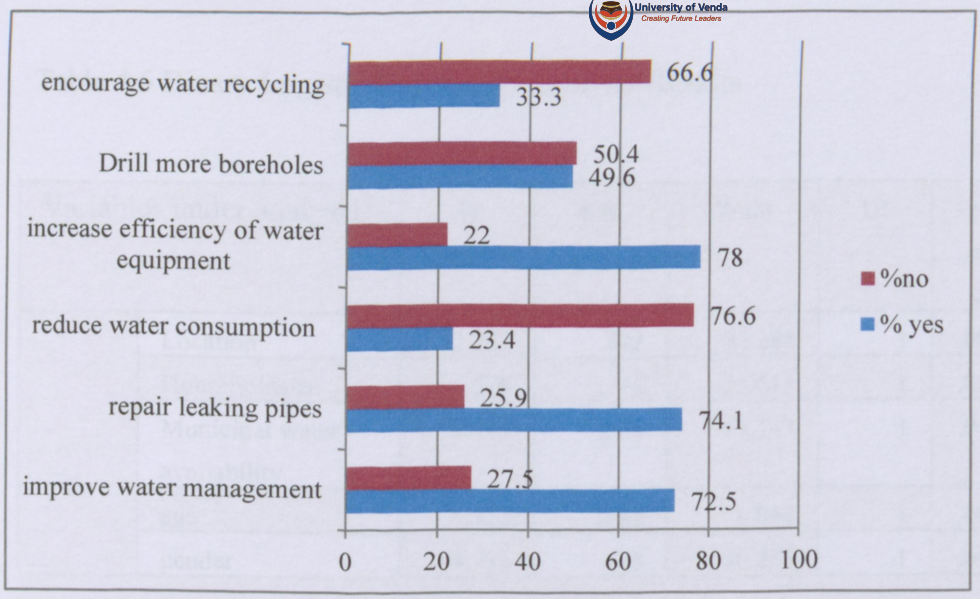


Figure 4.10: Intervention Measures

The most rated measure was improving the efficiency of water equipment which had 78%. Most residents viewed the water equipment infrastructure used to supply water as aged, out dated and currently not able to meet with the increased demand due to increased population. Repairing leaking pipes and improving water management was viewed by 74.1% and 72.5% respectively as another measure which the municipality can take. Reducing water consumption and recycling water did not get a favourable response as evidenced by low figures of 23.4% and 33.3%. Drilling more boreholes was seen as another alternative measure by about 49.6%, which the council may adopt to ease the water challenges.

4.7 Results of Binary Logistics

To statistically validate the findings of the study Binary regression logistic model was used and below are the results in table 4.5

Table 4.5 Binary Logistic Regression Analysis Results

Variables under analysis		B	S.E.	Wald	Df	p-value	Exp(B)
	Location	2.387	.402	35.288	1	.000	10.881
	Householdsize	.576	.114	25.613	1	.000	1.780
	Municipal water availability	1.795	.538	11.143	1	.001	6.018
	age	-.514	.181	8.044	1	.005	.598
	gender	-3.731	.678	30.255	1	.000	.024

The Nagelkerke R^2 and the Wald test were used to evaluate model strength and relative contribution of each variable in influencing water related sickness in a family. The higher the Negelkerke R^2 value the stronger the model. Wald statistic was assessed using the Beta coefficient (CB) values and p values. The significance of these results however, was determined by the p values. Significant results were signified by a p value less than 0.05 ($p < 0.05$) whilst insignificant results were signified by a p value greater than 0.05 ($p > 0.05$).

The Hosmer & Lemeshaw (H-L) inferential goodness of fit test yielded a Chi-square (8 degrees of freedom) of 7.079 and was insignificant ($p > 0.05$) suggesting that the model fitted well to the data. Two other descriptive measures of goodness of fit are R2 indices defined by Cox & Snell (1989) and Nagelkerke (1991). The results reflect 65.4% to 87.2% of variations in the outcome (i.e. the probability of a randomly selected household agrees that there are family members who have suffered from water related sickness in the last 4years.

