University of Venda

Investigation of Water supply challenges in Thulamela Municipality: A case study of Bunzhe and Tshififi villages

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Declaration

I, Ndishavhelafhi Enos Nemalamangwa, declare that this dissertation hereby submitted to the University of Venda for the degree of Master of Environmental Sciences in Geography has not previously been submitted by me for a degree at this or any university and that it is my own work in design and execution and that all reference material contained therein have been duly acknowledged.

Signature: 

Date: 21/10/2020

Dedication

This work is exclusively dedicated to my wife Nemalamangwa Salphina and my family members for their unconditional support, encouragement, patience and understanding during the entire period of the study.

Acknowledgement

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Abstract

Water is one of the basic needs for the survival of human beings. Water is used for drinking, food preparation and hygienic purposes, however, rural areas are still faced with serious water supply challenges; water supply challenges also impact on a country's development. Rural areas which experience water supply challenges are likely to face disruption of food supply for their people, as well as negatively affect livestock and economic development. According to UN-Water (2006), water supply challenge is a situation whereby water sources become inadequate for the community due to factors like, problem with infrastructure, increase in population and others that may lead to problems with supplying water for different categories of consumption. The focus of this study is on water supply challenges at Bunzhe and Tshififi villages in Thulamela Municipality. In recognition of the essential nature of water, Thulamela municipality has three dams and, although, they are filled with water, villagers residing next to such big dams do not get enough water. The study found that the causes of water supply change are, mainly - population growth, illegal connections, incapacity, aged infrastructure of the Vondo purification plants and the poor state of R3 water main pipelines which supply water to Bunzhe and Tshififi villages. Findings revealed the challenges affecting the daily livelihoods of the people in the two villages, such as in the rearing of livestock, farming and informal businesses that serve as their sources of income, as they obtain below 50 liters of water per day. Water supply challenges, in addition, were identified as contributing to illiteracy as learners miss their classes when they have to fetch water far from their homes, from nearby villages. People are forced to gather, for long periods of time, at one tap as competition for water is very high; the ratio stands at 1:148 households per tap. This contributes to conflict, spread of contagious diseases such as fever, chickenpox, tuberculosis and coronavirus (Covid-19). Recommendations are that the government should employ more skilled workers, including qualified engineers, water scientists, managers, technicians and artisans to enhance water supply to the villages. A cross-sectional survey design and analytical descriptive method were used in this research. Random sampling was used, to ensure that every household got an equal chance to be selected. Questionnaires, observations and interviews were used to collect primary data while analysis of documented materials were used to collect secondary data. The study concluded by suggesting possible strategies which can be used to alleviate water supply challenges in the study area.

Key words: Water supply, Infrastructure design, Sustainability, Resource, Municipal services and community

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Definition of key concepts

Community: refers to a group of households in a particular area that share one or more water supply facilities (Kativhu 2016: 18)

Infrastructure design: refers to a major project that involves skills, services, planning, good design that can withstand for a long time. e.g. water engineering, bridge design, tele communication and transport (Ismail and Mahyideen 2015: 11)

Municipal services: refers to the services provided by the municipality to the villages including water, road, electricity,housing, solid waste,sewerage and sanitation (Dau 2010: 26)

Resource: a source of supply, support, or aid especially one that can be readily drawn upon when needed (Nkuna 2012: 64)

Sustainability: refers to water supply facilities being maintained in a condition that ensures a reliable and adequate potable water supply over a prolonged period of time (Davis and Brikke 1995: 6)

Water supply: refers to the process of providing water to the community,using reservoir, tunnels and pipelines for domestic purposes (Chaminuka and Nyatsanza 2013: 23)

Used acronyms

ANOVA.....Analysis of Variance

IDP.....Integrated Development Plan

IWMI.....International Water Management Institute

NPU.....National Population Unit

PPAs.....Power Purchase Agreements

RDP.....Reconstruction and Development Programme

SPSS..... Statistical Package for Social Sciences

TWAD.....Tamil Nadu Water Supplies and Drainage Board

UNDP..... United Nations Development Programme

UNECE..... United Nations Economic Commission for Europe

UNESCO..... United Nations Educational, Scientific and Cultural Organization

UNFPA.....United Nations Fund for Population Activities

UNICEF.....United Nations Children's Fund

VDM.....Vhembe District Municipality

WDM..... .Water Demand Management

WHO.....World Health Organisation

WMA..... Water Management area

WMD.....Water Demand Management

WML.....International Water Management Institute

WWAP.....World Water Assessment Programme

CHAPTER 1: INTRODUCTION

1.1 Background

Water supply is a process that has been described by different scholars from different perspectives. Musonda (2004) describes water supply as the provision of clean and safe water to the rural community through construction of boreholes, protected wells and spring, while Collins (2012) describes water supply as a process of supplying water to the community, including reservoirs, tunnels and pipelines. On the basis of the above descriptions, it can be deduced that water supply is an involving process that is broader than the simple provision of water. Hence the process can be quite challenging with an array of factors that influence water supply challenges. According to Faures *et al.* (2012), many municipalities around the world face water supply challenges as a result of poor infrastructure and population increase. According to UN-Water (2006) water supply challenge is a situation whereby water sources becomes inadequate to the community due to the problem of infrastructure, increase in population and other factors that may lead to supply problem of water for consumption. Water supply challenge is viewed as lack of water in relation to water requirements (Tapela, 2012). Globally about 1.9 billion people stay without fresh drinking water while 3.6 to 4.6 billion people around the globe especially in densely populated countries like India, China, Asia, Arabic peninsula, North Africa, Armenia and others are moving to a chronic water supply problem by 2050 (Burek *et al*., 2016: 13).

Nayar (2013: 76) predicts that by 2025, about 3.4 billion people will be staying in regions with water supply problem and they will go hungry without enough food. Additionally, it has been estimated that there is 0.5 per cent of the water available on the planet for human use and this small percentage of water is under pressure of the growing population. Globally, per capita available water declined from 20,000 cubic metres per capita to 14,000 cubic metres /capita and it is expected to fall again to 5,400 cubic metres by 2050 (Rivas and Nonhebel, 2016). Water is very important in sectors such as agricultural, industrial, household and recreational activities. In many parts of the world water demand already exceeds supply as the world population continue to rise (Chartres and Varma, 2010). Water is important for life since it is a major basic need and is also important for economic activities. According to Wanjohi (2015:1) almost 80% of Kenyans continue to have inadequate access to water, drink unsafe water and spend much time and money trying to acquire it. In South Africa different water users face serious problem of water supply as water is not always available and accessible to everyone (Goldblatt, 1996). Limpopo Province is mainly composed of rural areas,

where 89% of the land is rural area while 11% is urban area. The study was conducted at Bunzhe and Tshififi villages in the Thulamela municipality. Thulamela municipality has three dams that are filled with water but villagers do not have access to that water. There is water supply problem at Thulamela Municipality as the households seek water for drinking, cooking, gardening, washing and for agricultural use as well as sewerage system in urban area. The households at Thulamela Municipality mostly depend on Thulamela Municipality for water supply. The municipality has a serious challenge because there is no consistent flow from water taps, poor infrastructure and water supply has not reached the target in terms of backlog (Thulamela Municipality IDP, 2017/2018). The main source of this water is Thathe Vondo dam, Damani and the newly constructed Nandoni dam. This situation motivated the researcher to investigate the water supply challenge in the rural Thulamela Municipality in Limpopo province, South Africa.

1.2 Problem statement

The study was conducted at Bunzhe and Tshififi villages in the Thulamela municipality. The importance of reliable adequate water supply cannot be overemphasized. In recognition of water as one of the basic human needs, the South African government has constructed a number of dams and reservoirs to safeguard water supply to the communities. Thulamela municipality has three dams Nandoni, Thathe Vondo and Damani. The unfortunate challenges that the communities residing next to such big dams are as follow: remain without water for days, weeks, even months, hunger, diseases, unemployment and travelling long distance to fetch water. Water supply is undoubtedly one of the biggest challenges faced by Thulamela municipality residents. A case at hand is that of Bunzhe and Tshififi villages which are hardly 15km from Nandoni dam. Communities from the afore mentioned villages need water for drinking, cooking, gardening, washing and for agricultural use. Water supply challenges in these areas is such a serious problem, people travel long distances to fetch water from alternative water bodies. The situation has reached a stage where protests and demonstrations against water challenges have become a common feature. The municipality has a serious challenge because there is no consistent flow from water taps, poor infrastructure and water supply has not reached the target in terms of the backlog (Thulamela municipality IDP, 2017/2018). Hence the study seeks to get into the bottom of the challenge. Water is a basic human need and its shortage often disrupts many social and environmental processes. Water supply at Thulamela Municipality in rural villages is not reliable and is below standard.

1.3 Aim of the study

The aim of the study was to investigate the challenge of water supply at Thulamela Municipality

1.4 Objectives

- To identify the causes of water supply challenge in the Thulamela Municipality
- To determine the water supply capacity in the Thulamela Municipality
- To examine the efficiency of water supply infrastructure at Bunzhe and Tshififi villages
- To assess the impact of water supply challenges at the studied area
- To suggest possible strategies to be used to alleviate water challenges and its impact in the study area

1.5 Research questions

- What are the causes of water supply challenge at Thulamela Municipality?
- What is the capacity of water supply at Thulamela Municipality?
- How efficient is the water supply infrastructure at Bunzhe and Tshififi villages?
- What are the impacts of water supply challenge at the Thulamela Municipality?
- Which possible strategies can be implemented to alleviate the water challenges and its impact in the study area?

1.6 Justification of the study

Previous studies have managed to show the following findings: lack of knowledge on various water uses on agricultural sector and households (Tshikolomo *et a*l., 2012), the demand of water services is rising from inadequate management (Cashman *et a*l., 2010) or service delivery of water and sanitation that result in water borne diseases which are common causes of illnesses and death in developing countries (Dau, 2010). Information available in most studies is of water pollution in different areas (Nyangeri and Ombongi, 2007). This study is important as it focused on water supply challenges at Tshififi and Bunzhe villages. The study is going to solve problems that had been caused by water supply challenges such as poverty, illiteracy, unemployment, economic decline in the study area. If reticulation pipelines from Nandoni and Thathe Vondo regional water scheme can be constructed people in these villages can practice farming as a result poverty will be reduced. Learners will be able to attend their classes instead of walking long distances to fetch water. Water supply challenges affect their daily livelihood such as building houses, farming and time for other activities. The study will limit walking long distances and reduce spread of dieseases related to long distances to fetch water. The study is also expected to help to contribute to the body of knowledge in the field of environmental sciences and to inform policy makers in the government.

1.7 Description of the study area

1.7.1 Location

The study was conducted at Bunzhe and Tshififi villages. The geographical coordinates for Tshififi is $22^0$55’20” S$30^0$32’36”E and for Bunzhe is $29^0$34’40’’S $31^0$04’25’’E in ward 16 at Thulamela Municipality under Vhembe District, Limpopo Province. The study area is located within the municipal area in the Thulamela Municipality on the eastern part of the Vhembe District. Thulamela Municipality covers an area approximately 2904.55 km² and is located between line of latitude $22^0$57’S and line of longitude $30^0$29’E (Vhembe District Municipality IDP, 2017/2018). Thulamela municipality stretches to Kruger National Park on the eastern side. The region extends northward to the Limpopo river that forms the boundary between Zimbabwe and South Africa. On the eastern part of the study area Luvuvhu river forms the boundary with Kruger National Park. The (R 524) regional road of Punda Maria cut through the municipality jurisdiction area to Kruger National Park North Gate (Thulamela Municipality IDP, 2017/2018). The study area is characterized by several rivers such as Dzindi, Mvudi, Luvuvhu, Mutale, Ngwedi and Mutshindudi river.

Bunzhe village is located approximately 8 kilometres on the eastern side of Thohoyandou shopping complex along the Punda Maria road (R524). It is bordered by Tshikhudini village. According to the local headman Bunzhe is composed of 700 households. On the other hand, Tshififi village is situated at about 18 Km on the north eastern side of Thohoyandou complex. Bunzhe is located south east of Tshififi village, the distance apart is approximately 2 km. According to the local headman there are 4000 households at Tshififi village. Figure 1.1 shows area serviced by Thulamela municipality. The area is composed of a number of rivers, dams and villages. The above area has got both perennial, seasonal rivers and dams that support the villagers.

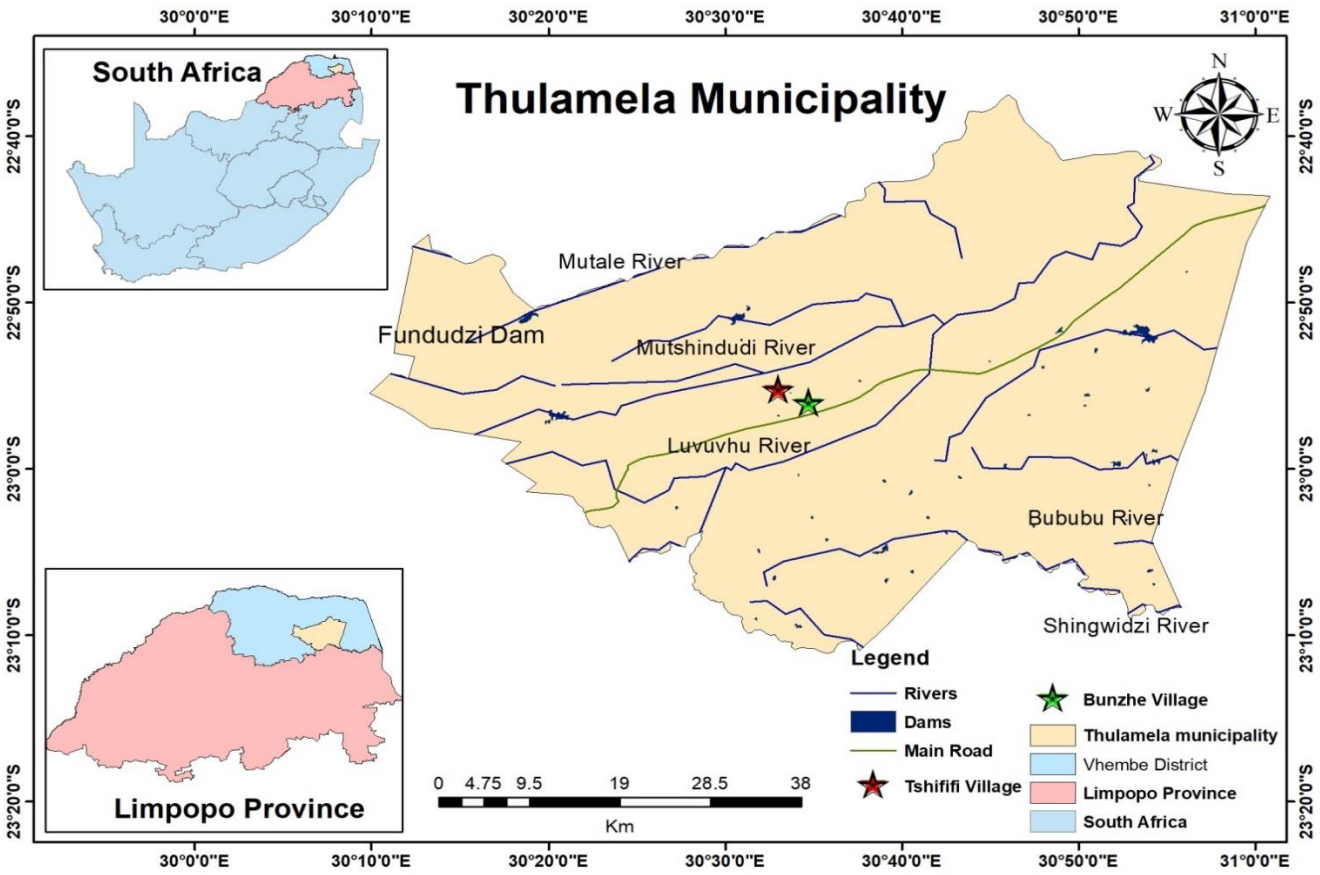

Figure 1.1: Map showing the location of Bunzhe and Tshifiti in Thulamela Municipality (Source: Thulamela GIS section, 2018)

1.7.2 Climate

The climate of Bunzhe and Tshifiti villages at Thulamela municipality is typically subtropical, with mild, moist winter and wet warm summers characterized by low veld. The area experiences annual rainfall of approximately 500mm per annum out of which about 87.1% falls between October and March. The rainfall pattern is largely influenced by the orographic rain effect of the Drakensburg Mountains joining the Soutpansberg perpendicularly decreases from east to the west of the district (Thulamela Municipality IDP, 2017/2018: 31). The region is generally hot and humid with a summer rainfall. The average summer temperature is 23^0C and the average winter temperature is 17^0C. The prevailing wind in the study area direction is east to southeast in both summer and winter (Van Riet and Louw, 2003).

1.7.3 Geology and soil types

The geology of the study area characterized by sand stone, shale, conglomerate, quartz and basalt. Tshififi village is situated on top of the hills and this has impact on the supply of water from one area to another. When looking at the soil types of the study area and other villages it is not uniform. Some areas are characterized by sandy soil while others by loam soil which is fertile. In the study area within Thulamela municipality the soil has been exhausted due to continuous cultivation and both sheet and gully erosion is evident (Van Riet and Louw, 2003).

1.8 Delimitation of the study

This study focuses on water supply challenges in the Thulamela municipality case of Bunzhe and Tshififi villages. The scope of the study is limited to the two villages. The reason for doing that was to reduce the amount of time, effort that could be spent on certain activities that are unrelated to the study and the other reason researcher did not have enough money to cover a large area. In addition to the reason for setting boundaries was that results obtained from Bunzhe and Tshififi villages cannot be taken as generalization for all villages because some of the villages might be getting water everyday. Leedy and Ormrod (2005) describe delimitation of the study as to demarcate the research aims to make the research topic manageable from a researcher's point of view. The field research was limited to the geographic area of Ward 16 villages under Thulamela Municipality at Vhembe District, Limpopo Province: South Africa.

1.9 Theoretical Framework

This study employs a relational theoretical framework between water supply challenges, impact of water supply challenges and water supply storage levels. Figure 1.2 illustrates the relationship between the dependent variables (impact and challenge) and independent variable water supply as the main focus of the study.

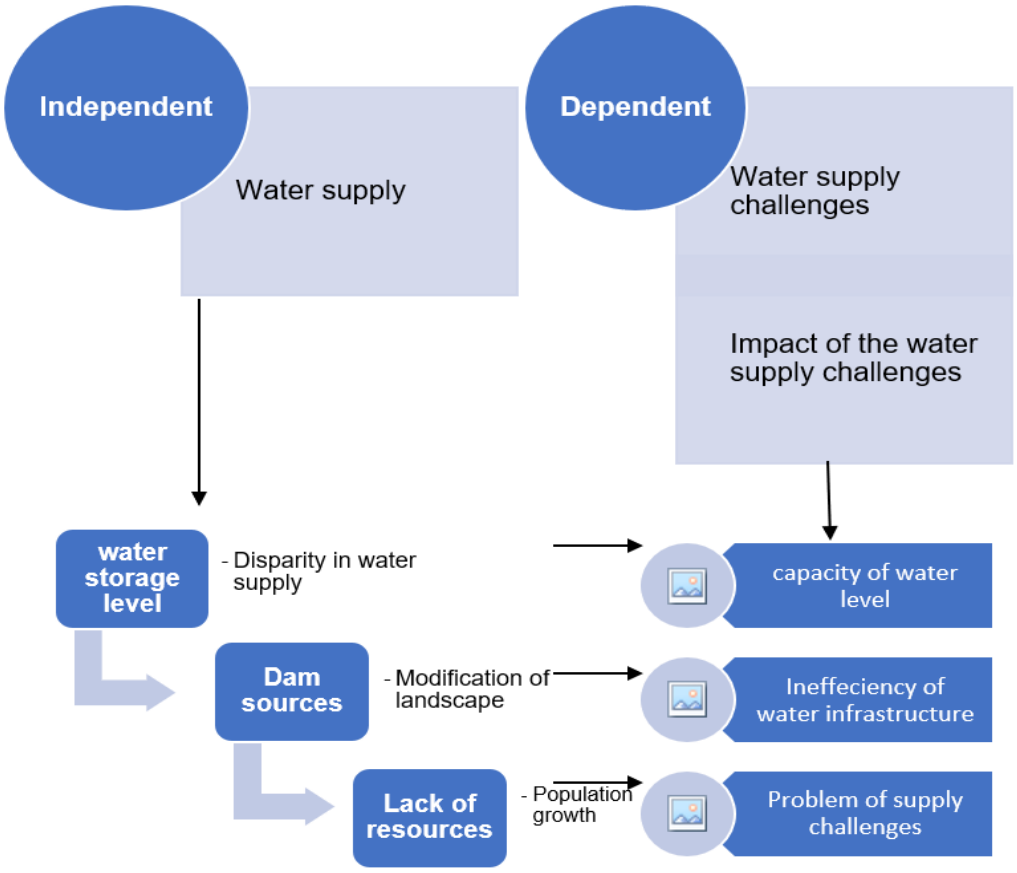

Figure 1. 2: Theoretical framework

The water supply challenges and its impact were dependent on the water supply level at Bunzhe and Tshififi villages in Thulamela Municipality of South Africa. It is important to note that the water supply challenges differ from region to region hence it should be address with specificity. Disparity in water supply is considered to affect the water storage level and the capacity of water supply. Due to the heterogeneous nature of this water supply challenges, landscape has been modified due to construction of dam and purification plants affect the water supply infrastructure system. The efficiency of the water infrastructure is considered as dependent variable on the financial resources implication and population growth which possibly contribute problem of water supply challenges.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The main trust of this section was to show what had been covered by other researchers in relation to water supply challenges. The literature included information from government documents, internet, journals, previous studies and books. Sub-questions were formulated to facilitate the discussion in exploring literature from various authors.