Five variables were used as parameters to test the relationship between each variable and how it influences water-related sickness in families. The five variables used in this study were: Location, Household size, Municipal water availability, Age, Gender

Statistics from the binary regression model shows a positive beta estimate on household locality implying that people who are in the high density suburbs are 10.881 times (i.e. Exp (B) =10.881) more likely to witness water related sickness than those in medium to low

density areas. Such variations between the low density and the high density were significant as shown by the p-value of 0.00 which is less ($p<.0.05$). This finding concurs with the findings of Tanyanyiwa and Mutungamiri (2011) that poverty and basic service deprivation among urban dwellers go hand in hand. It is the less affluent members of the society who suffer more from water and energy related challenges than the affluent members who normally reside in affluent communities in the low residential zones.

Positive beta estimate on household size implies that households with big family sizes are 1.780 times more likely to get sick as indicated by Exp (B) with a value of 1.780. Gumbo and Zaag (2003) noted that poor households in the high density suburbs usually with many family members suffer more to water challenges. For the affluent household usually with small family sizes the opposite is true, their ability and willingness to pay is large, and water use is mainly governed by sizes of gardens and the presence of swimming pools which are all but non- essential for life.

Another significant factor recognised in the study was water availability which shows a positive beta estimate whereby people with regular and uninterrupted access to water are 6.018 times more likely not to have family members suffering from water related sickness than those who have irregular supplies of water. The p value of 0.01 which is less than 0.05 indicates a high significance of the water availability to the households. The quality and quantity of water supplied in Zimbabwe's urban centres has decreased in recent years due to the difficult economic situation and several challenges that the country faces. The situation in most cities in Zimbabwe is desperate and pathetic, evidenced by the poor delivery of water services, which faces severe water rationing and an ever recurring outbreak of water-borne diseases in the urban areas. The recent outbreak of epidemics has all been traced to lack of access to safe water and poor sanitation, two twin factors in controlling the spread of diseases. Shortage of water has resulted in the wide spread of water-borne diseases in most urban communities in Zimbabwe causing serious discomforts to urban residents (Makwara and Tavuyanago, 2012; Chigonda, 2010)

Age was also discovered to vary significantly with sickness which is reflected by a negative beta estimate value of -0.514. Thus as we move along the demography from young age groups to older ones, sicknesses is highly likely to be more prevalent among young ages towards elderly people. Diarrhoea is one major cause of morbidity and mortality among

children in the developing nations. Based on a review of surveillance data from studies conducted in the 1950s, 1960s and 1970s, by WHO, it was estimated that about 4.6 million children died annually from diarrhoea (Kosek, & Guerrant, 2003; WHO, 2012).

Study results also revealed that gender was a significant factor in the study. A negative beta estimate of -3.731 indicates that males were 0.024 times more likely to suffer from water related sickness than females as shown by the Exp (B) of .024.

4.8 Summary

This chapter profiled the nature and extent of water challenges in Beitbridge. The questionnaire survey was used to collect to do the assessment in view of residents with regard to the severity and consequence of the water challenges in Beitbridge. Frequency distribution analysis and tables were used to present data. To statistically validate the findings, binary logistics regression analysis was employed.

CHAPTER 5 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

Although the importance of water supply has been a world agenda in most of the world conferences and of key note the Rio Earth Summit of 1992, by various governments of nations and by interested stakeholders such as the WHO, UN, World Bank among others less has be done to ensure that nations are able to supply clean water to everyone. Regardless of the fact that water issues have been given some preference in summits and set as a millennium development goal, this study argues that less is being done on the ground to ensure the implementation of the strategies so as to realise the set goal of providing access to safe and clean water to everyone. It has been noted in this study that if good supply of clean water is made available it can go a long way in reducing most of the major water related disease outbreaks faced especially in Africa.