Globally, water supply challenges are becoming major issues of concern as the gap between demand and supply is increasing (Graymore and Wallis, 2010). Water supply challenge leads to other serious concerns related to areas like - poor health, low food production, poor economic development, poor agriculture, low survival of livestock and fish, prevents good sanitation and hygiene (Hunter *et al*., 2010).

2.2 Water resource, its importance, management and supply systems

Generally, water resources are necessary in most human activities. Water is useful in human activities such as, agriculture, domestic purposes as well as in the recreational and industrial sectors (Fang *et al.*, 2019). Studies have shown that about two-thirds of the 97% of salt water on earth are found in a frozen state at the polar regions while freshwater constitutes the remaining unfrozen 3% of water (Wang *et a*l., 2020: 2). On a global scale, the demand for water resources for various uses is increasing due to factors like, increasing population and uneven spatiotemporal distribution of water resources (Zhang *et al*., 2019: 13). According to the United Nations (2015), an estimate of 75%, 22% and 8% of water is used for agriculture, industrial and domestic purposes, respectively (Liu *et al*., 2019: 1). Findings from the International Water Management Institute (2016) research on viability of water for agricultural purposes showed insufficiency to meet the demands of over 1. 2 billion people in the world, majority of whom are found in African countries (IWMI, 2016: 15). This has led to water supply challenge for farmers to produce food required for the present and future, particularly, in Africa. For industrial purposes, renewable energy sources from hydroelectric dams, extraction of natural gas from shale rock have been powered by water resources (Lausier and Jain, 2019). In South Africa, challenge of water resources compelled the use of coal for generation of electricity, rather than using water (Eia, 2011). Water resources also find application as solvents in chemical processes, oil refineries and ore processing. Domestically, the basic water requirement per person has been estimated at 50 liters per day (Addisie, 2012: 9) excluding water for home

gardening. Usage of water resources for domestic needs, such as drinking, laundry, ablution and cleaning require sustainable management. Management of water resource in a safe, sustainable and reliable manner, hence, is crucial for its myriad of applications. According to Sarmento (2015: 1) the death toll is expected to be 580 000 children, world-wide each year, as a result of water supply challenge. Water supply challenges result in inaccessibility to safe drinking water and adequate sanitation (Sadat *et al.*, 2020). Studies by (Hamidi, 2020, Sadat *et al.*, 2020) have suggested that the water supply challenge could be influenced by population growth, domestic and industrial usage. Portable water supply, is required for drinking, food preparation and other uses to prevent health-risk diseases (Lalika *et al*., 2015).

The importance of water resources has been explained by various scholars from different contexts. The work of Hannemann (2015) describes water supply in the Sub-Saharan Africa as essential to life on earth; as one of the most basic needs, for people's livestock, agricultural activities, as a means for transportation and power source. Machethe (2011) outlines that water is an indispensable resource and life would be impossible without water; people cannot survive for many days without it. In Kenya the development rate is very low since some activities are based on high water outputs which are not available. In addition, water supply challenge also affects the health status of people living in Kenya resulting in poor sanitation, environmentally- related infections as well as psychological and social illnesses. These are all caused by water supply problem, according to Wanjohi, (2015).

2.3 The process of water provision to rural areas

Water provision in many African countries is carried out by the governments through public institutions. This process of water supply is financed by government funding, taxes and external donors (Molden, 2007). Globally, billions of people do not have access to drinking water and collecting sufficient drinking is a major challenge (Velleman, 2009). According to White Paper on Water Supply, water is normally used as follows - 25 litres per person per day. This is considered to be the minimum required for basic hygiene daily activities (Molden, 2007: 8). In addition, the distance should not be more than 200m away and the availability of water from the outlet should not be less than 10 liters per minute. According to studies by Hoffman and Nkadimeng (2016: 18), at Motetema area in the Limpopo Province, residents spent days without water because of unreliable water provision from Elias Motsoeledi Local municipality. Motetema rural and informal settlements fall below the average, as per basic water regulations. Cairncross (1987) provides an example from

Mozambique that demonstrate that water consumption is not enough in the country, since people spend more than five hours to collect a bucket of water. Studies by Omarova *et al.* (2019) at Kazakhstan in Eurasian, indicate that the underground water supply has got limitations, such as the cost of drilling boreholes which depends on the house owner and distance; tanked water is delivered to the village once a week and people pay for each liter. Rananga and Gumbo (2015) also gave an example for water supply problem at Tshilamba wherein residents spent about a week with no water for drinking, or ablutions and this has affected their daily activities. This background assisted the research to compare the water supply problem in the rural villages, globally. Water supply in most rural communities is a major concern; this helped the researcher to provide a context for villagers facing water supply challenges.

2.4 Water supply infrastructure

This study examined the efficiency of the available water infrastructure at Bunzhe and Tshififi villages. Water supply infrastructure refers to dams, reservoirs and boreholes to deliver clean water to communities (Felio, 2015). According to Hollingworth *et al.* (2011), water supply infrastructures include weir, canals, pipelines, dams and reservoirs; basically, anything that is used to store, divert or control the water in rivers. Water infrastructure system is designed to provide water services over its life-time, usually, period lasting everywhere from 10 to 100 years and must be adapted over time to meet evolving circumstances, such as changes in technology, society and business.

The South African population has access to water infrastructure but only 85% of this infrastructure is operational (Camdessus and Winpenny, 2015: 4). At the national level only 65% of this infrastructure is considered to provide a reliable service, whereas in rural areas the figure of the operational water infrastructure is much lower. In Limpopo Province the figure of operational water infrastructure stands at 40%, Mpumalanga 39% while almost 70% of water infrastructures in most rural areas have collapsed due to lack of maintenance and vandalism, hence, affecting the efficiency of water supply to the rural communities. In South Africa about 95% of the population has access to water infrastructure (Camdessus and Winpenny, 2015: 4). In the Sub-Sahara Africa, for example, the Pasi water treatment plants are old, outdated and the engineer revealed that the water system had leakages that is estimated at 500, 000 liters of water lost per year (Makwara and Tavuyanago, 2012: 158).

2.4.1 Efficiency of water purification plants

According to Ibrahim *et al.* (2014) water plant that is efficient is one that is operating properly, has no leakages, therefore, is able to treat and deliver safe water to the communities. Water purification plants which are not operating efficiently, therefore, will not deliver potable water to the residents. This study looked at how purification plants operate in treating and distributing water to the reservoirs in rural areas. The research traced if there were any leakages that can affect the efficiency of water supply to the study area. Water supply inefficiency is due to old and poorly maintained water pipelines that have out-lived their useful lives (Kristi *et al*., 2017). Water purification plants that operate in efficient and balanced way received raw water and treated it to become potable water that is safe for human consumption and complies with drinking water standard (SANS, 2005). The Thathe Vondo water purification plant is able to traeat 52ML/day (600L/s) while Nandoni dam which is the largest dam in the Thulamela Municipality with the capacity of 164 000000 is treating 60 ML per day (Thulamela Municipality IDP, 2017/2018).

2.4.2 Efficiency of water supply through pipelines

Hollingworth *et al.* (2011) explain that the pipeline system involves the supplying of potable water from the reservoirs to individual consumers. Efficiency of water supply means doing more, better with less by obtaining more value with the available resources; by reducing the resources consumption and reducing the pollution and environmental impact of water use (Muller *et al*., 2009). To ensure the efficiency of water pipelines involves the following - routine maintenance, pressure management, leak detection, repair, metering, meter reading and budget for maintaining the infrastructure (DWAF, 2008). In order to maintain the efficiency of water supply from the reservoirs, requires technical team to support, to repair and maintain the damage pipes to ensure good supply of water and to prevent non-revenue water losses (Hollingworth *et al*., 2011). In some areas, for over more than two weeks, communities will be without running water. In some cases, researchers checked if water supply problem is caused by the operators who are not available at when the infrastructure is broken (Mothetha *et al*., 2013).

2.4.3 Efficiency of water supply through tap water

Taps that are efficient are those that are able to supply water to the households without leaks while inefficient taps are always run dry, have leakages and unsafe water supply (DWAF, 2004). In order to maintain efficiency of water supply through taps to meet the future needs, operations of the broken taps must be attended to (WUE, 2017). This study examined efficiency of water supply infrastructures including streets taps and main pipelines connected to the tap from the reservoir, to see whether they are fit to supply water to the community. The study also looked at the maintenance of infrastructure if there was a damage that can affect water supply as there could be lots of water losses during the distribution period (Khari and Vairavamoorthy, 2007). The water supply system must have enough water available every day for the basic water needs of households (Majuru, 2011).

2.4.4 Efficiency of water supply from boreholes

The study looked at the efficiency of borehole as a means of supplying water to the Bunzhe and Tshififi villages. Borehole is an appropriate way of extracting water from underground. Many villages in South Africa prefer to use underground water for domestic use. The borehole should be at least 30-50m away from potential pollution sources such as toilet and cattle kraals (WRC, 1998). The study looked at the efficiency of borehole to supply water to the community. The challenges, such as theft of generators, pumps and vandalism of water pump valves that affected the efficiency of water supply was also examined at Bunzhe and Tshififi villages. These problems with boreholes, for example, happened at Mankweng Township an area that is under the jurisdiction of Polokwane Local Municipality and a similar incident occurred at Louis Trichardt where residents had no water for the entire day after cables at the pump station at the Albasin dam were stolen (Manamela, 2010).

2.5 The causes of water supply challenges

This section focuses on the water supply challenges in the study area in relation to population growth, disparity in water supply, modification of landscape and lack of financial resources. Furthermore, this section provides information on the impact of water supply problem on development of rural area, population, ground water, crop yields, livestock, health and social relation. All the above factors have been discussed in detail according to the reviewed literature.

2.5.1 Rapid population growth

According to Dau (2010) population growth is an increase in population in a specific area. It is projected that the global population is expected to increase from 6.9 billion to 9.3 billion by 2050 (Rivas and Nonhebel, 2016). Water supply challenge occur when there is large increase in population that exceeds the existing water supply (Barkatullah, 1999). The concern becomes more urgent when it is recognized that nearly most of this growth will occur in developing countries where there is already an inadequate water supply to support the increasing population levels that existed in previous years (Bigas *et al*., 2012). Yemen is one of the countries with highest population growth in the world, thus, with many people who are in need of water (Glass, 2010).

Water supply challenge will put more pressure on the government to deliver more water to the areas that have less water (Tapela, 2012). Population growth also means rapid development whereby people seek more water for building houses, shopping complexes, agricultural activities and industrial development. The increase will also put more stress to the sources of water in rural areas, like in the Limpopo Province. The population at the Thulamela Municipality was 618 462 in 2011 while in 2001 there were 580 829 people; the difference is 37 633 (Stats SA, 2011). This difference of 37 633 indicates that population in the Thulamela Municipality is increasing very fast and the demand of water will also increase.

2.5.2 Disparity between water demand and supply

Disparity is defined as the difference or inequality in access to improved water system due to differences among geographical areas, social class (rich and poor), race, ethnicity and gender (UN, 2014). The disparity at regional scale, shows that almost half of the two billion people and four out of ten people who gained access to improved drinking water source live in China and India while the lowest numbers are found in Sub-Saharan Africa and Oceania (UNICEF, 2014). According to Mainganye (2006) disparity is seen in the way of unequal distribution of water between villages. In some villages there is uninterrupted water supply while in other villages people receive interrupted water more than 24 hours. The fact that water supply problem may result from unequal distribution among residents is also supported by the White Paper on water supply and sanitation policy (1994). South Africa, for example, experienced disparities in water distribution towards the end of the 19th century, Whites, Indians and Coloureds were receiving 95% while 57.7% who were Black communities who did not have piped water to their houses (White Paper on Water Supply and Sanitation Policy, 1994: 3). The municipalities in South Africa that are charged with the responsibility

of household water supply are local municipalities with large towns as their focus (Clifford-Holmes, 2015). Weaver *et al*. (2017) indicate that in urban areas there were sections in a towns that were set aside, during apartheid for the Black residents and they receive minimum service provision of water supply infrastructure. According to the studies by Weaver *et al.* (2017) Grahams Town East which is found in the Eastern Cape Province is experiencing water supply challenge because of the lack of financial support, lack of infrastructure and all these have been caused by disparity during apartheid.

People are changing the land to make it more attractive by adding trees, paths and other features. Water supply is needed to help those plants to survive. Today, more water is needed to produce more food (Spillmann, 2003). Globally, agriculture is the largest water-user and about 70 percent of water is withdrawn to be used in producing food. This large amount of water used in agriculture led to water supply challenge (FAO, 2017: 2). Agriculture is seen as the main cause of modification of the landscape through the world as people use it to produce more food. Removal of riparian vegetation, wetland to make land available for agriculture and urban growth decrease evapotranspiration infiltration as such water supply problems then start to occur. Irrigation system is used to transport water from the surface water source to an individual field and during the process, water is lost through leakages out of the pipes or it evaporates on its way to the field (UNFPA, 2001).

2.5.3 Inadequate financial resources

Many developing countries have problem of finance that is hindering them to supply sufficient water to the rural villages. The debt hangover of many developing countries, particularly, of the heavily-indebted poor countries has not been resolved. The serving of debt absorbs budgetary and foreign exchange resources, hampering a government's ability to fund its social expenditure programme including the water and sanitation sector (Annamraju *et al*., 2001). South Africa is dealing with inherited service backlogs and most of the municipalities have infrastructure that is in appropriate for current needs and to maintain these water infrastructures need a lot of money to either buy or repair them (Camdessus and Winpenny, 2015: 2). Lack of sufficient resources is posing a serious problem for municipality development. Different scholars have their own perspectives on the use of financial resources on water supply to different communities. Barhan and Mokherje (2006) said that services provided to communities come at the expense of other water services which are used in other communities. Devas and Rakodi (1993) indicated that financial management and resources remain some of the key constraints on the provision of water service. This problem means that municipalities are unable to eradicate service backlogs that are in existence. Thulamela Municipality is experiencing shortage of funds, for example, Mhinga sewage ponds are in need of R6, 725,989 and Phiphidi Ndondola reticulation is in need of R500-000 to upgrade water scheme (Thulamela Municipality IDP, 2017/2018). Inadequate funding for drinking water infrastructure, maintenance and for buying water pipes is causing water supply challenge (Foster and Briceño, 2010). Camdessus and Winpenny (2015) indicated that more money is needed to provide for recurring expenditure on administration, treatment of waste-water from both households and industry.

2.6 The impact of water supply

Water supply problem can hinder different development projects such as building houses, shopping malls, road construction, industrial development and bridges (SAPA, 2010). Water supply in industry is needed for cooling, transportation and washing finished product (UNESCO, 2000). Industrial water use in the developed countries is expected to increase as a result of the need for economic growth (National Population Unit, 2000). Limpopo Province is one of the poorly-developed provinces when it comes to water infrastructure and water supply challenges; these can hinder economic growth (Blignaut and Van Heerden, 2009).

2.6.1 The impact of polluted water

Bernardini (2007: 2) estimated that millions of people in the United Nations Economic Commission for Europe (UNECE) do not have access to safe drinking water, hence, are affected by water-related diseases, such as malaria, cholera and typhoid. Nleya (2008) argues that water supply problem is a manifestation of poverty and lack of water can force people to drink polluted water from the rivers. Pollution from the use of agricultural fertilizers and pesticides are the major causes of water supply problem in developed and developing countries like South Africa (Giupponi *et al*., 2006). Water pollution results in direct harm on agriculture, fishery, livestock, industry and seriously affects people and their future generations (Graymore and Wallis, 2010).

2.6.2 The importance of ground water

Groundwater is an essential water resource to be used to supplement water demand in a country, however, water supply problems is putting tremendous pressure on ground water. According to Farhan and Salim (2014) there is overdrawing of groundwater in Pakistan by users to compensate for shortage and this in turn reduces recharging owing to less percolation; this has resulted in rising of saline water levels nearer to the ground surface. Changhong (2008: 9) estimated that the ground water use is as much as 25% of the total water supply in Ghana, 40% in Mauritius and in Egypt the amount is 10% of the total water use. Countries such as Libya, Chad Sudan and South Africa that have arable land use ground water for irrigation (Changhong, 2008).

During normal conditions when there is enough rainfall, ground water storage is recharged and the water level will rise. The problem starts when precipitation is below normal when the usual period of peak ground water is reduced; when there is overdrawing of ground water at this time, there will be a serious challenge of water supply. Over-exploitation of ground water has been caused by rapid development of industry and agriculture. The groundwater usage is on high demand and its exploitation has caused an imbalance between water-users and groundwater recharge. As a result, the ground water table has decreased causing a serious water supply problem to the water-users (Graymore and Wallis, 2010).

2.6.3 Impact of water supply on economic development

A reduction in stream flows can reduce ecosystem-based recreation; this creates an economic impact which can be given a dollar value and potentially traded for other economic impact. People would like to pay for a healthy fish, by doing so the economy of the country would be growing. In addition, children like outdoor recreation activities such as boating and swimming which can also generate money for the country and contribute to job creation. Water supply challenges has a negative impact on the education, rural developments, socio economic development and employment opportunities (Ali and Ahmad, 2018); water supply problems can cause a decline in the economy of a country (Werick and Whipple, 1994). Water supply challenge will also affect economic development at Thulamela Municipality because the majority of people use water for gardening, brick-making projects and car wash businesses. The projects mentioned above provide employment to the people in villages at Thulamela Municipality. Water supply shortages have a great impact on domestic use. Small businesses such as building houses, tiling of houses require water, hence are affected by water supply problems. People in rural communities have backyard gardens and community gardens which they cannot irrigate due to water supply challenge (Mnisi, 2011).

2.6.4 Impact of water supply on crops

The problem of water supply leads to the failure of crops which has a negative impact on the study area because the communities run short of food. When this problem occurs, a country will start to import food grains which are expensive (Farhan and Salim, 2014). When the land dries up there will be poverty and there will be no food as water supply challenge can cause loss of production/crop failure in rural areas. Cash crops, especially cotton, oilseed and wheat have declined in terms of production; water supply problems negatively affect small and large-scale farmers. There is usually, over reporting of loss of production by larger farmers as they expect state authority to compensate their loss of harvest depending on the size of land owned by the farmers (Roy and Hirway, 2007).

2.6.5 Impact of water supply on livestock

Water supply problem also affect domestic animals such as cattle, sheep, donkey and goats in the rural villages under Thulamela Municipality. According to a study by Glass (2010) a shepherdess in the mountains reported that five out of 25 of her sheep had died out of dehydration or starvation; both of which are caused by lack of plants as a result of lack of water. Livestock need water for cooling; this requires the transfer of physical water and chemical energy. Livestock play important

role in regional income, in several ways. Livestock produce products such as milk, meat, eggs, wool, and skins that contribute much to the Gross Domestic Product of a country. Livestock need water for drinking and to bath in summer. When African countries encounter water supply challenges, their livestock die and their economy declines. Livestock may die due to lack of pasture which depends on the availability of water (Sanjiv, 2007).

2.6.6 Impact of water supply on health and social relation

The challenge of water supply can cause various impacts on public health and development. Presently, United Nations Children's Fund (UNICEF) and the World Health Organization (WHO) estimate that billions of people have water supply challenge as such many people have been affected by various diseases associated with lack of safe drinking water. Approximately 60% of deaths reported globally were linked to the diseases such as diarrhoea, trachoma, malaria and others (Faissal and Meryen, 2012). Water supply challenge may contribute to malnutrition and death caused by various diseases such as diarrhoea, cholera and HIV/AIDS. Women and children are vulnerable to HIV/AIDS, they are raped while walking long distance to fetch water (Nkuna, 2012). If water supply challenges can continue to happen there will be poverty, health problems, hunger, high mortality, lack of access to safe water, poor socio-economic status, unemployment, few bricklaying projects, no gardening and no development that will take place. Cherutich *et al*. (2015) indicate that if the duration of water supply challenge is prolonged, there will be lack of education and malnutrition which can be dangerous to children and people living with HIV and AIDS. If the water supply challenges can prolong it means that women will travel long distances carrying heavy water jars and this put women's health at risk and may result in premature birth and its complications (Cherutich *et al*., 2015).

2.7 Global water supply analysis

Water is an indispensable natural resources which is provided by ecosystems to people (Liu *et al.*, 2019). Human activities are considered as a major factor that changes water flow paths (Qin *et al.*, 2015). The natural flow refers to the flow of water downstream based on difference potential at different terrains, without human intervention. From another perspective, flow with artificial interference often occur to supplement water resources during water supply challenges (Silvestri and Kershaw, 2010). Human intervention through building of reservoirs, dams and interbasin water transfer are inclusive in artificial interference which could be used to address the uneven distribution

of water resources. Water is available in the form of groundwater, precipitation, glaciers and wetlands (Mohammadzadeh and Heydarizad, 2020). The freshwater represents 2.5% of the earth's water as against the frozen saltwater at the Arctic, Antarctica or Greenland. Part of the freshwater percolates through the soils to constitute the groundwater (Mohammadzadeh and Heydarizad, 2020: 7). Furthermore, precipitation in the form of rainfall or snow is a form of freshwater but it is distributed as surface and groundwater components yet varies greatly in different part of the world. Studies have shown that about 40% of precipitation had been formed from evaporation from the ocean and land; this then replenishes desert region at an amount less than 100mm per year and over 3400mm in the tropical regions (Li *et a*l., 2019: 1). The wetlands are characterized by water-saturated regions which includes lagoons, swamps, bogs and marshes.

Seckler *et al.* (2003), indicated that the global water supply problem is mostly influenced by population growth and if there is no intervention strategy about this, the situation will also affect next coming decades. An increase in population globally will cause a burden on water infrastructure and there will be less water per capita (Nayar, 2009). Water supply is low in areas with low rainfall and high population density. Countries such as Central Asia, West Asia and North Africa are already close to or below the 1000 m^3/capita/year threshold (Nayar, 2013: 84).

Wallace (2000: 107) estimates that in essence all of North Eastern, Southern Africa, and the Middle East, will drop below 1000 m^3/capita/year before 2050 and Egypt is likely to drop below 500m^3 within the next 25 years. In addition, more water is needed per day to grow products such as cereal grains, maize, wheat and water for consumption purposes; currently, the amount is insufficient because people need thousands of liters of water per day to drink. Water is needed to grow food for people and domestic purposes - 50 litres per person per day (Yang *et al.,* 2003: 3051). The list of countries in Africa and Asia which will have renewable water resources below threshold of 1500m^3/capita/year by the year 2030 is shown in Table 2.1. The bold names are the countries entering the water deficit after the year 2000 (Yang *et al*., 2003: 348). This gives the researcher reasons to recommend some intervention strategies to be implemented as soon as possible.

Table 2.1: List of countries renewable water resources below the calculated threshold of 1500 m^3(Yang *et al*., 2003: 3051).

Afghanistan	Egypt	Kenya	Rwandwa	**Uganda**
Algeria	**Eritrea**	Korea Republic	**Nigeria**	Tunisia
Bukina Faso	**Ethiopia**	Lebanon	Pakistan	Togo
Burundi	**India**	Libya	**Niger**	**Tanzania**
Cape Verde	**Iran**	**Malawi**	Saudi Arabia	Emirates
Comoros	Israel	Maldives	**Somalia**	Yemen
Cyprus	Jordan	Morocco	South Africa	Zimbabwe

2.8 Thulamela Municipality water supply capacity

In the Thulamela Municipality, the water supply capacity is relatively low, however there are many sources of water, such as perennial rivers, dams and wetland. In addition, rainfall is distributed unevenly over the region, with humid subtropical conditions in the east. Sources of water in South Africa include rivers, lakes, estuaries, wetlands and groundwater which accounts for 15 percent of water used in the region (Hoffmann and Ashwell, 2001).

2.8.1 Rivers as the main source of water

Rivers are the natural pathways that take water from the earth surface to the oceans. The Limpopo Water Management area forms part of the internationally shared Limpopo River Basin which includes sections of Botswana, Zimbabwe and Mozambique. Figure 2.1 is significant because it shows the perennial rivers in the Thulamela Municipality, such as Luvuvhu, Mutshindudi, Mutale, Nzhelele, Phungwane, Sand River, Shingwedzi and others.

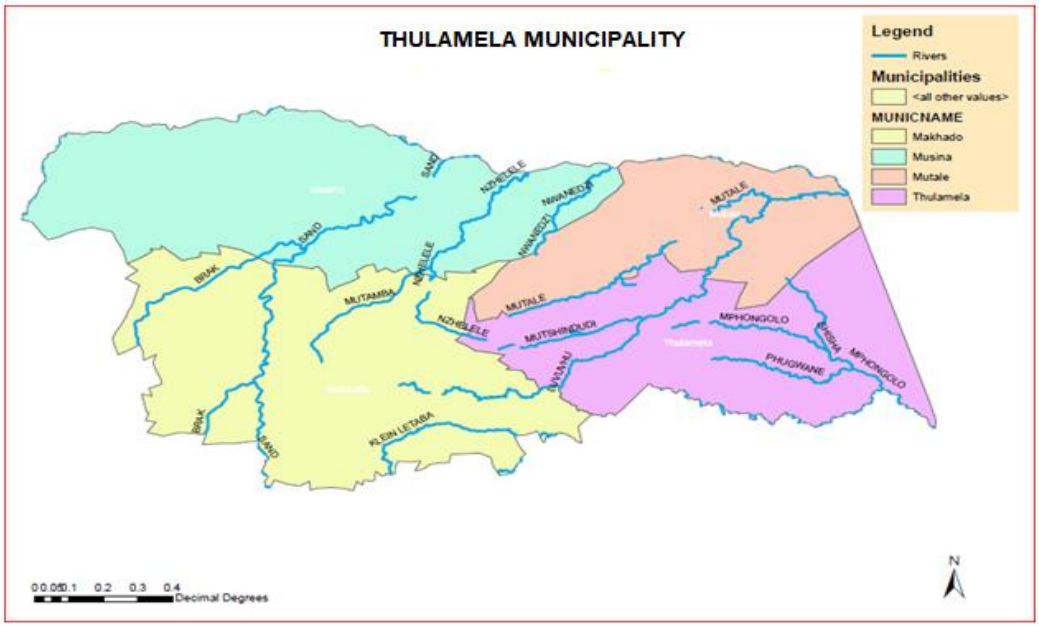

Figure 2.1: Map showing perennial rivers in the Thulamela Municipality (Source: Thulamela GIS section, 2018)

The Limpopo River forms the border between Botswana and Zimbabwe before flowing into Mozambique and into the Indian Ocean (DWS, 2017). Nandoni and Vondo Regional Water Scheme (RWS) falls within the Luvuvhu\Letaba water catchment area which spans across Vhembe and Mopani District Municipality. Some of rivers, such as Dzindi, Tshinane and Mvudi are found in the Thulamela Municipality. The main source of water at Thulamela Municipality is rainfall which then water flows into rivers, lakes and dams. These rivers are the main source of water to the households that are found in the Vhembe District. The Department of Water Affairs as the custodian of water resources had constructed dams along these rivers in order to supply water to the different villages (Vhembe IDP, 2014/2015). According to Stats SA (2018: 41) Vhembe District Municipality has the highest proportion of freshwater about 81.1% which is more than in the Capricorn and Waterberg districts. The study looked at the availability of water at Bunzhe and Tshififi villages as community members were seen as without water to drink. Overall, in South Africa water is becoming a scarce and a crucial resource, particularly, because both people and industries need water and electricity for their survival.

2.8.2 Local water supply dams and their capacity

The following dams, such as Albasin, Damani, Luphephe, Nandoni, Nzhelele, Nwanedi, Vondo and Mutshedzi store water for different purposes, for example, Nandoni dam stores water for irrigation

and for domestic purposes. The dam levels fluctuate because of seasonal changes (Vhembe IDP, 2014/2015). The Table below illustrates the dam levels and capacities in the Vhembe District Municipality.

Table 2.2: State of dam levels and capacity on 06 November 2017(DWEA, 2017)

Name of the dam	Year completed	Capacity per m^3	Area Covered	Dam level
Albasin	1952	28,200	3498	78.1
Damani (Thulamela)	1991	11000	130	60
Luphephe	1963	14000	1416	60.1
Nandoni (Thulamela)	2005	164000 000	15700	97.2
Nzhelele	1948	51200	5442	49.8
Nwanedi	1964	15100	-	75.4
Vondo (Thulamela)	1971	**52000**	-	88.5
Mutshedzi	-	-	-	97.2

The big dams, such as Albasin, Damani, Luphephe, Nandoni, Nzhelele, Nwanedi, Vondo and Mutshedzi are found in the Vhembe District Municipality. During rainfalls dam levels increase and during dry season, especially in winter, the dam levels decrease. Villages under Thulamela municipality receive their water supply from Vondo, Nandoni and Damani (Thulamela IDP, 2016/2017). Thulamela municipality has many sources of water to supply its communities, although many people are still complaining about water supply challenge. Thulamela Municipality's sources of water come from local water schemes, where there is preservation and conservation water before it is used by the community.

2.8.3 Availability of underground water

Groundwater is a very valuable source of water at Vhembe District Municipality. In order to get groundwater a borehole has to be drilled to maintain a constant supply of water to the villagers. According to Vhembe IDP (2014/2015) the total number of boreholes in the Vhembe District is 38 521 with 278 electric pumps, 241 uses diesel engine and 839 hand pumps. Majority of rural villages under Thulamela Municipality obtain water from motorized or hand-pumped boreholes, and some by the water-tank system. Surface and underground water are very important for economic

development of a country. They are useful in different sectors, such as agriculture, industries, recreational activities and in domestic use. These sources of water are decreasing due to demand for water that already exceeds the supply because the world population continues to rise (Chartres and Varma, 2010).

The drinking water sources available may either improve or deteriorate depending on the nature of construction or the kind of intervention applied. Improved drinking water sources should, but do not always, provide safe drinking water and include piped household water connection, public stand pipes, borehole, unprotected dug wells, protected springs and rainwater collection. According to Omarova *et al*. (2019) sub-standard drinking water sources include: unprotected dug wells, dams, lakes, ponds, streams, canals, irrigation channels, vendor-provided water and tanker-truck water. The underground supply has got disadvantages, such as the cost of boreholes, depending on the house owner, traveling long distance, tanked water being delivered in the villages once a week and people pay for each liter. Some areas receive more than enough water while others experience water supply challenges. Average areas in Africa receive an annual rainfall of between 200 and 800 millimeters. In Africa all possible sources, such as wells, streams, lakes and canals are likely to be utilized (Wanjohi, 2015: 9).

2.8.4 Dams, Purification Plants and Design Capacity

In South Africa, most dams can store about 1000 cubic meters per capita for the middle income population (Briscoe and Malik, 2006: 19). There are many dams in the Thulamela Municipality such as Nandoni, Nzhelele, Damani, Tshakhuma, Mutshedzi, Vondo, Nwanedi, Lupepe, Middle Letaba and Abasin dam. In the Thulamela Municipality there are three big dams such as Nandoni, Damani and Vondo. Nandoni dam is constructed along the Luvuvhu river which is situated in the north eastern part of South Africa and its catchment area extends from near Louis Trichardt in the west to the Kruger National Park. The Nandoni dam was completed in 2005 and the designed capacity is 164 000 000 cubic meters. Nandoni is designed to produce 60Ml/d to rural villages. Nandoni has three pipelines - NR6, NR5 and NN20B. NR6 pipeline supplies water to Thohoyandou town, Mutoti, Dumasi, Budeli, Tshikhudini, Mphego, Tshulungoma, Manini, Tswinga, Shayandima. NR5 pipeline supplies water to villages, such as Makumeke, Dovheni, Jim Jones, Mahonisi, Mukhomi, Gumbani while NN20B pipeline supplies water to Mbahe, Nweli, Malavuwe, Makhuvha, and Mukomaasinanndu and in the future it will supply Giyani and Polokwane. The following rivers: Lutanandwa, Dzondo, Dzindi, Mvudi and Luvuvhu supply water to the Nandoni Dam (Van Riet and Louw: 2003). Damani dam get its water from Mudaswali river.

Vondo Dam's regional water scheme was established in 1971 and the Mutshundudi river supply water to the Vondo dam. The design capacity for Vondo dam is about 52 000 m3/day and was meant to supply a population of about 588000. Vondo regional water scheme is situated between latitude 22^0 38' and 30^0 31' longitude. The scheme serves a population of about + - 588 000 people. A total of 95% of the populations served by the scheme are rural areas and only 5% of the water is used by the Thohoyandou Urban area; Thohoyandou consists of 167 villages excluding Malamulele rural township. At the present moment the scheme is experiencing demand over-load (Phuthu, 2012).The design capacity is now unable to cope with high demand of water supply because of the growing population. The water pipelines are ageing and money is needed to speed up the process of renovation. Damani dam get its water from Mudaswali river. These dams are the biggest in the Thulamela Municipality. All three dams are meant to supply domestic water to the rural villages under Thulamela Municipality (DWS, 2015). These dams are seen to be full of water, yet, people are still complaining about water supply challenges and others are sharing water with animals.

2.9 Possible strategies to alleviate the water supply challenge in the study area

According to the literature review, there are different intervention strategies for minimizing water supply challenge. The study will focus on the following strategies - reuse of waste water, better water demand management, water privatisation, appointment of skilled managers and workers, as well as refurbishment of the water infrastructure.

2.9.1 Reuse of waste water

According to Sharma *et al*. (2007), reuse of wastewater is the process of tapping a wastewater network and extracting the sewage form it by treatment and reusing the resultant water as recycled water. Treated water is supplied back through a pipe that is separate to the potable line and used for toilet flushing and irrigation (Willis *et a*l., 2013). Reuse of treated effluent water should be viewed as a water demand management or water conservation option that can increase the effectiveness of water use within existing water supply or industrial systems. A number of treatment systems have been developed to treat discharges from the mining industries. Amazi project is one of the major current initiatives related to mine-water treatment. The project deals with the treatment of up to 87.7mm^3 of water per annum and represents the combined efforts of several mines in the Gauteng Province (Smakhtin *et al.,* 2001: 21).

2.9.2 Water demand management

More attention is being paid to ensuring the effectiveness and efficiency of water use within existing water supply system. An important opinion of the WDM is for extending the availability of water resource. The water demand management encourages the building of more dams, inter-basins' transfer schemes, a wise-water gardening campaign, identification of sources of water losses, an escalating tariff structures and informative billing system. Water-demand management includes water regulation, water conservation, water leakage management and more. According to the Gauteng Planning Commission, which is responsible for the Gauteng Integrated Infrastructure Master Plan, South Africa is not managing its water demand effectively (Camdessus and Winpenny, 2015). The demand for water is increasing in a number of regions and as water is claimed for agriculture, industries, household and nature reserves which exceeds the amount of fresh water available; this demands a better management of fresh water. Irrigated agriculture is by far the biggest consumer of fresh water, hence, increasing water productivity in irrigated agriculture is a good way for managing water. Irrigation engineers have focused on irrigation efficiency, which commonly relates to the amount of water diverted from rivers or reservoirs to the amount of water actually benefiting soil moisture storage. Irrigation engineers and groundwater policy-makers, for instance, may recommend the cultivation of dry rice instead of paddy rice, as less irrigation water is required to produce the former, thereby, there will be more water available (Van Dam *et al*., 2007).

2.9.3 Water privatization

Water privatization is a new paradigm needed which was included in the UN World Water Development report to reassess, check and re-engage with water availability. The paradigm is trying to face away the traditional notion of taking water as a free gift from nature. This new paradigm shifts also repeated in the report of the International Water Management Institute (IWMI) titled - Water for food and Water for life. The report shows that agriculture requires more water for adequate food production. To avoid serious water supply challenge, water sources need a special attention. This changed paradigm of water delivery was tested in 450 villages across Tamil Nadu by the Change Management Group of engineers of the Tamil Nadu Water Supplies and Drainage Board (TWAD), with very good results. There was a decrease in the cost per households by 60 percent and they saved up to 33 percent; this means the proposal is a good paradigm shift for saving water (Nayar, 2013: 90).

The changes in paradigm are continuing in order to ensure the viability of the public and private sector to efficiently provide water to the citizens who are beneficiaries. The approach of erecting water supply infrastructures from government funds is overtaken by the demand management approach of controlling people through pricing and moral behaviour, because of the economic difficulties. Water privatization can be implemented through responsible service contracts on defined duties, inspection contracts, rents, operations and maintenance negotiations. Power Purchase Agreements (PPAs) shared ownership and full divesture**.** A private contractor collects all the monies of water provision and that money is used in running water supply, repairs and the costs; the remaining money is kept as profit. Another example of a country applying privatization of water is Cameroon, in order to avoid the trap of funds mismanagement (Saidou and Tewari, 2010).

2.9.4 Refurbishment of the water infrastructure

The refurbishment of the water system is a top priority to prevent the start of diseases such as cholera can be established (Makwara and Tavuyanago, 2012). Damaged infrastructure such as borehole pumps, reticulation pipes, and street tapes will be assessed to prevent loss during distribution of water to the villages (Khari and Vairavamoorthy, 2007). This research study would examine the possibility of Thulamela Municipality adopting new technologies with ready spares and better efficiency, instead of the old equipment. The municipality has to ensure that old infrastructure is replaced immediately to avoid water supply problem. This study will also assess whether water supply challenge is exacerbated by ageing infrastructures such as old water pipelines and purification plants.

2.9.5 Appointment of skilled Managers and Workers

The intervention of training water scientist in the universities, involvement of local professionals, water consultants, appointing water scientist and managers should be established. In South Africa and other parts of Africa, the ratio of 20 engineers per 100 000 people have now dropped to 3 engineers per 100 000 people. The ratio is clearly indicates the crisis in skills' shortage (Cashman *et al*., 2010: 63). In summary, this literature review has described the water supply challenges, water availability, infrastructure design, water sources, management and supply systems. The review has indicated contributes from the body of knowledge on previous water supply challenges on a global, national and municipality scales. Having an adequate knowledge of the current global water supply challenges is essential to ameliorating the water challenges described in the study.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter deals with how the data for this research was collected. The chapter describes different methods that were used to collect data on water supply challenges in Bunzhe and Tshififi villages in the Thulamela Municipality. The methods that were used were - (secondary data), literature review and for primary data, cross-sectional survey, questionnaires, sampling techniques, statistical analysis of variance, descriptive statistics and ethical consideration.

3.2 Research design

The study was conducted using a cross-sectional survey design. Cross-sectional studies are carried out at one-time point or over a short period (Neil, 2010). They are usually conducted to estimate the prevalence of a phenomenon of interest. In cross-sectional design, the researcher collected data at one point in time (Cris *et al*., 2004). The researcher used this design to collect data by meeting with the respondents at one specific occasion. The cross sectional survey was used to determine the state of water supply in selected rural areas in Thulamela Municipality. The study used mixed method design; this means both quantitative and qualitative method were used to collect data. For the quantitative method, a descriptive survey in the form of a questionnaire was used whereas with the qualitative method, a case study method in the form of interviews was used.

3.3 Methods of data collection

The primary and secondary data collection approach was used to obtain the required information for this study. Questionnaires, observation and interviews were used to collect primary data from Tshififi and Bunzhe villages. The sample was based on simple random sampling, where 470 respondents were selected from 4700 households (Bunzhe 70 and Tshififi 400) which represent 59% out of a population of 8000. The selection of 470 households was based on the availability of people within the two villages. The study also used key informant interviews using random sampling method to interview officials from the Department of Water Affairs, and selected participants from Bunzhe and Tshififi villages. Objective number two to determine water supply capacity at Thulamela Municipality- the researcher used secondary sources from the Department of Water Affairs and Stats SA to get dam levels and reservoirs capacity. Primary data was collected from key informants' interviews with community leaders and inspection of the location; this was for determining details

like - number of taps per households, number of active borehole and size of the water- supplying infrastructure.

3.3.1 Primary data

Primary data included personal observation and questionnaires. The primary data sources were selected households and key informants comprising of community leaders, the private sector, water project developers from the Department of Water Affairs and Thulamela Municipality officials.

3.3.2 Secondary data

Review of literature was used in obtaining secondary data. Through this method information was collected through the existing information that had been published already by various authors about water supply challenge. This method falls under secondary data because the information was acquired from library books, journals, government books, internet, maps and census report from private and public institution, as well as previous work of other students. Data from secondary source provided a starting point and background information for the research topic.

3.4 Techniques used in data collection

This section gives the details of all methods that were used to collect data about the water supply challenges at Bunzhe and Tshififi village. This section includes details on the observation, questionnaire, key informant interview and sampling techniques.

3.4.1 Observation

This involves a researcher getting primary data by visiting the study area and directly observing, and in this case, the water infrastructures that were available. This was undertaken at Tshififi and Bunzhe where tap water, reservoir and borehole were observed. During the observation the researcher took photos of the water infrastructures at the same time asking, from participants the condition of water supply at the study areas. The purpose of field observation, therefore, was to examine the capacity and condition of water supply infrastructure and to see whether villagers get water on a regular daily basis or not. The observation assisted in getting a clear picture of water supply challenges at Bunzhe and Tshififi villages; the information collected was recorded in a notebook for reference.

3.4.2 The questionnaire

Questionnaires were administered to 470 households out of the total number of 4700 in Bunzhe and Tshififi villages to help gather information on the challenge of water supply. The questionnaires were administered face-to-face to participants in their households; the researcher with the help of research assistants waited until the participants completed the questionnaires and collected them. The researcher used closed and open-ended questions. The reasons for using closed questions are that they are good for surveys, easy to be analysed statistically and appropriate for collecting data from a large population. For the closed-ended questions, there were multiple or set of answers and the respondents were asked to choose from among them by ticking a box. The researcher also used open-ended questions wherein respondents were given a chance to answer in their own words. Open-ended questions contained a blank section for the researcher and the research assistants to write in answers provided by the respondent. The reason for using open-ended questions was that the researcher wanted to find out what people think about water supply challenges.