In Zimbabwe, water supply to both the rural and urban people has not been prioritised mainly due to the more than a decade economic recession which has resulted in dwindling financial resources coupled with massive brain drain. The economic recession experienced in Zimbabwe particularly from 2000- to date created a challenging environment to virtually all sectors of the economy. It is of paramount importance to note that, Zimbabwe around the 1990s had made a milestone in availing water access to its people which was later followed by a sharp contrast in decline of water provision. Water shortage has been noted to have an effect ranging from environmental sanitation to health. This chapter summarises the findings of the study. This is followed by the conclusions and finally recommendations.

5.2 Discussion

Table 4.1 shows the socio demographic information of the participants in this study. Age, sex, education level, income status, household locality were the socio demographic information included. Slightly more females participated in this study compared to males, with 52.3% being females and 47.7% being males. Household locality has also been included in the socio demographic profile of residents as it has been seen to have an influence on water supply. Several studies such as by Mugumbate, Maushe & Nyoni (2013) and Manyanhaire et

al (2009) concluded that variations in household locations, income status and household size have an effect on water supply and demand and overall affecting people's health and sanitation differently.

After the socio demographic section, the first objective of the study was to assess the causes of water scarcity in Beitbridge. In this study, the causes of water scarcity were mainly divided into three parts, namely: managerial issues, climate change and urbanisation. It has been concluded from this study that management issues are seen as the major challenge in the supply of water to residents. The management issues that were discussed included issues related to municipal administration of water issues, lack of maintenance and repair of damaged pipes and tapes and lack of financial capacity to deliver adequate water to the residents. Climate change and population increase were also seen as contributing factors to water scarcity in the town. The ever increasing population of Beitbridge town is viewed as a challenge to the capacity of the municipality to supply water within the town. However this has been rated as the least challenge.

According to the report by the World Bank (2013), Zimbabwe's water and sanitation services suffered a major collapse as a result of a decaying economy. No new meaningful investments in service delivery were done since 2000, resulting in the complete failure of an already existing aging infrastructure. In addition there was a notable reduction in water supply for both industry and domestic consumption, and non-repair of infrastructure and maintenance services. A remarkable increase in unemployment led to collapse in service provision as fewer customers were willing or able to pay their water and sewerage bills. The sharp decline in economy left cities and towns with almost non-functioning water and sewerage systems, few qualified technical and administrative staff, and with no funds to operate and maintain systems due to hyperinflation.

Studies carried out by Mwendera et al (2003) and Manyanhaire et al (2009) noted that the problems of water supply in most African cities are similar and these range from poor water infrastructure, poor administration, lack of political will as highlighted by Swatuk (2008). Most of the problems are intertwined and complement each other if not addressed. In this study the causes of water scarcity were mainly divided into three parts, which are managerial issues, climate change and urbanisation. From Table 4.2 majority of the households with

37.2% strongly agreed that the problems of water scarcity are mainly as a result of municipal administration challenges to supply water to residents. The other 5.2% of the households strongly disagreed that water problems are a result of municipal administration. A small figure of 5.5% also disagreed that municipal administration is causing water problems.

Lack of maintenance and repairing of damaged pipes was also established as another factor contributing to water challenges in town. Results obtained from the survey carried out revealed that, 39.9% of the households agreed to the fact that lack of repairing of damaged pipes in Beitbridge contributes to water shortages , whilst 27% of households strongly agreed to this, 6.6% strongly disagreed and 12.4% also disagreed to view lack of maintenance as affecting their portions of water supply by the municipality. It can be safely concluded that lack of maintenance to damaged pipes and ageing infrastructure is affecting water supply as can be deduced from the statistics displayed in Table 4.2.