3.4.3 Key informant interview

The researcher conducted an interview with six key informants, including community development workers and officials from Water Services. A key informant's interview was done to collect information from a wide range of people with knowledge about water supply challenges at the study area. Their selection was based on their positions in their villages and in the Municipality.

3.4.4 Sampling technique method

The study used random sampling because it provides relevant information in a short space of time. The random sampling was used because the approach saves time, funds, and usually, eliminates travelling costs. It is an easy method for collecting data because the selected households clearly showed that it represents the needs of all the villages within the study areas; this is essential since it is impossible to collect data from all the rural villages available in the Thulamela Municipality. Different scholars define sampling from different perspectives. Newman (1997) defines sampling as a process of systematically selecting cases for inclusion in a research project, while Mercado (2006) explains it as a system of selecting a representation from the general population, depending on the objective of the study, availability of money, time and effort in gathering research data (Mercado, 2006). Probability sampling method and its subtype - simple random sampling method was used. A simple random sampling approach, a subset of a statistical process in which each member of the subset has an equal probability of being chosen. The researcher had selected two villages in Ward

16 at Thulamela Municipality - Tshififi and Bunzhe - based on their water supply challenges. The total number of households at Tshififi was 4000. At Bunzhe total number of households was 700. In each village 10% of households were sampled, so this means that researcher sampled a total of 470 households. The sampling size used the following formula by Fishers (1983) to determine the number of households: $n = Z^2 (p\ q)/d^2$). From the equation (n) represent the desired sample size which was 489 households, Z is the Standard normal deviate at 95% level of confidence = 1.96, P is the proportion of target population estimated to have the characteristic under investigation (50% or .5) to maximize sample size (precision), q is a proportion of target population without the characteristic (1-p = 50% or .5) and d is the level of precision corresponding to statistical significance level of .05 or 5%. The Substituting for the values is $n = Z^2 (p\ q)/d^2) = 2.58\ ^2(.9^*\ .1)/\ (.01)^2 = 6.25)/.0025 = 4888.7.16$, hence, 489 (10%) households. Proportionate sampling for Tshififi village was 4000/4700= 416 while for Bunzhe it was 700/4700= 73, hence 489 households were to be interviewed. The response rate was 400 for Tshififi and 70 for Bunzhe village, hence, a response rate of 470/489%.

3.5 Sampling method strategy

Proportionate stratified random sampling was used in sampling the households from Bunzhe and Tshififi villages. The first, step was to arrange households in terms of their stand numbers. The stand numbers at Bunzhe were treated as random numbers ranging from (001-700). At Tshififi stand numbers were also used as random numbers ranging from 001-400. The households were picked randomly from a box containing stand numbers through lottery until the target number was achieved.

3.6 Validation of data

Validity is defined as the degree to which a study actually measures what it purports to measure (Bless and Higson-Smith, 2000). Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are (Joppe, 2000). In order to ascertain the appropriateness of the research instruments, the researcher conducted a pre-test with 50 respondents. A pre-test of the questionnaires was carried out to ensure that the content in the questionnaire remains unbiased while content validity was used to check on the suitability of the word and phrases used in the questionnaire.

3.7 Analytical method

- **Descriptive statistics**

Data obtained from the selected households was analysed statistically using descriptive statistics and presented in tables, pie charts and graphs. When all questionnaires were collected, the researcher selected all incomplete questionnaires which were then sent back to the study areas to be corrected in order to ensure the quality of the responses. The responses from the households' questions were coded into statistical package for social sciences (SPSS) for analysis. The reason for using descriptive statistics was that it is easy to interpret, understand and compare frequencies. Descriptive statistics is concerned with the description and summarization of the data obtained for a group or individual units of analyses. Descriptive research refers to the type of research question, design and data analysis that will be applied to the research topic. This methodology is applicable to the current study because it is concerned with questions that try to find out "what is…?" The study carried questions, such as - What are the causes of water supply challenges? What are the impacts of water supply challenges? (Welman and Kruger, 2001). Descriptive statistics uses techniques such as, frequencies, mean and standard deviation to present analysis; the results of this study were presented in the form of tables, graphs, diagrams, pie charts and percentages (Welman and Kruger, 2001).

- **Analysis of variance**

Analysis of variance was performed to check if there are significant differences in weekly water consumption between Bunzhe and Tshififi villages. The hypotheses tested were as follow: H_0: $\mu_1 = \mu_2$ (There is no significant difference in weekly water consumption between Bunzhe and Tshififi villages) and H_1: $\mu_1 \neq \mu_2$ (There is significant difference in weekly water consumption between Bunzhe and Tshififi villages).The significant level was set at, $\alpha = 0.05$. The rejection criterion was p – value less than 0.05. The acceptance criterion was p value greater than 0.05. This means that, if the p – value is less than 0.05, there is insufficient evidence to accept the null hypothesis, hence, there are significant differences in weekly water consumption between Bunzhe and Tshififi villages. If the p – value is greater than 0.05, there is, however, sufficient evidence to accept the null hypothesis. This means that there is no significant difference in weekly water consumption between the two villages.

The Analysis of Variance (ANOVA) was carried out to check if there are differences in mean hourly water supply per day between the two villages (Bunzhe and Tshififi). The researcher intended to find out whether the two villages experience water supply challenges in the same way. The Statistical Package for Social Sciences (SPSS) version 25.0 was used to do this analysis. Some diagnostic was conducted to see whether the dataset meets the required assumptions of normality of the data, equal variance between the two samples and independence of sampled data values. Some histograms and box plots were constructed to check for normality and data symmetry.The null hypothesis is that all day means per day in hours are exactly equal (H_0: $\mu_1=\mu_2$). The alternative hypothesis is that all water supply means per day in hours are not equal (H_1: $\mu\neq\mu_2$). The significance level is $p<0.05$. This means that if the p – value is less than 0.05 there is sufficient evidence to reject the null hypothesis at 5% level of significance, however, if the p-value is greater than 0.05, the null hypothesis at the 5% level of significance is accepted.

3.8 Ethical considerations

The researcher complied with professional ethics when conducting this study. This study ensured that participants operated from an informed consent perspective. Participation was on voluntary basis so that respondents could withdraw at any time they wish. The researcher respected the participants and the sites for the research.

- **Informed consent forms**

This study ensured that participants operate from an informed position. Informed consent was obtained from the participants after details about the study had been provided for them; details included the study's goals, the procedure to be followed and the rights of the participants. The researcher highlighted that the participants' information will be kept confidential. The researcher wrote letters to the relevant authorities - the management of Thulamela municipality, headman from Bunzhe and Tshififi villages - to obtain permission to conduct key informants' interview.

- **Confidentiality and Anonymity**

Participants were assured by the researcher that the information obtained from them was secured and in a safe place where no one can access or disclose the information. The researcher assured the participants that the data collected in this study will be kept confidential, except as may be required by a court order or by law.

CHAPTER 4: DATA PRESENTATION AND INTERPRETATION

4.1 Introduction

This chapter deals with the presentation and interpretation of collected data from the study area. Data was collected from Tshififi and Bunzhe villages located in the Thulamela municipality. Four hundred and seventy households and three key informants from Bunzhe and Tshififi villages, as well as three key informants from Thulamela Municipality, participated in the study. Standard deviation, frequencies, statistics package for Social Sciences, analysis of variance and subthemes were used to compute relevant variables which helped to address the water supply challenges for the study area.

4.2 Demographical information

Demographic information provided the researcher with viable information related to population composition. Such information tends to be directly related to water demand because different groups within a community tend to have specific water-related needs, thus, giving an idea of the kind of water supply services that the Thulamela municipality is expected to provide. Demographic information is relevant to this study as it would assist readers to have a better understanding of the background characteristics of the villagers in the study area. Such information embraces variables, such as gender, age, marital status, size of the households and other characteristics of the people within the study area.

4.2.1 Gender of respondents/Participants

Out of the 470 participants, a total of 252 were males in both villages which constituted 53% of the total participants; the remaining 218 were females from Bunzhe and Tshififi villages which constituted 47%. Bunzhe had few male respondents which is 20 (4%) while Tshififi had more males than Bunzhe with 232 (49%) respondents. Out of the 470, the total female respondents at Bunzhe were 50 (11%) while the total females at Tshififi village were 168 (36%). Tshififi village, therefore, had the highest percentage of female participants as compared to Bunzhe. This is shown by Table 4.1 below.

Table 4.1: Gender of the respondents

Villages	Male	Female	Total
Bunzhe	20 (4%)	50 (11%)	70 (15%)
Tshififi	232 (49%)	168 (36%)	400 (85%)
Total	252 (53%)	218 (47%)	470 (100%)

Bunzhe village had more females than males and most of them were single parents. Single parenting at Bunzhe village was caused by various reasons which include: separation, widowhood, divorce, abandonment and natural death of a spouse. Women as heads of the households have been influenced by different programmes that have been developed, especially after 1994, such as Reconstruction and Development programme (RDP), Poverty Alleviation Projects (PAPs) and National Development Plan (NDP) that aimed at empowering rural people, particularly women, by creating employment. The Reconstruction and Development Programme (RDP) which is providing houses to the poor rural people also has an influence on the issue of women as heads of the households. Reconstruction and Development Programme (RDP) is influencing women as heads of households by stipulating that 50% of the RDP houses must be given to them and this was extended by Lindiwe Sisulu, Minister of Human Settlement when she added that " when they get divorced the house belongs to the women". It is also supporting women as heads of the households by providing pregnant women and small children with free health care programmes and primary school children with nutrition. Through these initiatives, the RDP is supporting women as heads of households ensuring that they now have less burden in supporting their children.

Women as heads of households at Tshififi village experience challenges in receiving services provided by RDP, PAPs and NDP and for example, the water supply challenge slows down the process of building projects in both villages. Another reason which enables majority of females to be productive heads of households is that, now women are economically active and they can support themselves and their dependants, this makes them less dependent on men. For instance, women unlike men are more involved in informal jobs or enterprises such as trading, street vending and cooking in their villages for economic purposes. To perform these duties they need water. According to Tripathy (2003: 1), the rate of women as heads of families in developing countries has been

accelerated by the increasing number of women in informal business sectors which constitute a quarter of the world industrial labour as well as contributing 50% of the world food supply.
The findings at Tshififi village indicate that percentage of male respondents who headed households were more than that of Bunzhe village. This is influenced by the African culture whereby married women are submissive to their husbands, as such a male is regarded as head of the household (Thesane, 2001). The males at Tshififi village are affected by the water supply challenges since they are also assisting in the building constructions.

4.2.2 Age group of respondents

Out of the total of 400 from Tshififi village 93 (23%) respondents were below age of 20 while a total of 70 from Bunzhe 21 (30%) respondents were below the age of 20. The data further indicates that 119 (30%) respondents from Tshififi villages were between the ages of 20-39 whereas at Bunzhe village, they were19 (27%) of the respondents. About 108 (27%) respondents at Tshififi were between the ages of 40-59 while respondents at Bunzhe were 21 (30%). About 80 (20%) respondents at Tshififi were above 60 while only 9 (13%) such respondents were from Bunzhe.

The different age categories are shown in the Figure 4.1. below from the total sampled of 470 households. A total of 138 (30%) of the respondents were between the age of 20 and 39 years. Followed by 129 (27%) respondents who were between the ages of 40-59 were from both villages. About 114 (24%) were respondents less than the age of 20, while 89 (19%) were above the age of 60. The data shows that all the age groups need water for their day-to-day activities, although the percentages of water usage differs from one age group to another. Respondents who were 60 years and above and those below the age of 20 use less amounts of water whereas those in the age groups of 20-39 and 40-59 use more water on daily basis. This group is affected by water supply challenges as they demand more water for building, car-wash, hygienic purposes and for farming activities compared to older people who use water mainly for domestic purposes. The findings show that if there is water supply challenges there will be reduction in economic activities, such as in the building project and this leads to increase in unemployment in the villages. The impact of water supply challenge also leads to the easy spread of diseases and farming activities will also be impacted as there will be low yields resulting in food insecurity.

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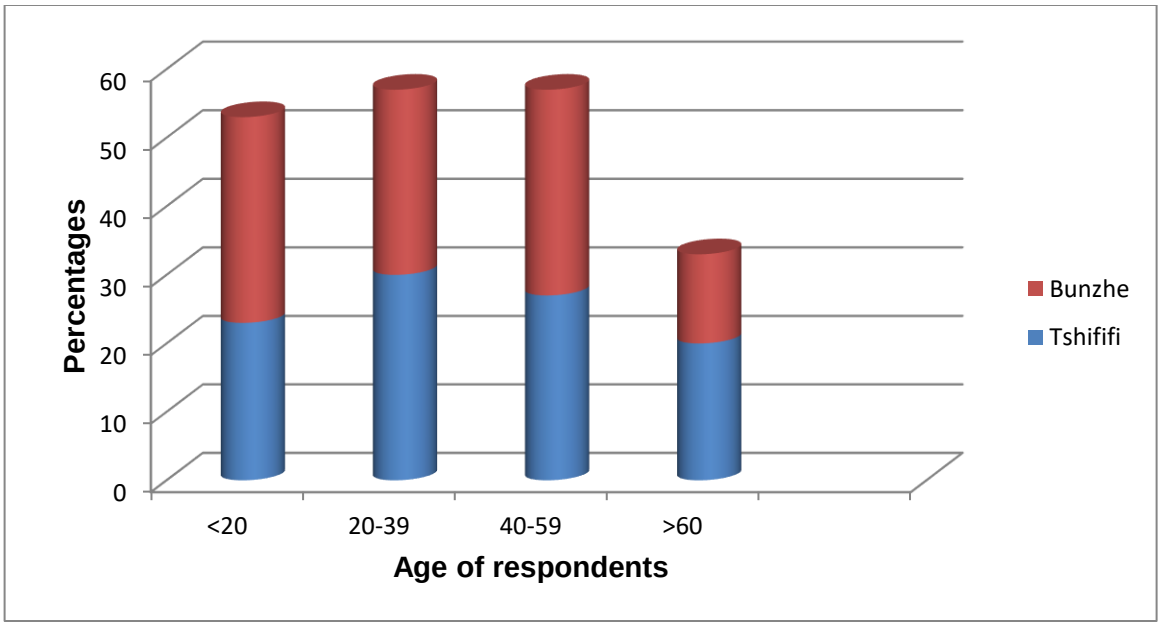

Figure 4.1: Age of respondents

4.2.3 Marital status

Out of 470 participants, 221 (47%) respondents were single while 214 (46%) were married. The data further revealed that 29 (6%) were widowed while 6 (1%) were divorced. It can be inferred that the uneven distribution of water supply is a result of the differences in the percentages of water usage among the single and married and the divorced and the widowed. The inconsistent provision of water affected everybody, regardless of their marital status, hence, all respondents, irrespective of their marital status are affected by water supply challenges as they all need water for either domestic and /or business usage.

4.2.4 Gender of head of the household

Data indicates that majority 248 (53%) of the respondents who were males were heads of the households and only 4 (1%) males indicated that they were not heads of the households. In comparison, 206 (43%) of the respondents who were female indicated that they were heads of the households and only 12 (3%) indicated that they were not heads of the households. This is shown by Table 4.2 below:

Table 4.2: Gender of head of the household

		Head of household		
		Yes	No	Total
Gender	Male	248 (53%)	4 (1%)	252
	Female	206 (43%)	12 (3%)	218
Total		454 (97%)	16 (3%)	470

Looking at the variables of gender, males were more than females; the responsibility of males in the household is to protect manage and ensure that there is enough food. Majority of the households in the community of Tshififi were headed by males. This is in line with African culture whereby married women are submissive to their husbands as such males are recognized as heads of the household (Thesane, 2001). The other implication of many households headed by males might be caused by the question of patriarchy. According to Kramarae (1992) patriarchy was originally used to describe the power of the father as head of the household. The reason for many of the households being headed by women might be due to poverty, death of the male through natural causes, civil conflict, family disruption, divorce and separation (Sultana, 2011). In some households men are available, however, women at Bunzhe and Tshififi have the responsibility to take care of the households and children. Domestic work such as collecting water is seen as the responsibility of women.

4.2.5 Duration of stay in the study area

Out of the total of 400, 9 (2%) respondents at Tshififi have been living there for 1 year, while 5 (7%) respondents out of the total of 70 from Bunzhe also for a period of 1 year. The findings point out that 13 (3%) respondents at Tshififi and 14 (20%) at Bunzhe have been staying there from 1-4 years. About 10 (3%) respondents at Tshififi and 8 (11%) respondents from Bunzhe have stayed there for 5-8 years. The data further indicated that 20 (5%) respondents at Tshififi and 9 (13%) respondents at Bunzhe have resided there for 9-12 years, while 348 (87%) respondents at Tshififi and 34 (48%) at Bunzhe had lived for there for 12 years and above (Figure 4.2). It is important for this study to establish the length of stay of respondents at Bunzhe and Tshififi villages. This information enabled the researcher to understand the trend of development of the water supply challenges experienced

in the study areas. The data showed that from the total of 470, 382 (81%) of respondents who had been living at Tshififi and Bunzhe villages for more than 12 years and 29 (6%) had been living there for about 9 to 12 years; about 18 (4%) of the respondents had been living there for between 5 and 8 years while the remaining 41 (9%) had been living there for less than 5 years. In the research study, majority of the respondents had been living in the same place for a long period and therefore they had witnessed the development of water supply challenges at Bunzhe and Tshififi villages. People who lived in the two villages before 2004 did not experience any water supply challenges because the population was low in these two villages but had started increasing in the last 12 years.

The population at Bunzhe and Tshififi, therefore, started to experience water supply challenges after 2004 when the population started to increases. The population increase at Bunzhe and Tshififi was due to a large place of land which became available for settlement. People who settled on this large space of land demanded more water for various purposes, such as: building houses, irrigating crops, domestic use and for rearing domestic animals. These new settlers were exposed to old water infrastructure, such as boreholes, reservoirs, water taps that were unable to meet their water demand. This situation led to water supply challenges which affected their activities and even the schooling of the children.

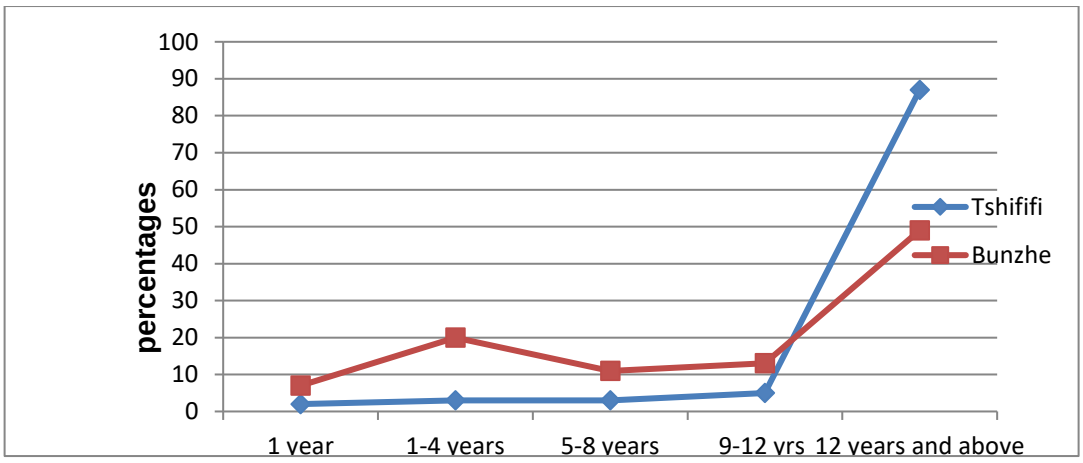

Figure 4.2: Duration of stay in the study area

4.2.6 Duration of water supply challenges

Out of the 400, 14 (4%) respondents at Tshififi have encountered water supply challenges for 1 year while at Bunzhe there were no respondent who indicated that they had experienced water supply challenges for the period of 1 year. The findings point out that 10 (3%) respondents at Tshififi and 4 (4%) at Bunzhe have been experiencing water supply challenges for two years. About 5 (1%) respondents at Tshififi and 5 (7%) at Bunzhe indicated that they have experienced water supply challenges for four years. About 368 (92%) respondents at Tshififi and 61 (87%) at Bunzhe had been experiencing water supply challenges for more than five years. The highest percentage of respondents, at Tshififi (92%) and Bunzhe (87%) indicated that both villages have been experiencing water supply challenges (See Figure 4.3). The data shows that 470 participants from both Bunzhe and Tshififi villages, a total of 429 (91%) of the respondents have experienced water supply challenges for more than five years while 41 (9%) of the respondents had experienced water supply challenges for less than five years. There were indications that respondents who lived in the two villages before 2004, had experienced less water supply challenges, since the villages had low population which required less consumption of water. The other group of participants who started residing in the two villages from 2014 have experienced water supply challenges because of the growing population who required more water. The water infrastructure is now aged and need to be repaired. Now there are few water taps operating to supply water to the increasing population in the villages (Figure 4.3). The above mentioned have impacted negatively on development in the study area, resulting in challenges like, starvation and high death rate in livestocks.

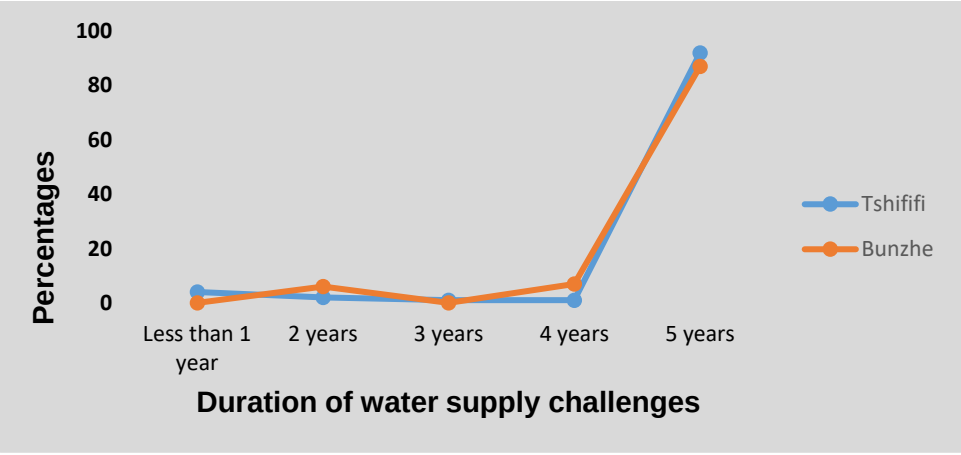

Figure 4.3: Duration of water supply challenges

4.2.7 Educational level

Out of the total of 400 respondents at Tshififi, 272 (68%) had no formal education while at Bunzhe 37 (53%) respondents out of 70 had no formal education. The findings point out that 84 (21%) respondents at Tshififi and 19 (27%) at Bunzhe had primary education; about 20 (5%) of respondents at Tshififi had tertiary education, while only 9 (3%) at Bunzhe had tertiary education. About 24 (6%) respondents at Tshififi village had secondary education and 5 (7%) respondents at Bunzhe had secondary education. This means that in both villages, out of the 470 participants, 309 (66%) of the respondents did not have formal schooling while 103 (22%) had primary education; 29 (6%) of the respondents had secondary education and the remaining 29 (6%) had tertiary qualifications (Figure 4.4). Respondents with no formal education were the old people and the youth. The second groups which showed the highest percentage were those with primary school qualifications who were facing water supply challenges. These groups have been indirectly affected by water supply challenges which had affected their education. The result of this high percentages, 66% of the respondents with no formal schooling, is poverty at Bunzhe and Tshififi villages, from the increased by water-supply challenges.

Respondents from these two villages depend on the inadequate supply of water which is used for various purposes like, livestock keeping and informal business operations, to enable them to earn a living that also serve as the source of income to support education. The final group of respondents were those with secondary and tertiary education qualifications; these two groups have been experiencing the similar water supply challenges. One of the reason for their low percentages is because they attend their secondary or tertiary education in places with enough water supply and they only experience water supply challenges when they are back at home. They become vulnerable to water supply challenges when they need water for bathing, sanitation and other domestic purposes. The old people who do not have formal schooling are also vulnerable to water supply challenge as they need water for agriculture and domestic purposes. The reason for no formal schooling was inadequate provision of schools and there was no water infrastructure that could get water close to them. Water supply challenges are hindering the development of the two villages because many people are not getting an education. Water supply challenges causes illiteracy as learners lose momentum in their studies as they had to deal with stomach pain, diarrhea and hunger due to lack of water . Water supply problem contribute to illiteracy as learners miss classes to go to fetch water from the surrounding villages that have water sources. Learners also miss their classes to care for sick parents or sibling who have to walk long distances to fetch water. The respondents'

reasons for having only primary education were similar to those who did not have any formal schooling. This clearly shows that water supply challenges are affecting villagers from Bunzhe and Tshififi.

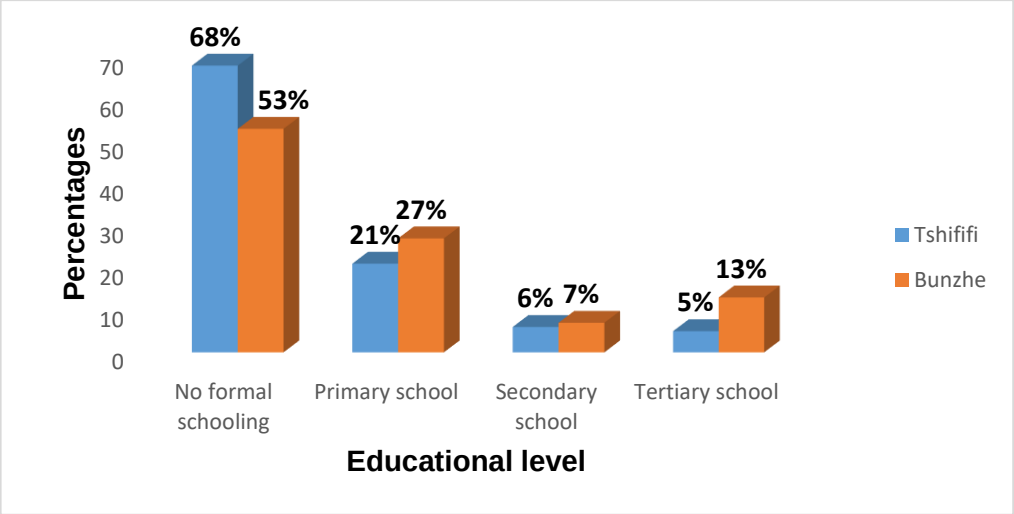

Figure 4.4 : Educational level

4.2.8 Employment status

Out of the total of 400, the number of unemployed respondents at Tshififi were 280, which constituted 70% of the total participants. Out of the total of 70, the number of unemployed at Bunzhe were 50 (71%). The data also showed that self-employed respondents at Tshififi were 40 (10%) while at Bunzhe they were 6 (9%). About 14 (20%) respondents at Bunzhe and 80 (20%) respondents at Tshififi were employed. Out of the total 470, the number of employed respondents were 140 which constituted 30%. The employment status data showed that 330 (70%) of the respondents were unemployed at Bunzhe and Tshififi villages while 94 (20%) were employed; 46 (10%) of respondents were self-employed (see Figure 4.5). Employment status determines development in the sense that people who are working are able to afford better living conditions when it comes to accessing water in their households. Due to the water supply challenges, bricklaying projects were forced to close down, therefore, those people employed in these projects lost their jobs. Another cause of high unemployment at Bunzhe and Tshififi villages was the failure of the agricultural projects that demand high water supply.

The water supply challenges, thus, affected these projects as there was not enough water to facilitate their projects; this is the main cause of high unemployment rate in the study area. The employed respondents also experience water supply challenges when they need water for bathing and food preparations before they go to their workplaces. Water supply challenge also affect them when they arrive late at work as they spent a lot of time trying to fetch water. A small group, 10% of the self-employed people, also face water supply challenges when there is no water to run their day-to-day business operations, like car wash, gardening and poultry keeping. This is an indication that water supply challenges lead to high unemployment rates, therefore, if water is supplied to these villages, the problem can be solved.

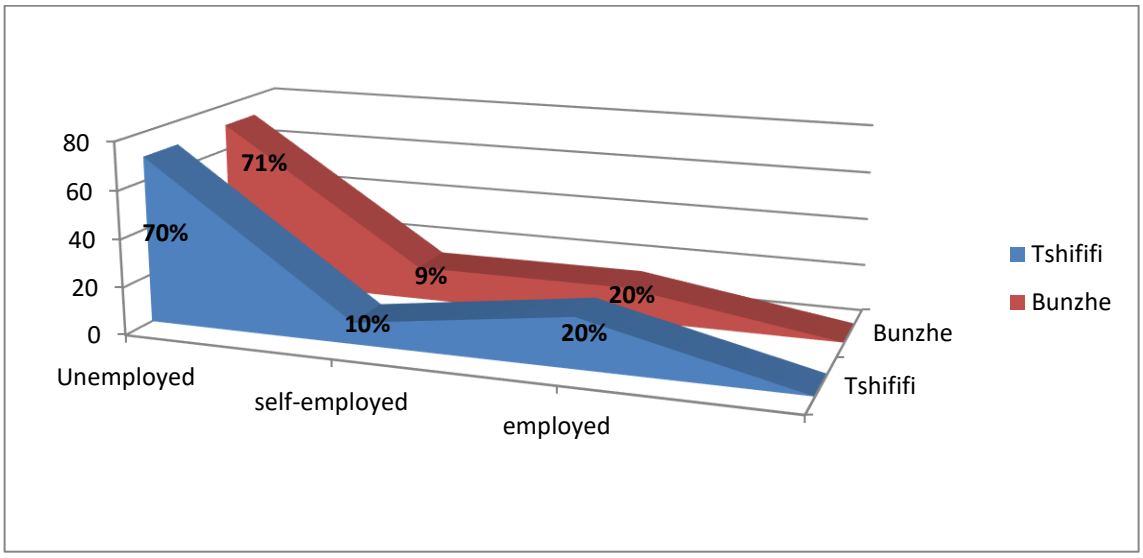

Figure 4.5: Employment status

4.2.9 Total income in the household

One of the items on the questionnaires aimed to find out whether residents of Bunzhe and Tshififi were earning an income that would enable them to pay for water supply services. This section sought to find out the income level of the respondents and their responses are shown in Figure 4.6.

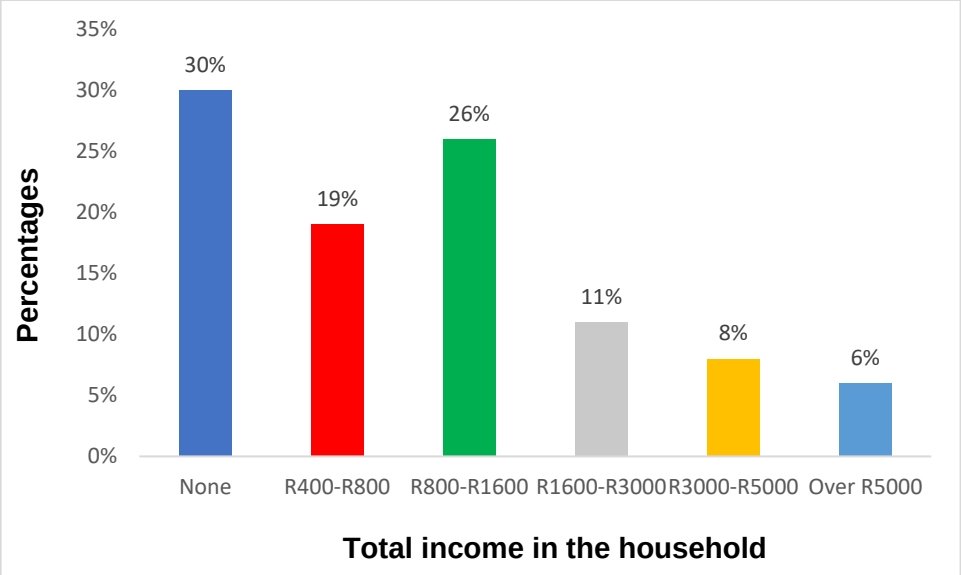

Figure 4.6: Total income in the household

Out of the total 470, the number of respondents who had a source of income were 329 which constituted 75%. The remaining 118 were respondents who earned more than R1600. 00 which constituted 25% of the total respondents. This means that 75% were respondents who earned less than R1600. 00, while 25% earned more than R1600. 00. A total of 141 (30%) respondents from Bunzhe and Tshififi villages were employed. The second group of about 89 (19%) respondents receive income of between R400-R800. The third group of about 122 (26%) respondents receive grants of R800-R1600, 51 (11%) respondents were earning R1600-R3000, 38 (8%) respondents earn R3000-R5000 while 29 (6%) respondents earn R5000 and above. The respondents who earn less than R1600.00 are more affected by water supply challenges, particularly, when they do not have money to hire transport to collect water from other villages, while those who earn more than R1600.00 did not seem to have a similar challenge as they have enough resources to pay water services and able to acquire water from neighbouring villages. They are, however, affected by water supply challenges due to the time spent to collect water. The length of time spent fetching water prevents them from doing other activities. The unemployed respondents are the worst affected group by the water supply challenges because they cannot afford to buy water from vendors on regular daily basis. The monthly household income investigation was conducted in order to determine if residents were able to afford paying for water during maintenance of broken pipeline to avoid water supply challenges.

4.2.10 The current source of income

Out of the total 470 from both Bunzhe and Tshififi, the number of respondents who depend on various sources of income were 329 which constitute 75%. Out of the total 470, the number of respondents who get formal salary and wages were 116 which constitute 25% of the total participants. This can be interpreted that 150 (32%) respondents depend on child support grant, 141 (30%) depend on other family member's source of income, this is either from government pension fund, social grants and other unsustainable sources of income; 50 (11%) respondents depend on pension fund, 76 (16%) depend on formal salary; 40 (9%) depend on wages; 7 (1%) depend on allowance from relatives while 6 (1%) depend on disability income (Figure 4.7). Both respondents receiving income less than R1600.00 and those who earn more than R1600.00 face water supply challenges. This means that all respondents who receive income less than R1600. 00 face water supply challenges since their money is not enough to support their family needs and wants; their money is not enough to pay water services even though they qualify for 600kl of water per month, per household.

This group also includes the disabled respondents who are severely affected by water supply challenges since they are unable to travel long distances to fetch water and they need regular supply of water to sustain them. The remaining 25% were respondents who earn R3000. 00 and above from wages and formal salaries. This group is also affected by water supply challenges because of water infrastructures which have not been improved. They are indirectly affected by water supply challenges as they have to spend some time collecting water. This group is mainly composed of people who are working on building contracts, therefore, they are seriously affected by water supply challenges because their work depends on availability of water. If their employment contract is terminated they will be affected because they will not have money to pay for water services.

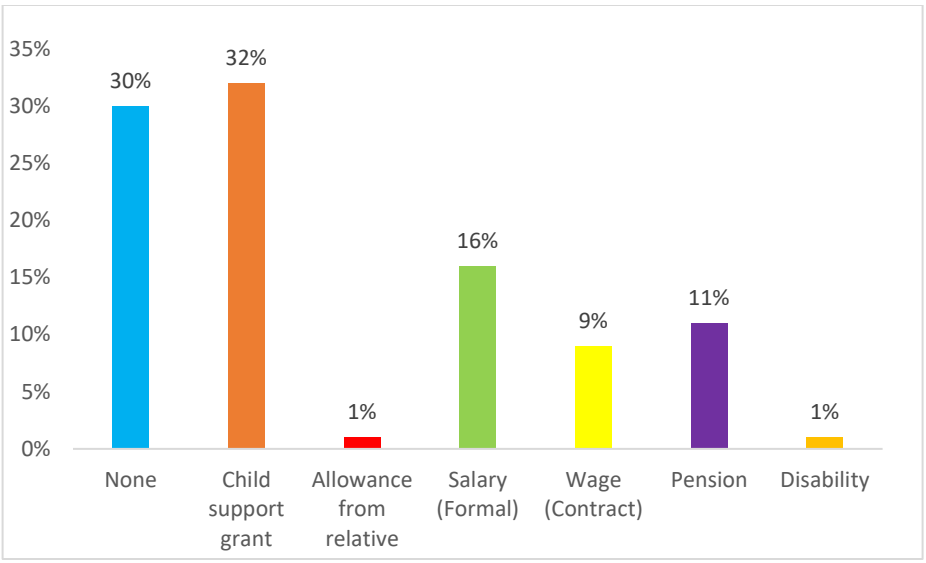

Figure 4.7: The current source of income

4.3 Causes of water supply challenge

This section deals with the questions on whether respondents experienced water supply challenges or not; how often Bunzhe and Tshififi villages obtain their water from the taps and what Thulamela Municipality is planning to do. The responses revealed that all respondents experienced water supply challenges which were caused by population growth, poor maintenance, backlog of water service on the side of the Thulamela Municipality. This result was also supported by the Thulamela Municipality Integrated Development Plan (IDP) (2011/2012: 17) which indicates that South Africa is experiencing huge service backlogs with respect to access to services, such as water and sanitation.

4.3.1 Causes of water supply challenges

Out of 470 participants, a total of 325 respondents selected the dominant causes of water supply problems which constituted 69%; the remaining 145 respondents selected other causes which constituted 31%. Based on the collected data, which offered 11 options to choose from, the most prominent one was the local municipality's failures which was chosen by 85 (18%) respondents; poor maintenance was selected by 85 (18%); population growth was chosen by 80 (17%); lack of finance was selected by 75 (16%) respondents; 52 (11%) respondents indicated that water supply challenges were caused by damaged infrastructure; 33 (7%) respondents indicated that water supply challenges were caused by lack of reservoirs, disparity was selected by 8 (2%) respondents, low pressure was selected by 52 (11%) respondents as causes of water supply challenges, while

modification of landscape and surface run-off was selected by few respondents. In summary, the were: local Municipality's failure, poor maintenance, population growth and lack of finance from the Thulamela Municipality were selected as major causes of water supply challenges. Both the local Municipality's failures and poor maintenance had the same highest percentage which is 18% of the respondents. The reason majority of participants selected local municipality failure is that they totally depend on water provided by Thulamela Municipality and many people selected poor maintenance as they expect it to maintain tap water, main water pipeline and other water infrastructure. The reason many people selected population growth is that the area is accessible as it is located close to the tarred road and located close to Thohoyandou Town, Sibasa and Makwarela. All these areas are fully occupied and since there are no further extensions there, people decided to buy stands at Bunzhe and Tshififi villages. When people from other villages come to live at Bunzhe and Tshififi villages it results in population increase. The other causes of water supply at Tshififi village are broken water taps and damaged boreholes. The collected data also indicate that the low water pressure at Bunzhe village is a major challenge which has resulted in low water supply from the taps. As a result of this low water pressure at Bunzhe, residents have to wait for a long time for water to accumulate to fill their tanks; this tells us that the water supply challenges are caused by different factors. The study conducted in Zimbabwe by Chaminuka and Nyatsanza (2013) indicate that water supply challenges were caused by ageing of the water infrastructure, leakages and power outages. Beside the options selected by the respondents in Figure 4.8, a key informant interview was conducted with community structures and water services' manager, who assert that there are illegal connections at Tshikweta village, within Thulamela Municipality.

The water services' manager maintains that illegal connections are challenges identified as affecting the supply of water in rural areas. Illegal connections affect the pressure of water in the pipelines, either to or from the reservoir, thereby, some piped water is lost along the way; this prevents the reservoir from getting full. During the interview with the process controller at Nandoni Dam, it was narrated that strikes also affect water supply; for example, the strikes that occurred on the 26th June 2019 at Mutoti village forced the plant to shut down for two days. This links to the study area because if Thulamela Municipality does not supply water to Bunzhe and Tshififi villages, a similar strike can reoccur. The strike was caused because of a burst pipeline which was unattended to by Thulamela Municipality. Three pipe lines - NR6, NR5 and NN20B - were affected and the villages that obtain water through them were affected; the communities affected are close to Nandoni Dam.

This section deals with the question that addressed the issue whether respondents experienced water supply challenge or not. This section also revealed that how often Bunzhe and Tshififi villages obtain their water from the taps and what Thulamela Municipality is planning to do. The study also revealed that all respondents experienced water supply challenge which was caused by the population growth, poor maintenance, water services backlogs on the side of the Thulamela municipality. This was also supported by the Thulamela municipality Integrated Development Plan (IDP) (2011/2012: 17), South Africa is experiencing huge services backlogs with respect to the access to services such as water and sanitation.

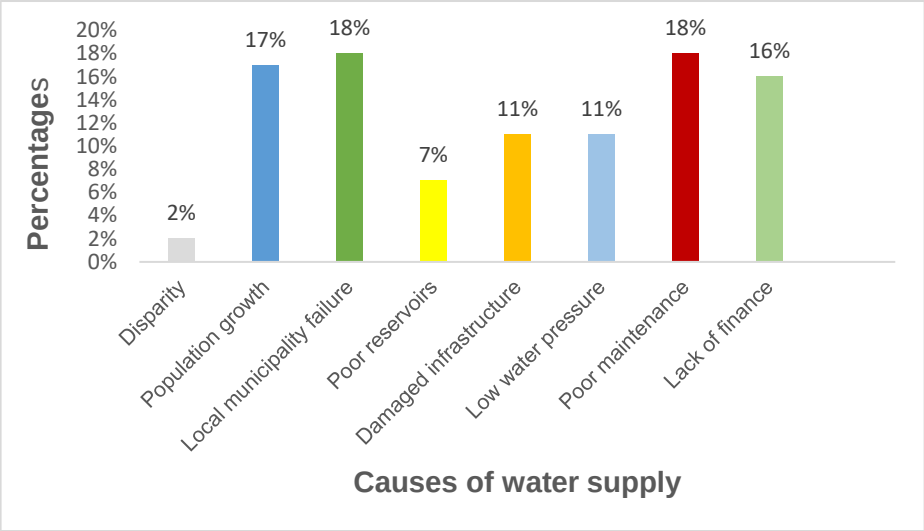

Figure 4.8: Causes of water supply challenges

4.4 Water supply capacity in Thulamela Municipality

This section deals with a presentation of water capacity at Bunzhe and Tshififi villages, such as through reservoir, boreholes and tap water from Thulamela Municipality. The section also details the number of water sources which are functioning and those which are not in the study area. This section also presents the water system's capacity, flow requirements, liters of water consumed per day per household, sources of water and status of water infrastructures in the study area.