Lack of finance in most African cities has crippled development and has seriously compromised the rate of development of water infrastructure in most African countries (Montgomery and Elimelech, 2007). From table 4.2 it shows that 21.5% of the households disagreed and on the other hand 10.2%of the households strongly disagreed that Beitbridge is hampered by financial constraints hence its failure to meet water demand. 12.1% strongly agreed and 13.8% also agreed that finance is a factor causing the current challenges water supply in Beitbridge. The views carried out in this analysis presented an interesting issue whereby majority of ratepayers do not consider lack of finance as a major setback in supply of water resources as can be concluded from the above statistics.

Most African cities face a challenge of rapid urbanisation. As population continues to grow, the cities are failing to cope up with demand on infrastructure and resources to meet the needs of the growing masses (Gwebu, 2002; Gumbo, 2004). In this survey population increase was noted as a contributing factor as far as water supply is concerned in Beitbridge. As shown on Table 4.2 above, 45.7% of the households agreed that indeed the population of the border town has increased drastically over the few past years supported by 19% who strongly agreed to it. Whilst on the other side, 9.9% of the survey strongly disagreed to the idea of population increase affecting water supply in Beitbridge. 13.8% disagreed to the fact of population increase affecting water supply in Beitbridge. However it can be noted that the majority

agrees to the fact that the border town has witnessed a huge population growth which the municipality was not prepared to cope with.

In line with the second objective to analyse water demand and supply in Beitbridge, an assessment was done on the water service level for the past four years (2011-2014). Based on the results of the survey , as can be seen on fig 4.1, it can be said that water supply in Beitbridge increased in 2014 than it was in 2013. This might indicate that the severe cholera outbreak of 2008-2009 and 2013 in Beitbridge sent an alarm to relevant government authorities, non governmental organisations and several authorities to take action. This also prompted the World Bank to set a special grant fund to finance water ressucitation project (World Bank: Beitbridge water Project) in in Beitbridge which begun in 2011.

Overall analysis of the water supply for the four year period in this study shows that there has been an improvement in the water supply from the year 2011 to 2014 as supported by the 2013 World Bank Water project. However more still needs be done in order to meet the daily requirements of households. More than 63% of the residents agree that they are faced with water shortage as they are not able to meet their daily needs. This has resulted in residents compromising on hygienic standards. Although a gradual increase has been seen in water supply still a majority is facing water shortage.

Table 4.3 which is a cross tabulation of water availability versus location, disparities are clear. From the statistics displayed, it is clear that water is scarcer in the high density suburbs of Beitbridge than in the low residential suburbs. The situation presents some disparities which raises more questions as to the allocation of potable water by the municipality. This concurs with the findings of Hove and Tirimboi (2011) that service availability is bad in the high density suburbs compared to low residential suburbs.

There is an imbalance in the supply of water across medium, low and high density suburbs. A reflection on the pie chart on fig 4.3 shows that municipal water is more unreliable to most households as shown by a 57% response rate. This suggests the reasons why more residents rely on community borehole water in Beitbridge than on municipal water.

When water becomes more unreliable this leaves residents with limited choices hence it will adversely compromise on their hygienic standards. Water rationing by the municipality and some technical challenges due to water equipment failure were the main reasons cited as causing erratic water supplies. In Zimbabwe most urban areas are characterised by irregular , erratic water supply.

In this study the third objective was to assess the impact of water scarcity on health, as water scarcity has been seen to promote disease outbreaks. Disease outbreaks have been seen as a more direct outcome of water scarcity. In a situation where both the quantity and quality has been compromised, people are more likely to experience waterborne diseases. . Several studies (Adeoye, 2001; WHO, 2012; WORLD BANK 2013; UN, 2006) have shown that there is a direct link between environmental factors and health. Provision of water and sanitation has been seen as key in disease prevention by such bodies as WHO, World Bank, UN among others hence it is an agenda on the millennium development goals (MDGs). Good supplies of quality water can minimise transmission of diseases whilst inadequate water supplies can seriously compromise on the health of people. It is estimated that 80% of diseases in the world are connected to unsafe water and poor hygiene (Gleick, 2002). In addition, Okun (1988) noted that adequate water supply and sanitation programs if implemented with community participation and accompanied by health hygiene education, can show their efficacy in disease prevention.