4.4.1 Water system capacity and flow requirements

Out of the total of 470, about 426 respondents (91%) indicated that they do not receive water for more than two hours, per day, while 44 (9%) respondents indicated that they receive water for more than two hours. The largest percentage of respondents, 91%, shows that there is no standard agreement between Thulamela Municipality water officials and the households in Bunzhe and Tshififi villages. The findings show that majority of the respondents relied on Thulamela Municipality for water supply but water availability in taps is very limited. The Municipality's inability to provide water for a minimum of two hours has a major impact on the respondents' personal hygiene. Their livelihood is also affected as there is no water for projects which generate income, such as gardening, car wash, poultry keeping and bricklaying. Not providing a minimum of 2 hours' water flow leads to the spread of water- borne diseases, such as malaria, diarrhoea and cholera as the communities use alternatives sources of untreated water from rivers. Lack of longer periods of water had a negative impact on job creation, affected schools, clinics and socio-economic activities. If the minimum two hours' of flow is not met there will be long queues which affect development time and leads to high rate of unemployment.

Through the researcher's observation there were long queues as people were spending about 15 minutes and more to fill 25 liters' containers. A household that has 7 members require about 175 l/d per household, therefore, a family of 7 members had to spend 1hr 45 minutes to collect enough water while others are waiting; this cannot accommodate the 2 hours flow of water. The time for collecting water, that is to the water point is about 1hour, especially, for households that are far away from the water point. The 2 hours for the flow of water is creating challenges since one household is getting only 25 liters which is below the required ration. The normal household with 5 members is supposed to get 125 liters per person per day which defeats the two hours water flow. This leads to households at Tshififi having a ratio of 1:32, meaning that each household gets only 32 liters of water per day. The ratio stated above does not meet the 2 hours minimum flow of water for a fully developed area.

4.4.2 Household water consumption per day

Out of 470, a total of 363 respondents indicated that they consume 50-150 liters per day per household which constituted 77%, while the remaining 107 (23%) respondents indicated that they consume less than 100 liters per day per household. The interpretation is that 40 (9%) of the respondents use less than 50 liters; 227 (48%) consume 50-100 liters, 67 (14%) respondents consume 100-150 liters and 136 (29%) consume 150 liters and above (Table 4.3). This means that the highest percentage, 77% need more water per day as these households have many family members, while 23% of respondents were from households that have few family members who consume less water per day. This implies that households that had 6 family members consume 150 liters per day if using 25 liter containers. This means that less than 50 liters and 100-150 liters, per day per household, are not even enough for consumption

Table: 4.3 Household water consumption per day

Liters of water consumed per day	**Size of the household for both villages**				**Number of respondents consuming water per day**		**Total number of respondents consuming water per day in both villages**
	Size of the household	**Bunzhe**	**Tshififi**	**Total**	**Bunzhe**	**Tshififi**	
25 liters	1 member	4 (6%)	14 (4%)	18 (4%)			
Below 50 liters	2 members	4 (6%)	19 (5%)	23 (5%)	14 (20%)	26 (7%)	40 (9%)
50-100 liters	3 members	17(24%)	60 (15%)	77 (16%)	31 (44%)	196 (49%)	227(48%)
100-150 liters	4 members	10 (14%)	82 (21%)	92 (20%)	7 (10%)	60 (15%)	67 (14%)
150 liters and above	5 and above	35 (50%)	224 (56%)	260 (55%)	18 (26%)	118 (30%)	136 (29%)
Total		70 (100%)	400 (100%)	470 (100%)	70 (100%)	400 (100%)	470 (100%)

4.4.3 Size of the household

Out of the total of 470 participants, 352 were households that had many family members which constitute 75% of the total respondents. The remaining 118 were households that had few members which constituted 25%. Further breakdown highlighted that, 260 (55%) of the respondents indicated that they had five members and above, followed by 92 (20%) who were from households with four members, 77 (16%) respondents indicated that they were from households that had three members, 23 (5%) were households that had two members, while 18 (4%) are small households of one member (Table 4.3). Majority of the households which comprised of 75% demanded more water for personal hygiene, drinking, cooking, washing, and gardening. These households need large size container to store water. The remaining 25% were respondents who had household members less than 4, they have low demand for water resources as compared to the afore mentioned group. If water supply does not meet the demand of the households in terms of the size of the households, therefore, there is water supply challenges. Small families demand less water since they do not have many house chores to undertake considering the number of family members. The households with few family members have enough income to raise their children, provide them with education, are able to buy food and pay water services.

4.4.4 Sources of water at Bunzhe and Tshififi villages

The details of sources of water in the study area show that 337 (72%) respondents get water from taps, 95 (20%) respondents get water from boreholes while 38 (8%) get water from rivers/dams (Figure 4.9). This means that some respondents rely on street-piped water from the Municipality and on water supply from borehole. The current borehole cannot sustain the villagers because of low water storage capacity. The two water tanks which are equivalent to 10 000 liters only supply 14 liters per household in a village of 700 households. A person requires minimum of 50 liters per day for both physiological and hygienic needs. The available 14 liters per person is not enough for human survival; it leads to poverty, health problems and decline in economic activities. This is supported by Makgope *et a*l. (2001: 1) who states that National Water Act RSA, 1998 recognise a needed amount of 25 liters, per person per day which is meant for washing, cooking and sanitation. According to Kativhu (2016) people who have limited water supply face an increase in child-death and health problem. The respondents of Bunzhe and Tshififi villages depend on Thulamela municipality for their water supply. The results reveal that there is no standard agreement on water supply between respondents from Bunzhe, Tshififi and Thulamela Municipality. This implies that residents at Bunzhe

and Tshififi must put in place adaptive strategies, such as rooftop harvesting and buying water from vendors in order to have enough water for domestic use.

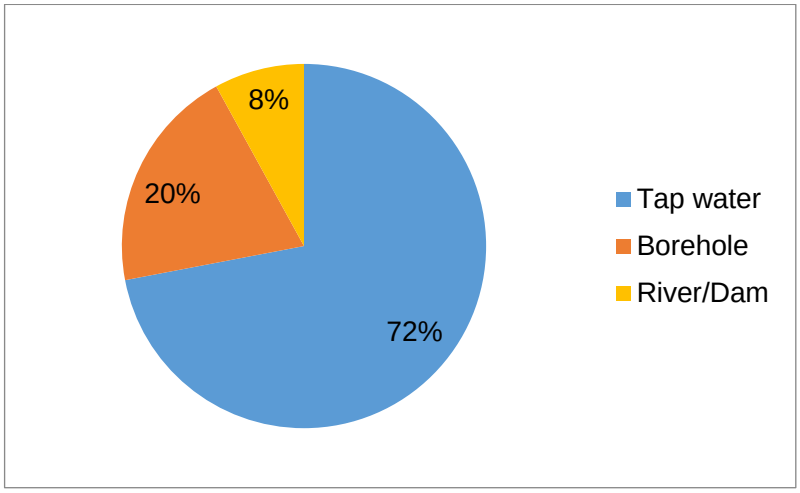

Figure 4.9: Sources of water at Bunzhe and Tshififi villages

During heavy rainfall respondents from these two villages collect water from rooftops while others have to buy water from vendors. This mostly occurs during water supply challenges which force them to hire bakkies to fetch water from the neighbouring villages. According to one of the key informants (General Manager, Vhembe District Municipality), Thulamela Municipality is not regularly supplying water by water trucks to the Bunzhe and Tshififi villages.The findings indicate that many people get water through taps and this means that if there is no water coming out from the taps, it will affect their daily lives. People are getting water from the taps because there are no other sources of water. The supply from the water taps are below RDP standard and this affects people's daily activities. The study discovered that there are many consequences of this, such as - conflicts (as many people are competing for water), stress (as many people get little water to use); time wasted (which should have been spent on other activities); high costs (buying of water is very high as people spent extra money paying the vendors); disease may arise (as there is insufficient water for sanitation); no water (for cooking, washing and gardening). Inadequate provision of water from taps can cause diseases, such as diarrhoea, ascaris, dracunculiasis, hookworm, trachoma and snail fever. This implies that the government has to construct alternative water points to avoid water-related diseases affecting the rural villages.

4.4.5 Positioning of water taps

From the question regarding the location of piped water, 452 (96%) respondents said that taps are located outside their yards while 18 (4%) indicated that taps are located inside their yards. The figures confirm that majority of the respondents fetch water outside their yards where many people use one tap which results in numerous social problems which include less water for personal hygiene. The availability of taps, determine the amount of water that the households will get if water is available. For four thousand households only 27 water taps are operating and this gives us the ratio of 1: 148. This shows that competition of water is very high at Tshififi village and this creates social problems, such as conflicts, time lost through queueing and easy transmission of contagious diseases due to physical contact among people.

4.4.6 Status of water supply infrastructure

The data shows that 355 (76%) respondents indicated that taps were present but broken down; about 79 (17%) indicated that taps were present but collapsed, while 36 (7%) responded that taps were available and functional (Figure 4.10). From the field observation Tshififi village had thirty two water taps that provide water to the have totally broken down. Twenty seven working water taps at Tshififi village are not enough to supply water to the whole village of Tshififi which has had rapid population growth. This has had a negative impact on the economic development of the village, resulting in poverty. It can be assumed that if many taps are installed in the village it means residents can have access to water near their households , hence, they have time to engage in other economic activities in order to earn a living. Few taps at Tshififi village has resulted in poor water supply that has affected projects such as brick-making, construction of shops and gardening. Limited number of water taps lead to less water being available to the households at Tshififi village; this will affect their physiological and personal hygiene needs. The impact of 27 taps for the whole village of Tshififi has forced villagers to spend money to buy water from vendors. The other reason that is affecting water supply are the broken taps, thus, even when water is available households close to these taps will not get water (Plate 4.1). The findings indicate that three (3) taps at Tshififi village had collapsed, one which is next to the tarred road was damaged during road construction and even the water main pipe is not working.

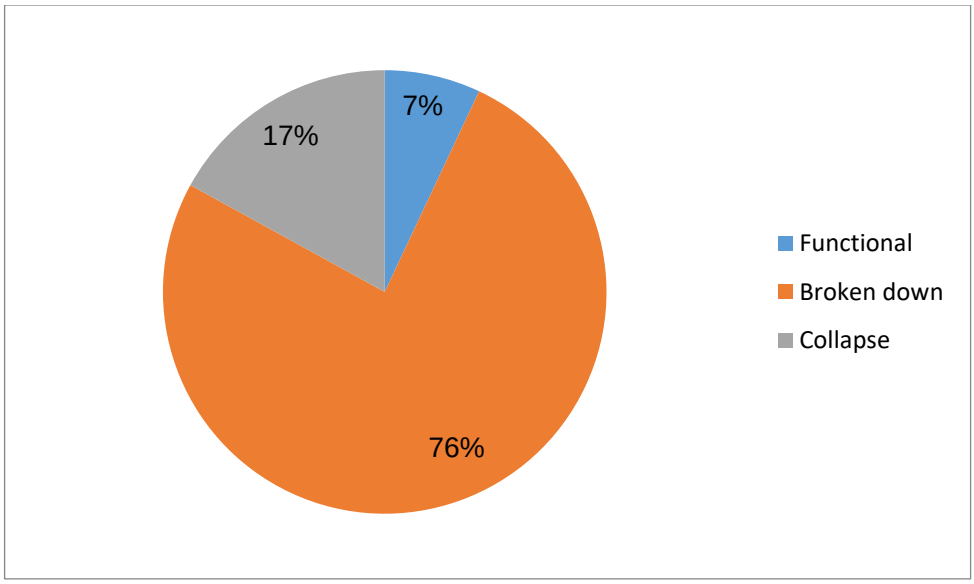

Figure 4.10: Status of water infrastructure

The remaining two (2) taps, heads are damaged and there is no water coming out. The status of these taps are preventing a constant supply of water to the households. They are affected because they do not get enough water for drinking, gardening and cooking. In the study area, there are taps that are no longer supplying water to the households because there is no supporting stand for the tap and the top head has also been removed (Plate 4.1a). This dysfunctional state of the taps might be due to their ageing condition. By implication, households which depended on these taps could not maximally use the water supply, hence, leading to water supply challenges. The damaged taps without top head and also not operating (Plate 4.1b) contribute to water challenges being experienced at Tshififi village.

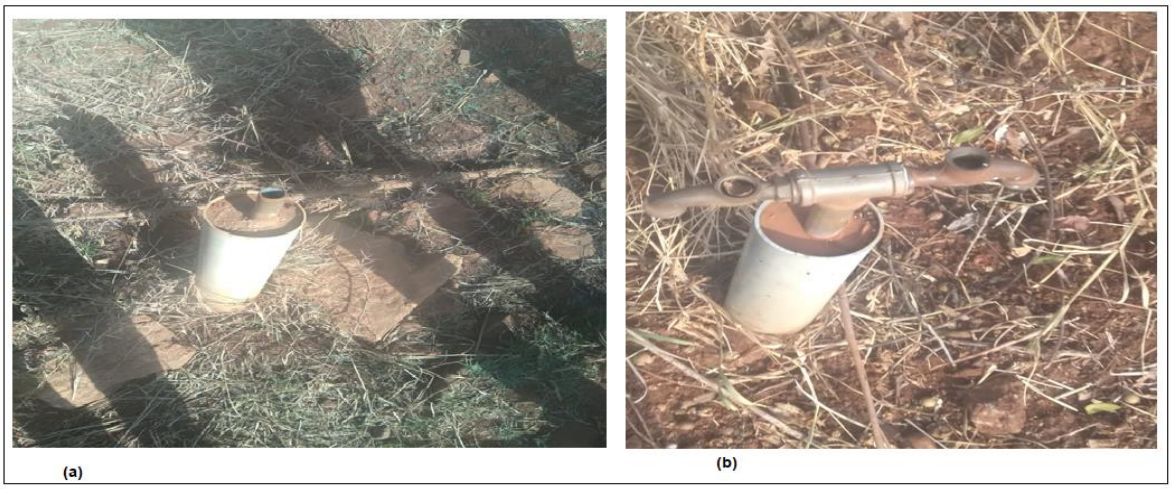

Plate 4.1: (a) Broken tap at Tshififi village (b) Damaged tap at Tshififi village (Photograph: 3 August 2019)

4.4.7 Date for tap installations

Based on data on tap installations, 416 (89%) respondents indicated that the water taps were installed before 2004; 10 (2%) indicated that taps were installed in 2004 and 44 (9%) of them answered that water taps were installed after 2006. The date of tap installation can be used to find out whether the taps need maintenance or not. The maintaining of the taps would improve the capacity and efficiency of the water supply infrastructure. The age of the taps was another contributing factor to water supply challenges. The residents from these two villages who are located close to the broken taps will not get water for domestic use, therefore, they will have to travel long distance to seek alternate sources of water. Majority of the respondents, about 416 (89%) indicated that tap installation was done before 2004. If the tap installation was done before 2004, it is therefore the age of the tap water that has contributed to the water supply challenges.

4.4.8 Size of the containers to fetch water

The details on the size of the containers used to fetch water show that 394 (84%) of the respondents use 20-liter' containers, 30 (6%) use 100-liter containers; 26 (6%) use 200-liter, while 20 (4%) use 40-liter container to fetch water from the street tap (Figure 4.11). Majority of the respondents who use 20-liter buckets were respondents who obtain water far away from their households, as such they carry light buckets to fetch water. The implication of the people using 40 liters, 100 liters and 200 liters containers is that they have many members in the households who are using water for

various purposes. This may also imply that they are business people who need high quantities of water to run their business.

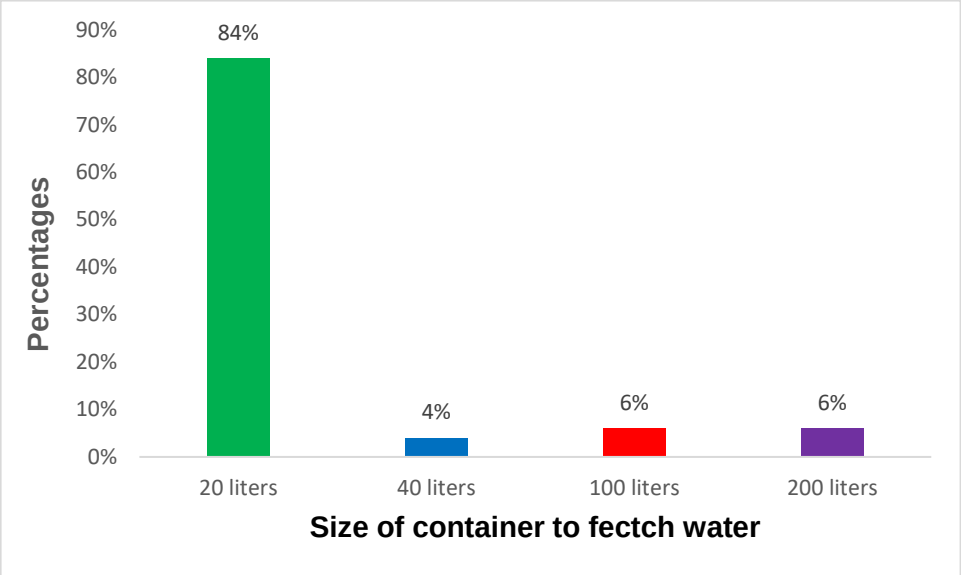

Figure 4.11: Size of the container to fetch water

The implication for using 20-liter containers in most households is that they are accessible and easy to carry; looking at the water point and the distance from the households, 20 liters of water is easy to carry; if the water tap is far from households it is logical to use small containers to fetch water and if the water tap is closer to the household the bigger the container to fetch water. Another reason will be that if one is using a wheelbarrow to carry the containers from home to the water point it is possible to carry three buckets (60) liters of water. If one hires a bakkie to fetch water it can carry many buckets of 20 liters or 200-liter drum at a time. Those who have access to transport are able to carry large size containers. This also implies that households spend money depending on the number of household members. From the field observation the researcher observed people carrying different sizes of water containers, ranging from 20-liter to 25-liter drums (Plate 4.2). Most of the people were using wheelbarrows while others were carrying them on their heads, from water points to their households; others used bakkies to carry water from the water point.


Plate 4.2: Container size at Tshififi and Bunzhe village (17 July 2020)

4.4.9 Comparing the size of the container with frequency of water collection

The section shows that the way in which respondents use water everyday is different, depending on the available sources of water; people use different sizes of containers to the different water points. The Table below shows frequency of water collection in the study area. It shows that different water users also use different volume of water containers. Table 4.4 below shows water collection ranging from 20 liters up to 200 liters and its frequency ranges from everyday up to a month. The respondents who use 20 liters everyday were 9%, those who use 100 liters were 7% and those who use 200 liters were 31%. The everyday 20 liters had least percentages since they use that water for domestic purpose and they travel long distances to fetch water. The hundred (100) liters water-users were 30%. They use water for various activities like laundry, cooking and cleaning. There are medium-sized families also show average storage of water. The users of 200 liters were 31%. This is a big-sized family which needs lots of water for domestic purpose. The results show that villagers have water supply challenges. The study area had respondents who fetch water once a week; those who fetch 20 liters were 39%; 40 liters were 70%; 100 liters were 43% and 200 liters were 27%. Twenty liters' water-collectors show that there is slight improvement in obtaining little water from their collection points at their villages. This shows that the other part of the village is still facing water supply challenges. Forty liters' water-collectors do not have enough water as they need more water in their households; they obtain water once a week; this means that they need more water to survive. Collectors of hundred liters were 43%; this shows that they have water supply challenges and to overcome the problem they have to limit usage of water. The users of 200 liters once a week were

27%. In comparison with other frequencies such as everyday and once a month are close to each other except twice a week. This shows that there are water supply challenges at Bunzhe and Tshififi villages. Compared to all frequencies twice a week frequency is below all frequencies because of severe water supply challenges; from the findings one can deduce that villagers do not receive water twice a week. The entire community depends on the neighbouring villages because of water supply challenges. About 844 million people on earth are facing water supply challenge and 79% of them are rural residents. A person needs 50 to 100 liters per person per day to meet the basic hygiene needs. People facing a limit of 20 liters per person, per day will be exposed to a high level of health concerns. Water supply challenges and its poor quality have been determined as vital concerns threatening the future prosperity of the country (Omarova, 2019: 2). According to Addisie (2012: 9) daily, a per person needs 50 liters of water, which includes 5 liters for drinking, 20 liters for sanitation and hygiene, 15 liters for bathing and 10 liters for preparing food, hence, most of the villagers accessing only 20 liters for their households indicates that water is not even enough for doing all activities.