In this study diarrhoea and cholera were seen as common diseases experienced by many residents in Beitbridge . It is of great importance, to note that there are other several factors and not only limited to water supply which can cause disease outbreaks. In Beitbridge the peak of the disease outbreak was in 2008, 2009 and 2013, in which the World Bank (2013) in its project noted that the cause of the disease outbreaks were due to water and sanitation issues in Beitbridge. Both water supply and sanitation are perceived as health threats by Beitbridge residents.

Figure 4.6 shows the statistics of residents who treat their water before use. Majority that is 72.45% do not treat their water in any way before drinking, while among those who treat , boiling is the common method. Another reason for not treating the water was noted by Mugumbate et al (2013) upon interviewing one resident in Zimbabwe, on why residents are not improving water before using it was that: *'We are limited. We can't boil the water*

because we do not have electricity. Neither do we have money for paraffin, wood nor water treatment chemicals like Water guard. We just trust God with our lives'.

In addition to that, the study has established that residents have at one time compromised on their basic water requiring activities as displayed on fig 4.7 About 13.2% had skipped flushing toilet and some missing a bath and others laundry as a result of water shortage. Quite a great percent of 36.6% missed all basic home requiring water activities at some point in time.

Not only has water challenge led residents to compromise on home hygienic standards but has also compromised on their health. Table 4.4 shows that about 79.3% of the study group had witnessed water related sickness in their family. This is a clear indication that the problem was affecting quite a big fraction of Beitbridge town. Erratic water supplies and poor sanitation explains the reasons why Beitbridge faces such disease outbreaks.

The unavailability of water and sanitation services contributed towards high figures of respondents who witnessed mostly diarrhoea and cholera diseases as shown on fig 4.9. Diarrhoea and cholera outbreak were associated with poor supply of water and sanitation services compounded by lack of maintenance of the existing systems. Fig 4.9 shows that diarrhoea was the common disease followed by cholera and on the least is bilharzia. The evidence is supported by the findings from the World Bank (2013), which revealed that, the town was facing water shortages due to inadequate raw water abstraction, treatment and storage capacity, coupled with erratic power supply. Such poor supplies affected toilet flushing system, dysfunctional sewer system coupled with a surge in and spills recorded each month. Solid waste collection in the city was very low, and was identified as 30 percent, contributed by factors such as acute shortage of a stable currency, exponential hyperinflation that led to a non-supply of required resources for service provision by the municipality.

Although it can be argued that water related sicknesses are a result of complex factors, water is seen as playing a big role in the ecology of diseases. In developing countries four fifth of illnesses are a result of water related conditions. Diarrhoea being the major cause of death especially among children (UN, 2003)

Deterioration of health and sanitation in Zimbabwe has resulted in Zimbabwe's Cholera outbreak in the few past years with the peak of outbreak around 2008. Zimbabwe recorded more than 90 000 cholera cases and over 4000 deaths and of the total statistics Beitbridge had 26% of the cases recorded in the country (World Bank, 2013).

Poor water and poor sanitation in Beitbridge, have resulted in cholera outbreaks and diarrhoeal diseases spreading easily in the in the border town (MSF, 2008; World Bank, 2013). The major cause of such water based diseases in Beitbridge has been identified by the World Bank project and WHO, as water and sanitation challenges in Beitbridge. This shows that vulnerability to sicknesses linked to water and sanitation in Beitbridge is high.

The last section of the questionnaire had a section on intervention measures. An assessment on the intervention measures was done by grouping the common intervention measures together. The interventions were grouped into two as managerial and community measures. In this regard the first category is of managerial issues. This group includes improving water management, repairing leaking pipes and increasing the efficiency of water equipment. Amongst the suggested intervention measures, increasing the efficiency of water equipment was rated by 78.6% as the most workable solution. This revelation was so because residents viewed water shortage as a result of the municipality failing to increase the efficiency of their equipment to meet the demand due to increased population.

Apart from management issues there are some interventions which rely on individual and communities effort to address the water challenge. This group is in this study named community based measures which include practising water recycling at home and saving water through minimising wasteful practises to reduce water consumption.

On management issues, improving water management and repairing of damaged pipes was seen as a major factor contributing to water shortage within the city. Conserving every drop is of significant importance, thus repairing of damaged pipes would reduce the amount of water that is being lost on a daily basis due to damaged pipes. Although no specific quantities could be given as to how many gallons are lost every day due to municipal pipe leaks and individual tap leakages, the fact that unnecessarily some water is wasted that way calls for interventions by the authorities in charge of water supply. There are huge rewards in leakage reduction. The city of Mutare in Zimbabwe experiences high water losses due to an aged

system of water reticulation, faulty metering and old leaking pipes. Unaccounted for water for the city of Mutare averages 57% (Marunga et al; 2006)

The second group which was named the community based measures, reducing water usage at home and recycling water was least viewed as possible solutions to minimise water shortages. 33.3% of the residents agreed to water recycling and 23.4 agreed to reduce water consumption at households so as to use water sparingly. From the observations based on this survey residents viewed water saving ideas as the last priority as they are more interested in having the volumes of water they receive daily being increased rather than trying to save the little they are supplied by the town council.

A sharp contrast can be noted from the two methods, that is managerial and community based measures. Managerial solutions were viewed as a better priority since they ensure that they are focused on increasing their daily supplies of water, rather than the community based issues aiming at saving water rather than increasing the supply.

Drilling more community boreholes seemed a nobble idea to about 49.6% of the residents. Based on this survey and taking the statistics on fig 4.9, it can be noted that community boreholes are the main alternative source of water in Beitbridge. Drilling boreholes was viewed as a less costly option which can ensure more supplies of water. A solution which would save the residents from frequent water cuts and water rationing as viewed by some residents.

5.3 Conclusion

The aim of this research was to assess the implications of water scarcity in Beitbridge town in Zimbabwe. Three specific objectives were set for an effective assessment. The first objective was to examine the causes of water scarcity in Beitbridge. The second objective was to analyse the domestic water demand and supply situation. Finally, the researcher assessed and made recommendations to address the impact of water scarcity on health and sanitation.

Findings from the study revealed that, inadequate and irregular water supply seriously compromises the health of people. This is mainly because of the role water plays in

promoting good health and in the prevention of diseases. It is therefore always necessary to consider water as life ,as it is a pillar of life hence the need to prioritise water related issues.

Findings from the study revealed that the prevalence of water related sickness in communities with poor and inadequate water supplies is higher than in communities which have a regular supply of water. The study therefore concludes that households in the low residential areas which had a better supply of water witnessed few family member sicknesses which are related to water and sanitation than their counterparts in high density suburbs.

It is apparent from this study that most of the residents view water challenges faced in Beitbridge as being due to managerial issues rather than the issue of climate change and rapid population increase in the town. The study therefore concludes that water challenges in Beitbridge town are largely a managerial issue of the municipal authorities although other factors have their share. The mandate of every city council working together with government stakeholders is to provide basic services such as water and electricity to residents.

Results obtained from the study also led to a conclusion that, of late the water supply situation in Beitbridge is gradually improving than it was in the last four years, this can be attributed to the contributions made by the World Bank project during 2011-2012, (World Bank 2013) together with the council, Non-governmental organisations (NGOs) and other stakeholders working on improving water supply to the Beitbridge community.

It is also from the findings of the study that majority of high density residents largely rely on borehole water to complement the piped water they receive. On the contrary, findings also showed that people in the low density suburbs rely mainly on municipal water than on community borehole water. Conclusions were that water supply is more regular in the low density suburbs of Beitbridge than in the medium to high residential suburbs respectively.