Table 4.4: Size of container with frequency of water collection

		Size of container used to collect water				
		20 liters	40 liters	100 liters	200 liters	Total
Frequency of water collection	Everyday	35 (9%)		9 (30%)	8 (31%)	52
	Twice a week	29 (7%)	1 (5%)	2 (7%)	2 (8%)	34
	Once a week	155 (39%)	14 (70%)	13 (43%)	7 (27%)	189
	Once a month	175 (45%)	5 (25%)	6 (20%)	9 (34%)	195
Total		394 (100%)	20 (100%)	30 (100%)	26 (100%)	470

4.4.10 Analysis of variance on weekly water consumption

Analysis of variance was performed to check if there were significant differences in weekly water consumption between Bunzhe and Tshififi villages. The average weekly water consumption for each village was recorded for this analysis. The hypotheses tested are as follows: H_0: $\mu_1 = \mu_2$ (There is no significant difference in weekly water consumption between Bunzhe and Tshififi villages). H_1: $\mu_1 \neq \mu_2$ (There is significant difference in weekly water consumption between Bunzhe and Tshififi villages).

Table 4.5: Test of Analysis of variance on weekly water consumption

Group	**Count**	**Sum p-value**	**Average**	**Variance**		
Tshififi	**400**	147340	368.35	0.0312		
Bunzhe	**70**	22235	317.64	0.0763		
F-table						
Source of variation	***SS***	***Df***	***MS***	***F***	***P-value***	***F crit***
Between groups	153178.726	1	1153178.726	1.779	**0.183**	
Within Groups	40297897.07	468	86106,618			
Total	**40451075.80**	**469**				

Table 4. 5 above shows an analysis of variance on weekly water consumption at Bunzhe and Tshififi villages. The significance value of the test between Bunzhe and Tshififi villages is not significant with a *p – value* 0.183 which is greater than .05. This means that the null hypothesis of equal means between the two villages is not rejected. The findings show that average weekly water consumption is not significant between the two villages, meaning that there is a water supply challenges at both Bunzhe and Tshififi villages. The challenge may be caused by poor infrastructure that are available in the Thulamela Municipality and surrounding rural villages (Plate 4. 1 and Plate 4. 3).

4.4.11 Adequacy of water supply

For this question, majority of the respondents 439 (93%) gave a “No” answer while 31 (7%) answered “Yes”. The implication is that Bunzhe and Tshififi villages experience water supply challenges. One of the reasons for majority of the respondents saying that there is inadequacy of water supply to Bunzhe and Tshififi village is due to the poor maintenance of water infrastructure. The other reason for inadequacy of water supply is that there are few water infrastructure that are supplying enough water to the villages for farming, construction, personal hygiene and domestic purposes. The respondents who indicated that there is enough water are those who are located close to the water source.The interpretation of data on the reason for water inadequacy shows that a total of 324 (69%) of the respondents travel a long distance from households to the water point. Followed by 81 (17%) respondents who indicated that they are long queues to fetch water and 65 (14%) respondents said that there is a low supply of water (Figure 4. 12). The proximity to a water

source and length of queuing time were identified as a challenge when respondents addressed the question of water adequacy. The most dominant reason is that of travelling long distance from households to the water source. The water quantity of 20 liters per day being supplied to households is not adequate, as majority of people travel a long distance to fetch water.

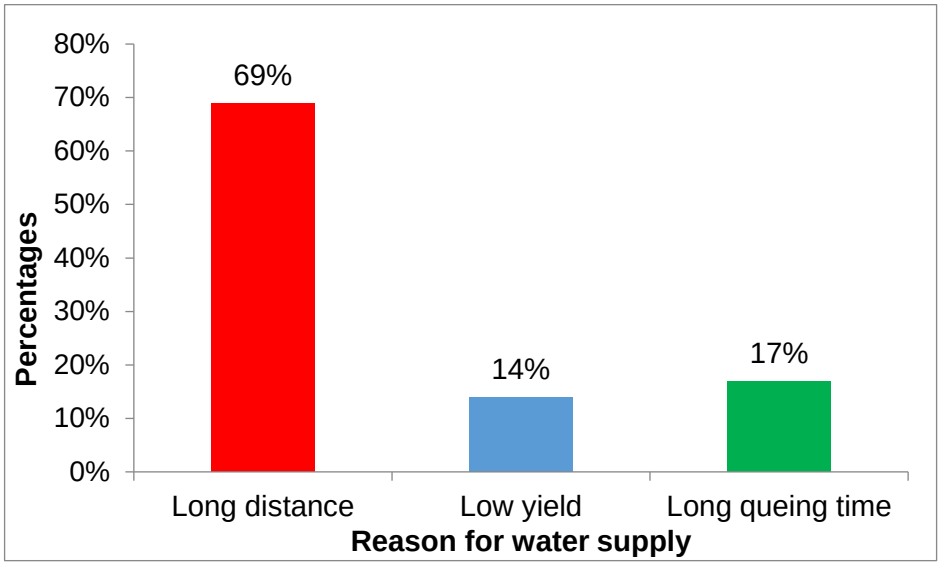

Figure 4.12: Reason for water supply adequacy

4.4.12 Distance from the water point

The majority of the respondents, that is 414 (88%) travel a distance of more than 200m to collect water which means they live far from the water sources. The remaining 56 (12%) of the respondents indicated that they travel less than 200m to fetch water which means they live closer to the water source. This is in line with Cheruiyot (2016: 26) who support the World Health Organisation (WHO) which consider a distance of 200m as convenient for fetching water and this gives time for doing other activities, such as pursuing education, high status work and civic activities. This means that members of households who travel shorter distance have more time to do other activities compared to those who travel for more than 200 meters; the latter group complain about health problems which results from walking long distances carrying water.

4.4.13 Duration for queue at water point

Answers on the duration for queuing at water points show that 240 (51%) of the respondents indicated that they spend 1 hour to 2 hours, 144 (31%) spend 10 to 30 minutes, 61 (13%) spend 30 minutes to 1 hour; 10 (2%) of the respondents said that they do not queue, while 15 (3%) queue less than 10 minutes (Figure 4.13). The different queuing time suggest variation in the number of people who fetch water at a time and the water running time. The few water collection point at Bunzhe and Tshififi villages led to the queuing for water, when water is available from the taps. When people are overcrowded around the few taps, it has a negative consequences of transferring contagious diseases, such as coronavirus (COVID-19), tuberculosis, chickenpox and other diseases that can spread from one person to another.

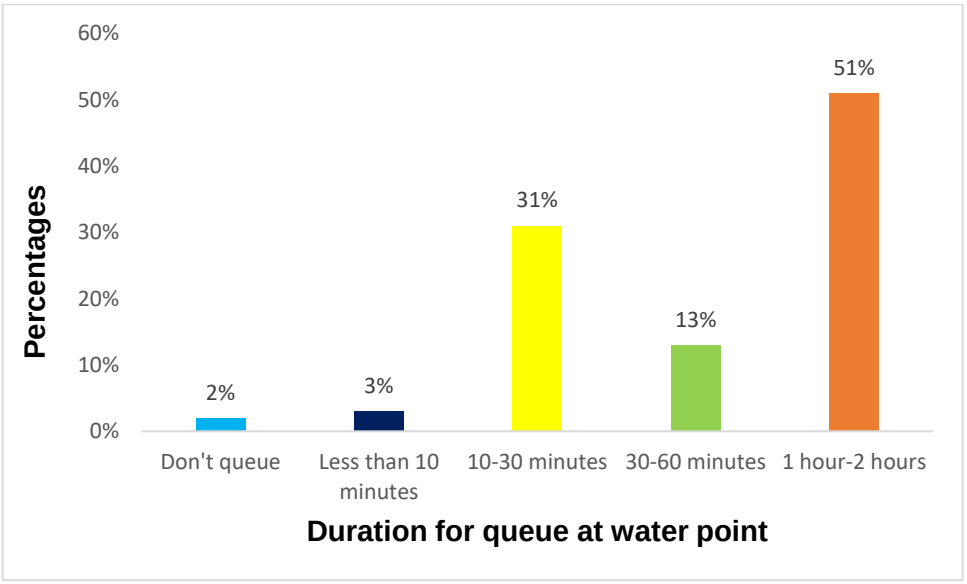

Figure 4.13: Duration for queue at water point

Plate 4.3 below shows people at Tshififi village queuing for water while others were still coming carrying containers to the water point, in order to join the queue. According to the field observation people can spend 1 hour to two hours to fetch water at the water point as some of them were carrying more than six empty buckets. The findings reveal that water supply challenge was a serious issue as people were queueing for long periods.

Plate 4.3: People queueing for water at Tshififi village (21 July 2020)

4.4.14 Water services as a basic necessity for both villages (Tshififi and Bunzhe) sign of water challenges.

Community members consider water supply as the most basic services to be delivered by the municipality to their villages. Figure 4.14 below shows water services as a basic necessity

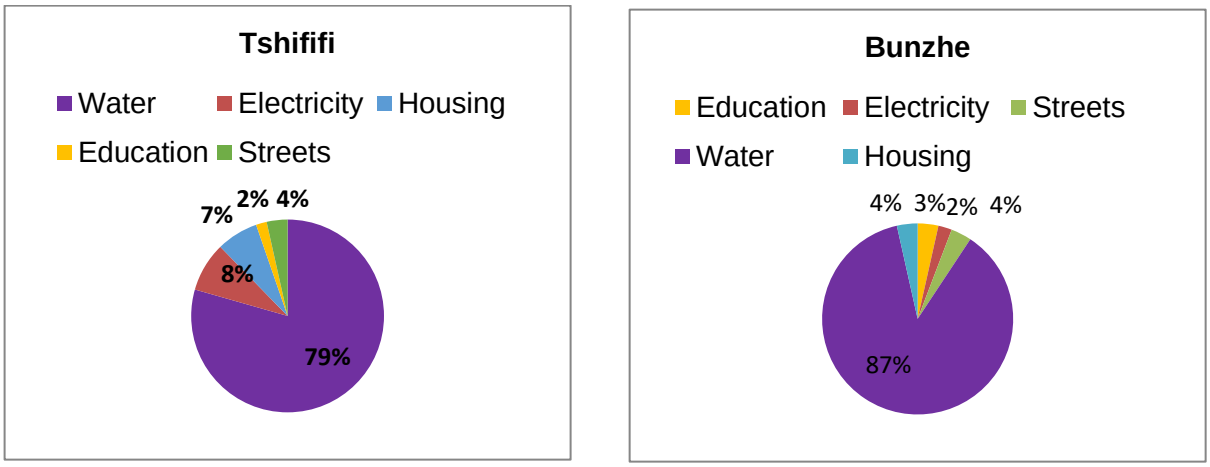

Figure 4.14: Water services as a basic necessity (Bunzhe and Tshififi villages)

Out of 400 participants from Tshififi, 316 respondents indicated that water is a basic necessity in the village which constituted 79%, while the remaining 84 (21%) were respondents who selected other services. Out of the total of 70 participants, 61 (87%) from Bunzhe indicated that water is an important basic need in their community while 9 (13%) respondents selected other services. Further breakdown indicates that, 316 (79%) respondents at Tshififi considered water as vital resource for their village, 32 (8%) selected electricity, 28 (7%) selected housing, 8 (2%) selected education and 16 (4%) indicated that streets were also needed. The data on Bunzhe shows that 61 (87%) respondents indicated that water is an important resource which is needed in their village; 3 (4%) respondent selected housing; 3 (4%) respondents selected streets, 2 (3%) selected education while only 1 (2%) respondent indicated that electricity is also needed in their village. The highest percentage of the respondents from Bunzhe (87%) and Tshififi (79%) shows that water supply challenge is seriously affecting economic developments; this means that the Municipality needs to attend to this problem as soon as possible.

4. 4.15 Reliability of water from tap

On the question of reliability, majority gave a “No” answer while the minority gave a “Yes” answer. About 433 (92%) said that water supply is not reliable because there is no consistent flowing of water through the taps, while 37 (8%) of the respondents said that there is consistent flow of water. The water supply is interrupted regularly so people spend lots of time without water. If water is reliable there will be less queuing time. From the findings at Tshififi, the new boreholes are not working, as such street taps remain dry. Due to the unreliable water taps, people seek other sources of water, hence, people spend more than 30 minutes fetching water and per capita water use declines to between 5 and 10 liters per day.

4.4.16 Person who fetches water

The data shows that 348 (74%) of the respondents selected “adult women” as the ones who fetch water rather than adult men. The respondents about 59 (13%) are adult men, 43 (9%) respondents chose female children, 20 (4%) respondents selected male children (Figure 4.15), bearing in mind that women are always above the total number of men. In typical rural areas, men are always at work out of the home, while their wives spent much of their time working at home. Another implication is when we looked at the cultural perspectives wherein females are the one who are responsible for fetching water at home. The other reason women were selected by many respondents in the study area is that women usually collect the water, while men will be doing other chores like looking after livestock.

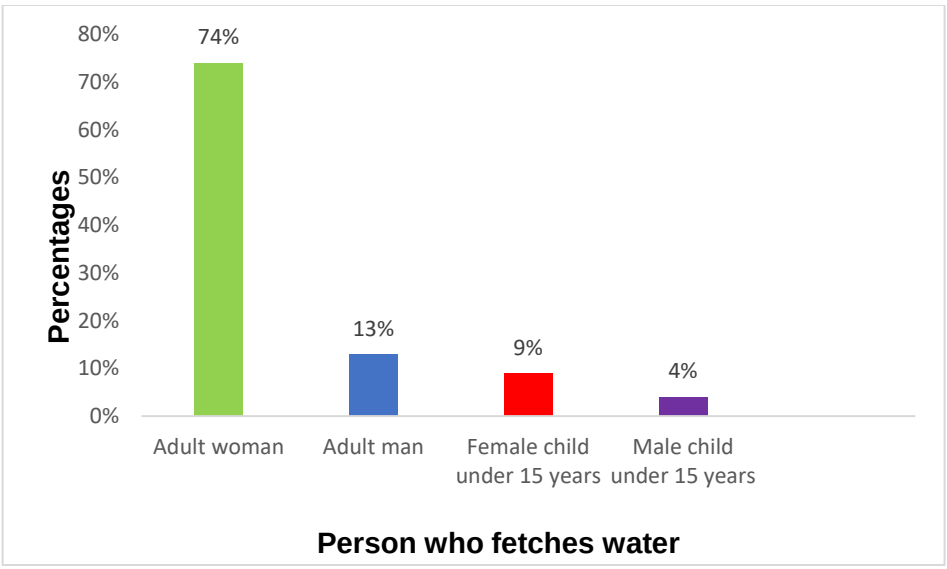

Figure 4.15: Person who fetches water

4.4.17 The frequency in fetching water

The question on the frequency of fetching water shows that 196 (42%) respondents said that they fetch water once a month. One hundred and eighty- nine (40%) respondents said that they get water once a week, 33 (7%) respondents access water twice a week while 52 (11%) respondents said that they receive water everyday (Figure 4.16). This indicates that water supply is unreliable as the majority of people access water only once a month. Once a month shows that both villages experience water supply challenges. This also means that there is no agreed standard time for collecting water. Low frequency in availability of water affects all respondents socially, economically and psychologically as they spend most of their time without water. They are affected economically because they have to spend a lot of money in buying water from vendors and for transporting water from villages that have enough water supply. Socially they are affected because they spend most of their time in fetching water from other villages instead of using their time, for pursuing education, sporting activities and for working. They are also affected psychologically because they always think on how they can obtain water and they are stressed if they fail to obtain enough water.

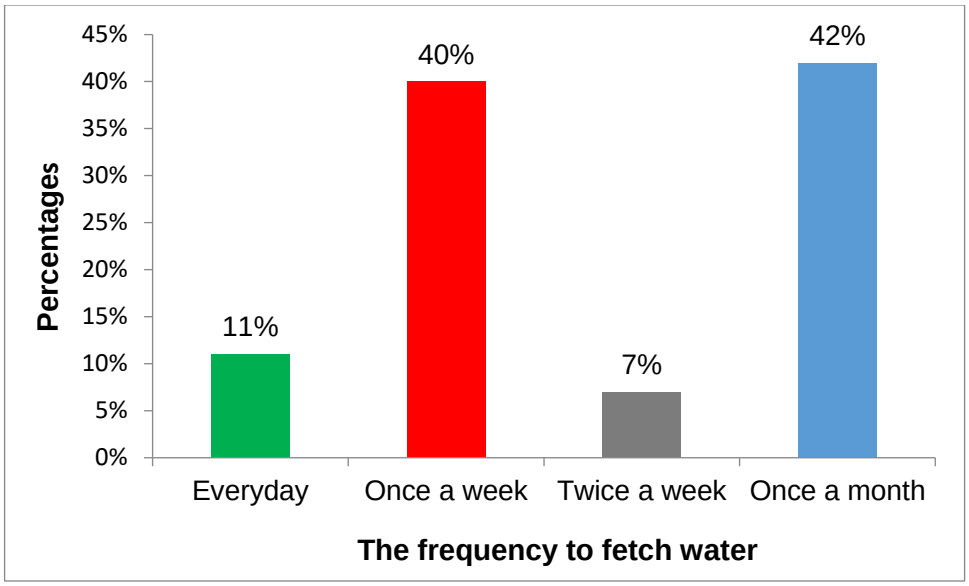

Figure 4.16: The frequency to fetch water

4.5 The efficiency of water infrastructure

This section deals with a different aspect to the adequacy of water because it assesses the performance of available water infrastructures. The water infrastructures that are available in these villages include, taps, damaged borehole, a water pipeline from Vondo regional water plant and one reservoir. Respondents come up with different views regarding the condition of the water supply infrastructure.

4.5.1 Efficiency of infrastructure

On the question of whether there is efficiency of water supply infrastructure or not, out of the total of 470, 382 (81%) respondents indicated that the water supply infrastructure is not efficient, while about 88 (19%) respondents answered with a “yes”. It is, therefore, apparently that Bunzhe and Tshififi villages have inefficient water supply infrastructure. The findings indicated that at Tshififi three boreholes have completely collapsed and the new one is not yet working. The reservoir at Tshififi village is always without water. It seems the respondents who indicated that water supply infrastructure is efficient is because they had their own water tanks, or they have boreholes in their households or are close to sources of water. At Bunzhe the borehole is the main source of water supply and the level of water is very low, hence, households can,take for a period of month wait for the borehole to supply water into the two tanks. The condition of the water tanks at Bunzhe is not at

a good standard as they are leaking; this has a negative impact on water supply to the households. During the key informant interview, it was indicated that water is not enough because it is not not supplied to all communities. The manager said that it is because of the lack of upgrading of Vondo purification scheme which is aged. The demand for water exceeds the supply because of the population growth. Some of the water pipelines are aging and they need replacement (Plate 4.4). The size of the pipes is too small to carry large volumes of water that would be sufficient to provide all the assigned villages, therefore, the Municipalilty needs to upgrade or replace with larger pipes. The plate below is showing the pipe-line to Tshififi village and others.

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Plate 4. 4: R3 pipelines to Tshififi and surrounding villages (Photograph: 26 March 2019)

4.5.2. Water supply per day

Out of the total of 470 participants, 466 indicated that they obtain water for less than 24 hours which constituted 99%, while the remaining 4 (1%) obtain water for 24 hours. The answers to the question on how many hours per day is water supplied to taps, were - 443 (94%) respondents answered that they get water supply for less than 8 hours; 23 (5%) get water between 8 hrs-16 hrs while 4 (1%) get water between 16 hrs to 24 hrs. The reason for not having enough water was due to the inefficiency of the water supply infrastructures, such as the purification scheme, broken pipe lines, collapsed boreholes and taps that are damaged. The respondents with the highest percentage, 99%, get water for less than 24 hours per day because of the high demand of water which exceeds the supply, poor water storage, the borehole had low water table, small-sized water pipe lines from Thathe Vondo to Tshififi and the designed capacity of the reservoir is small to support the growing

population. The fact that the villagers have few water taps and some of them are broken also contribute to inefficient water supply. The remaining 4 (1%) respondents who get water for 24 hours are those who have their own boreholes or have large water storage tanks at their households.

4.5.3 Test of Analysis of variance (ANOVA) and water supply per day

Analysis of variance was performed to check if there were significant differences in hourly water supply per day between Bunzhe and Tshififi villages. The water supply mean per day for both Bunzhe and Tshififi was recorded. The hypotheses tested were as follows:

(H_0: $\mu_1=\mu_2$) (The null hypothesis is that all water means per day in hours are exactly equal)

(H_1: $\mu\neq\mu_2$) (The alternative hypothesis is that all water supply means per day in hours are not equal).

Table 4.6 below shows Analysis of Variance on hourly water supply per day at Bunzhe and Tshififi villages. The significant value of the test in both Bunzhe and Tshififi villages is significant with a p-value .34 which is less than .05. This value of .034 is less than 0.05. There is sufficient evidence to reject the null hypothesis. This means that there is a significant difference in the mean hourly water supply per day between Bunzhe and Tshififi villages. The null hypothesis has been rejected because it is statistically significant at the 5% level. The p- value .034<0.05. Even though there is a significance difference between the two means, there is still a challenge of water supply in both places. The test shows that the two villages are not getting enough water, hourly and per day, therefore this lead to negative impacts such as unemployment, poor economic development and easy spread of diseases.