The study concludes that, twin environmental challenges faced by Beitbridge residents namely, water supply and sanitation are equally contributing to disease outbreaks such as cholera and typhoid. Both are perceived as major threats to health as they are closely related and influence each other.

5.4 Recommendations

In order to promote good health it is imperative for municipal and government authorities to supply adequate clean water. It has been established by this study that the most ideal solution to rectify the water challenge faced by Beitbridge community, the water infrastructure and equipment should be upgraded to function efficiently so that their daily supply of water can be increased. Thus the study recommends that the council together with the government and relevant stakeholders should aim to make water equipment, treatments plants and every infrastructural resource to function more efficiently so as to improve the supply of water to residents.

Repairing water leaking pipes and improving water management are also critical issues to address the water challenges in Beitbridge. The municipality loose quite a fraction of unaccounted water due to leakages. Leaking water pipes have an effect on the overall quantities of water supplied daily, monthly and annually. Clean and portable water meant for consumption is lost every day due to leaking pipes. In order to mitigate such problems the study recommends replacing of worn-out pipes, repairing of the leaking pipes and scheduling of planned maintenance to avoid loss of water meant for domestic use and consumption. On the same note also households to repair leaking tapes at homes to save water as much as possible or enlist municipal services.

Drilling more boreholes can be taken as another temporary measure to address the current water shortages in the town. It was noted from the findings that residents in the high density suburbs of Beitbridge rely more on borehole water due to poor supply from the municipal. As such it can be seen that boreholes have helped to alleviate the water situation in Beitbridge although the major outcry and challenge was on lack of maintenance and repairing of dysfunctional boreholes as quite a number of them are totally out of order. Although a temporary measure, drilling of boreholes in high density suburbs according to a research done by Mugumbate et al (2013) is viewed as 'ruralizing' the urban area or 'de-urbanizing' the town as is the case with most Zimbabwean towns. In Zimbabwe privately owned boreholes were a feature only found in the low density areas as a sign of affording personal water sources for such activities as gardening. However the fall in quality and quantity of service provision has led to drilling of community boreholes in most high density suburbs of

Zimbabwe which can be seen as reversing urbanisation or ruralising the town as have been argued to have its pros and cons.

This study assumed that water scarcity and sanitation situation in Beitbridge have a major bearing on water related disease outbreaks in Beitbridge. It is therefore recommended that, further studies should be carried out to determine if there are other factors that have a bearing and influence on water related disease outbreaks in the town under study.

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APPENDIX A: QUESTIONNAIRE

Research Topic: Environmental Health Implications of Water Scarcity in Beitbridge Town, Matabeleland South Province, Zimbabwe

ADMINISTRATION

Administered by……Date……../……../20……..

Administered at……

Questionnaire No……

Preamble

Zimbabwe has experienced a historic economic recession which has been evidenced by a sharp downward spiral in service provision over the period stretching from 2000- date. It has been a challenging environment for municipalities to deliver services especially water supply, garbage collction among other service which the municipalities are mandated to provide. Water supply in Beitbridge has proved to be an uphill task for the municipality and the recent reccuring of major disease outbreaks of Cholera in Beitbridge has becomme a disturbing feature at the border town. Studies have shown that there is a close relationship between water supply, sanitation and waterborne disease outbreaks.

This questionnaire survey is designed to obtain this data and you have been selected as one of the sources of this data. Personal confidentiality of respondents is guaranteed and the information collected is for and will be used for academic purposes only.

Should you feel uncomfortable to continue with the questions please feel free to stop at any stage. Please feel free to provide any additional information that you think may be useful in this study. Your cooperation is highly appreciated.

SECTION A: SOCIO DEMOGRAPHIC QUESTIONS

1. Gender: Male ☐ Female ☐

2. What is your age range?

   15-20 years ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ 51 and above ☐

3. In Beitbridge, which location do you stay (e.g, low density, medium density , high density suburbs)

   ---

4. What is the ownership status of your house?

   Rent ☐ Own ☐

5. How many people are staying in this household unit/ premises? ----------

6. What is the highest education level attained by members of the household?

   primary level ☐ secondary level ☐ tertiary level ☐

7. What is the average monthly income of your family

   < $100 ☐ $101-$200 ☐ $201-$300 ☐ $301-$400 ☐ $401-$500 ☐
   $500+ ☐

SECTION B: WATER AVAILABILITY

1. In relation to your experiences, rate which of these problems do you think are contributing to water shortage?

	Strongly Agree	Agree	I don't know	Disagree	Strongly disagree
Municipal Administration					
Lack of maintenance and repair of damaged pipes and tapes					
Limited Financial capacity of the municipality					
Wasteful water usage practice by households					
Worsening weather / climate situation					
Increased number of people					

2. On a scale of 1-5 (where 5= very good, 4=good, 3=Fair, 2=poor, 1 = very poor) How would you rate your water supply situation in your area four the past four years.

SCALE

Time	1	2	3	4	5
In year 2014 (tick)					
In year 2013 (tick)					
In year 2012 (tick)					
In year (2011 (tick)					

SECTION C: WATER AMENITIES

1. Do you receive your water from the municipality?

   Yes ☐ No ☐

2. Does the water you get from the municipality always available?

   Yes ☐ No ☐

3. Do you receive enough water for you needs from the municipality?

   Yes ☐ No ☐

4. Is water available every time from the municipality?

   Yes ☐ No ☐

5. Which of the following alternative sources of water do you use in your community?

   Community borehole ☐ Private well/ borehole ☐

SECTION D: SANITATION AND HEALTH

1. How would you rate your household water resources in terms of:

   A) Safety to drink and use? Excellent ☐ Good ☐ Poor ☐

   B) Reliability of water source? Excellent ☐ Good ☐ Poor ☐

2. Do you treat water you get from your source(s) in any way? Yes ☐ No ☐

3. What treatment methods do you apply to your water before drinking?

   Filtering ☐ Boiling ☐ Bleaching ☐

4. Does water shortage affect your hygiene? Yes ☐ No ☐

5. If yes, what activities do you fail to do?

   Laundry ☐ Bathing ☐ House cleaning ☐ flushing toilet ☐

6. What kind of toilet facility does your household use?

   Flush toilet ☐ Pit toilet ☐

7. Which of the following water related diseases have you witnessed most in your community? Please choose from the table below.

DISEASES	**Please tick**
Cholera	
Typhoid	
Diarrhoea	
Bilharzia	
Malaria	

8. In Beitbridge do you have health threats caused by water supply? Yes ☐ No ☐

9. In Beitbridge do you have health threats caused by sanitation conditions?

   Yes ☐ No ☐

10. Has any family members suffered from any water related sickness in the last 4 years?
    Give details on affected family members as summarized in the table below.

Member id	Age of affected member	Gender	Type of illness	Year
Victim 1				
Victim 2				

Victim 3				
Victim 4				

SECTION E: INTERVENTIONS

1. Which possible solutions do you suggest to mitigate or solve water shortages in your community?

Possible solution	Please tick (multiple selections possible)
Improving water management	
Repairing leaking pipes and tapes	
Reducing water consumption (excluding drinking water)	
Improving the efficiency of water equipment	
Drilling more boreholes / wells	
Encouraging water-reutilisation, recycling	

APPENDIX B: ETHICAL CLEARANCE CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Ms P Moyo

Student No: 11623469

PROJECT TITLE: Environmental health implications of water scarcity in Beitbridge Town, Matebeleland, South Province, Zimbabwe

PROJECT NO: SHS/14/PH/02/2803

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Prof HA Akinsola	University of Venda	Supervisor
Mr T Gondo	University of Venda	Co-supervisor
Ms P Moyo	University of Venda	Investigator - Student

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: April 2014
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: .....
Name of the Chairperson of the Committee: Prof. G.E. Ekosse

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