Table 4.6: Anova of water supply per day

ANOVA					
Water supply per day					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	25.221	3	8.407	2.906	.034
Within Groups	1348.228	466	2.893		

4.5.4 Major challenges to the efficiency of water supply infrastructure

The interpretation shows that 258 (55%) respondents selected that water supply challenge is because of poor maintenance (Figure 4.17). The second group, about 189 (40%) respondents indicated that the Municipality is the major cause of the inefficiency of water supply infrastructure; 18 (4%) respondents said that inefficiency is caused by leakages of water from pipelines and from storage tanks, while 5 (1%) respondents indicated that it is because of power outages.

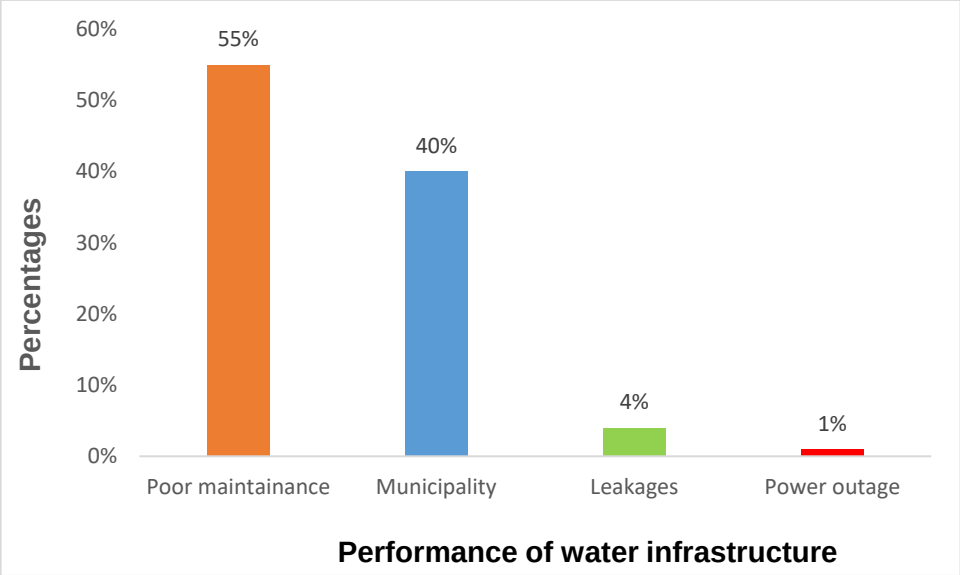

Figure 4.17: Performance of water supply infrastructure

The questionnaires also contained questions that sought opinion of the participants on the state of efficiency of the water supply infrastructure. Respondents indicated that at Tshififi there is one storage reservoir which is too small to accommodate the fast growing population. The reservoir always has insufficient water to supply all the people. The villagers indicated that there are four boreholes that are available; three are damaged and are no longer functioning while the fourth one is newly-erected one that has not yet started working because the Municipality is still waiting for an engine to pump water into the reservoir. There are thirty- two taps available at Tshififi but they are always dry. Out of the 32, five taps are damaged and have collapsed. This confirms that there is poor efficiency of water supply infrastructure. At Bunzhe there is one borehole where water is pumped to the main water pipeline that is supplying water to the two water tanks. The condition of these two water tanks is not good. During field observation the two water tanks at Bunzhe were even leaking indicating that there is insufficient water supply. There are 12 street water taps and three are damaged. During the researcher's survey some of the taps were locked, meaning that no one is supposed to fetch water until the two tanks are full of water.

4.6 The impact of water supply challenge

The section focused on the impact of water supply challenges; the majority of the respondents stated that they do not receive enough water. Water supply challenge affect water for domestic use, livestock, businesses, gardening, farming, bricklaying project and cash crop project.

4.6.1 Effects of water supply challenges

This effects of water supply challenges differs from the impact previously discussed as this section addresses domestic, business, livestock and gardening. Findings reveal that 426 (91%) respondents said that there is not enough water for domestic use including water for drinking, cleaning equipment, bathing, cooking and washing. Some of the respondents about 20 (4%) said that there is not enough water for livestock. The respondents, about 19 (4%) said that there is no water for gardening (Figure 4.18). Lack of water for gardening will cause poverty since residents from Bunzhe and Tshififi relied much on gardening. Lack of water supply affects planting of vegetables, forcing people to buy vegetables from shops and neighbouring villages that have enough water to grow them. The respondents about 5 (1%) selected that there is no water for business. The reason why business had been selected by few respondents is that there are few business people in the study areas.

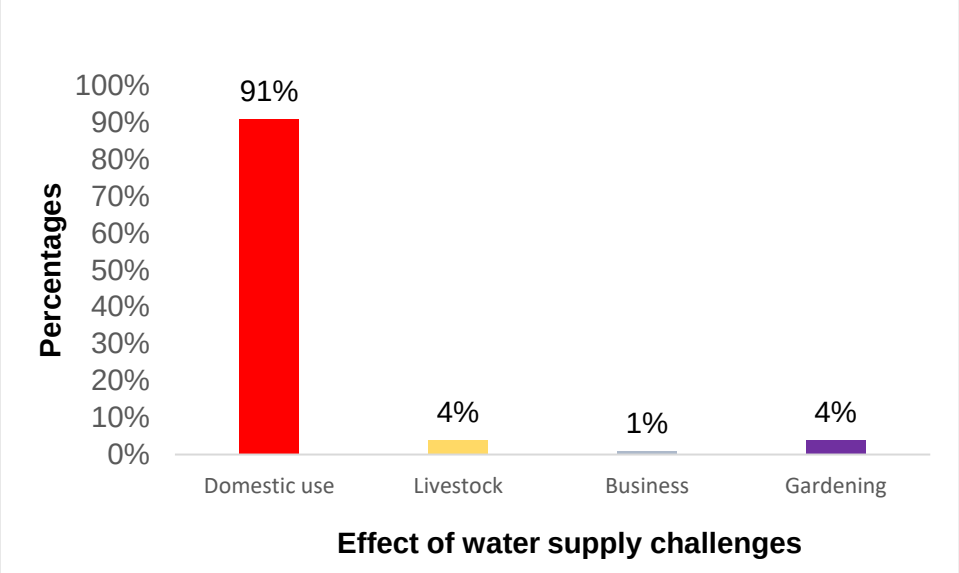

Figure 4.18: Effect of water supply challenges

4.6.2 Negative impact due to water supply challenges

The question about whether water supply challenges had a negative impact on development in the community or not, 452 (96%) of the respondents indicated “yes” while 18 (4%) indicated “no”. The

findings show that water supply challenge had a negative effect on the economic development at Bunzhe and Tshififi villages. Bunzhe and Tshififi villages rely much on subsistence farming, when water is available they plant their crops in order to sell so that they can get money. Lack of water supply has a negative impact on the development of Bunzhe and Tshififi villages because it affects crops, bricklaying project, gardening, maize, groundnuts, cabbages, sweet potatoes, onions, tomatoes and vegetables. It means that if these villages are supplied with enough water they can plant many crops. According to the study conducted by Mnisi (2011) in New Forest at Bushbakrich there is a big plot of land where people grow crops, mango, guava, papaya and banana throughout the year. When there is water supply challenges, fruit and crops are affected and people do not have income.

4.6.3 Development project affected in the community

Out of 470 participants, 334 (71%) were respondents who indicated that building houses was affected by water supply challenges, while 38 (2%) respondents indicated that building projects were affected, 123 (26%) respondents said that water supply problems affect cash-crop projects and 5 (1%) indicated that water supply problems affect bridges (Figure 4.19). The housing needs for rural poor inhabitants from Bunzhe and Tshififi villages are affected by water supply challenges. The reason more houses are needed is because of the rapid growing of the population. Urbanisation that is taking place at Bunzhe and Tshififi villages is being derailed by the few and broken taps, damaged boreholes and failure of the reticulation of water pipelines from Thathe Vondo dam as people need sufficient water. These factors normally affect housing project. Food security is also affected by water supply challenges; this happens when there is insufficient water for use on agricultural activities in order to produce more food and prevent food insecurity. Food insecurity causes hunger, high death rate, illness and political instability in a region. This was supported by FAO (2017) indicating that countries that experience food insecurity tend to engage in violence, hunger and increased death. This means that if water is available people from these two villages can cultivate crops and out of that, they could make some money by selling them. The findings indicate that the amount of water available is not enough for all development projects.

According to the key informant from Vhembe District Municipality, Thulamela Local Municipality only supplies free basic water for domestic use only. This implies that the available water at Bunzhe and Tshififi is meant for consumption only. There is no extra water supplied to the two villages, meaning

that there is no water for industrial purposes, building, bricklaying, cash crop projects and bridges. The respondents concur that the water that is supplied to them is not even enough for them to think of starting a business. This shows that Bunzhe and Tshififi villages have poor coverage of water supply and the research in these villages, also showed that the villagers do not frequently receive water. According to research findings rural villages are currently experiencing water supply challenges; this is a great concern considering that this problem is expected to become worse by 2050 (Wallance, 2000: 107). The implication is that if water is available at the study area people can make a lot of money by selling bricks and they can use this money to support their children in their studies. The bricklaying project can be hindered by lack of water, hence, there will be no employment that can be created. Those who had selected impact on bridges are people who are living near the river where there are no bridges. If the river has abundance of water, communities can inform the Thulamela Municipality to build a bridge for them.

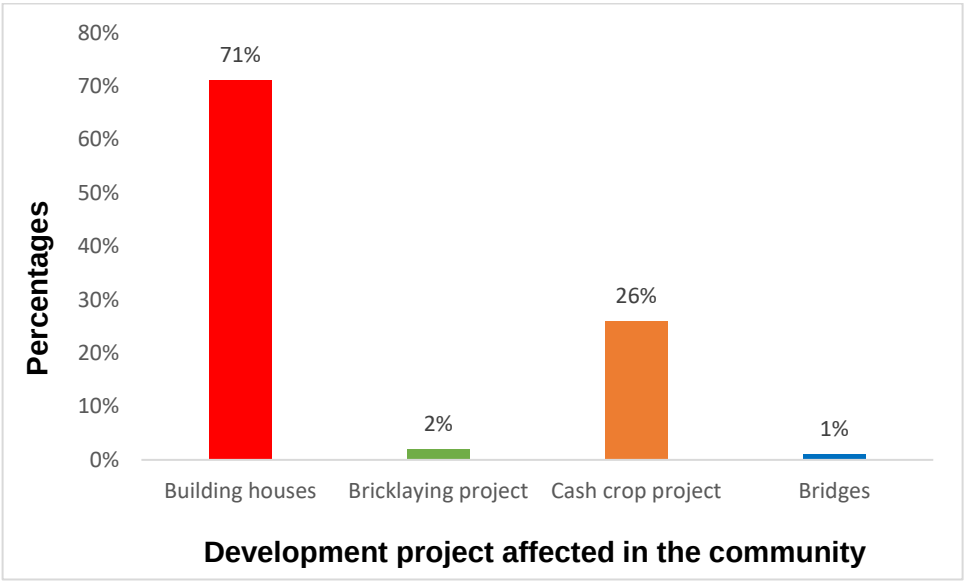

Figure 4.19: Development project affected in the community

4.6.4 Mean queuing time for the development project

The mean queuing time for bridges is 113 (24%) and the mean queuing time for cash crops is 117 (25%) (Figure 4.20). Mean queuing time for bricklaying project is 141 (30%) while mean queuing time for bridges is 99 (21%). The mean queuing time for the development project refers to the length of the time taken to queue at the water point to access water that is used to develop projects at rural area. The mean queuing time for the bricklaying project requires more trips and more walking time to fetch water. The reason for more mean queuing time is because of people who need large quantities of water for building. The other reason for the high mean hours was that the two villages

are growing very fast, therefore, more water is required and the queueing time will increase. The percentages for the mean queuing time for bridges and cash crop projects are very close to each other which means that people involved in these projects need more time to fetch water. Thulamela Municipality should increase the rate of water supply per hour as big developments like bridges are under its control. The progress of projects is affected as the workers spend lots of time queueing for water or incur high costs in transporting water from water sources that far away; this often result in unemployment.

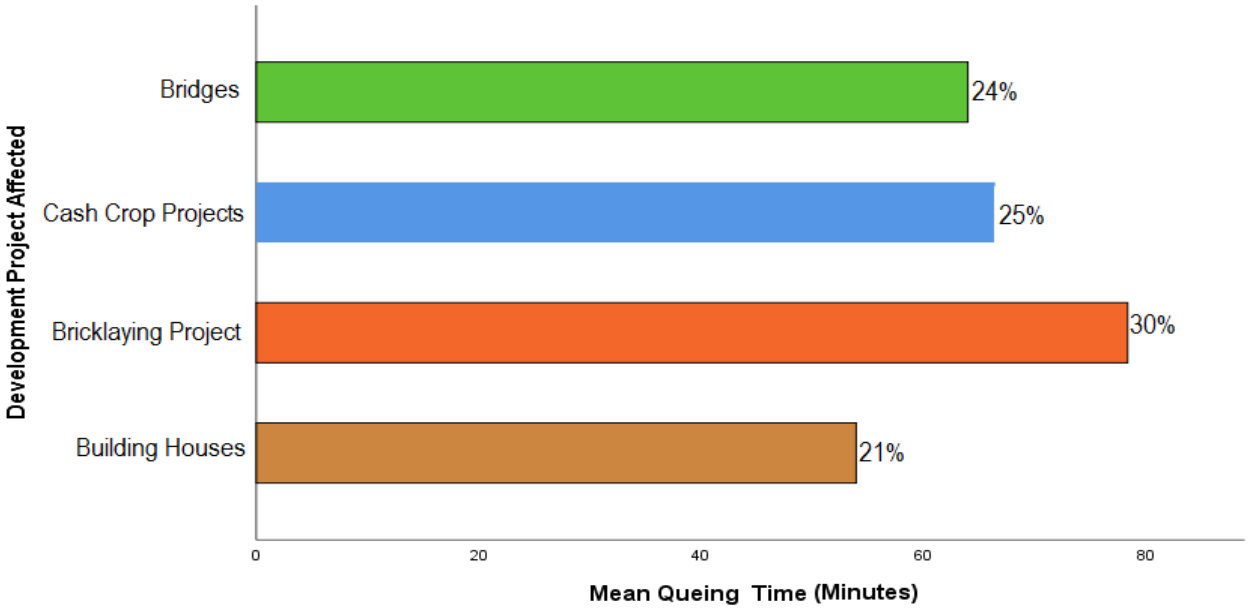

Figure 4.20: Mean queuing time for the development project affected

4.6.5 Economic development affected by water supply challenge

An analysis of the economic development shows that 446 (95%) of the respondents said job creation is the economic development which is mostly affected by water supply challenge (Figure 4.21). This implies that if development project such as bricklaying project is affected by water supply challenge even job creation will also be affected. The respondents 13 (3%) indicated that outdoor recreation as an economic project is affected by water supply challenge. The reason why this development project had been selected by few people is that there is not enough water to initiate such a project. This implies that if the community can be supplied with water people can start their projects and that can provide jobs to the community. The respondents, about 11 (2%) mentioned that car wash projects at Bunzhe and Tshififi villages are affected by water supply challenges while tiling as a project was not selected.

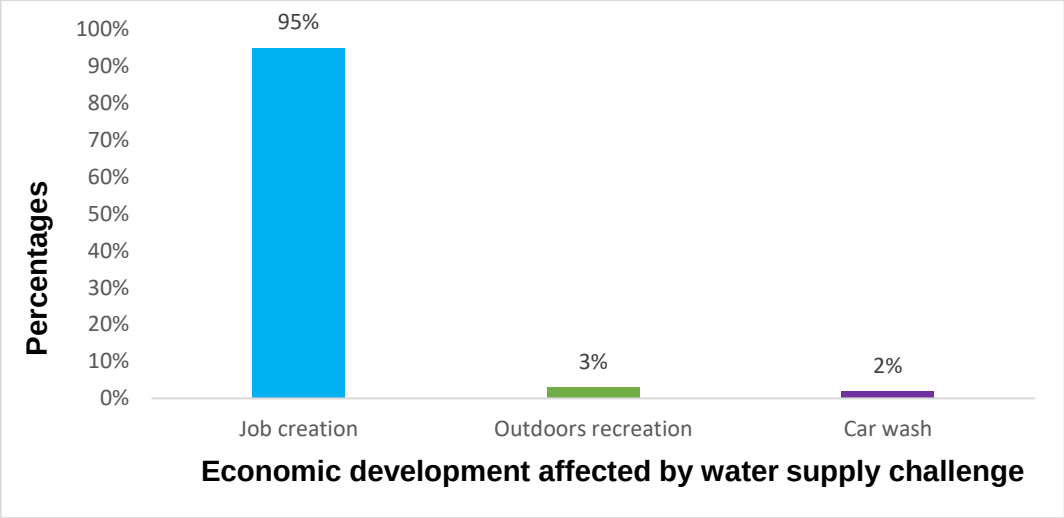

Figure 4.21: Economic development affected by water supply challenge

4.7 Possible strategies to alleviate water supply

The findings on this question showed that Bunzhe and Tshififi villagers have possible solution for alleviating water supply challenges. Different measures in adapting to water supply challenges, include, drilling boreholes, avoiding poor tendering, prioritization of water supply, reducing water usage, water recycling and obtaining financial resources to upgrade Thathe Vondo dam were suggested.

4.7.1 Adaptation to water supply challenges

About 341 (73%) of the respondents said that they use rooftop harvesting in order to adapt to water supply challenges. Rooftop harvesting is used to collect water during rainy seasons in order to ensure the availability of water in the households. Eighty six (18%) of the respondents had adapted a reduced water usage. They can adapt to reduced water usage by using dishes when washing clothes, washing dish and cleaning hands as well as other equipment at home instead of washing them directly at the tap. About 31 (7%) of the respondents indicated that they practice water reuse to adapt to the water supply challenges. The reason why this variable was selected by few respondents is the fact that water recycling is not in use at the Thulamela Municipality. About 10 (2%) of the respondents said that construction of harvesting schemes can be used in adapting to water supply challenges. The reason this option was selected by few respondents was that people do not know it and it is not practiced in these two villages.

4.7.2 The role of stakeholders in addressing water supply challenges

The respondents from Tshififi and Bunzhe identified different stakeholders who they thought were responsible in addressing water supply challenge in their villages. The possible stakeholders to remedy water supply challenges identified by community members included, Thulamela municipality, ward councillor, community-based water challenge, water supply responsibility and household water demand (Figure 4.22). The municipalities had been given the mandate to reduce water supply challenges to all rural villages under its jurisdiction although, initially it was the responsibility of the Department of Water Affairs. The Municipality as a water service authority has the responsibility to ensure that there is efficient supply and sustainable use of water in the rural villages.

The Municipality has water service authority development plan to ensure efficient and sustainable access to water supply that promotes sustainability and economic use (DWAF, 2003: 15). Thulamela Municipality has a vision aimed at providing sustainable water supply infrastructures to all rural villages under Thulamela Municipality. The main aim is to end water supply challenges to all households and educate people on how to use water in a sustainable manner. The National Development Plan (NDP) aimed to achieve a sustainable use of water infrastructure by 2030. South Africa needs to invest in a strong network of economic infrastructure designed to support the country's long term objectives. At the current moment water supply challenges in rural areas at Thulamela Municipality is mainly caused by poor maintenance of water infrastructure. The Vhembe District Municipality therefore aims to improve access to water supply through coordination of integrated development approaches by pivotal development points to ensure full benefits for the country. To ensure that there is no water supply challenges to the community, Vhembe District Municipality has a Comprehensive Infrastructure Plan (CIP) to deal with infrastructure development. This plan indicates that water should be available for at least 350 days per year and not be interrupted for more than 48 consecutive hours per incidents (Thulamela IDP, 2017/2018). The figure below shows stakeholders responsible for water provision services.

Figure 4. 22: A van diagram to show stakeholders responsible for water supply services

4.7.3 The role of community in alleviating water supply

There are different means that community members can use to alleviate water supply and increase sustainable use of water resources; these include, turning off the tap when washing dishes, hands and cleaning other equipments at home. Community members also suggested that Thulamela municipality must prioritise water supply as one of the basic needs, thereby use people who have knowledge in this area when awarding water tenders. Communiy members at Tshififi and Bunzhe villages suggested that people must use water from the buckets instead of using hosepipes when cleaning cars at home. Education was also suggested as the best weapon to help in alleviating water supply as some community members are wasting water because of lack of knowledge.

- **Prioritisation of water supply**

Majority of the respondents suggested that the Thulamela Municipality should prioritise water supply to all communities because water is one of the human basic needs that should be provided for the survival of human beings. Water is used for drinking, food preparation and hygiene. The respondents further suggested that Thulamela municipality has to allocate more money to improve water supply challenges at Bunzhe and Tshififi villages. The money will also be used in maintaining the aging water pipelines from Thathe Vondo purification plants and Nandoni dam as they cater for the needs of rural villages within the Thulamela Municipality.

- **Sustainable use of water**

The questionnaires results obtained from the key informant from the community suggested that water is not being used in a sustainable manner by some community members. This means that in villages where there is enough water supply, people are not using water in a sustainable way. They leeave their taps open for the whole day, washing car, using hosepipes and gardening. Sustainable use of water means using water and at the same time saving it, so as to meet the needs of the present and future generation. In order to achieve sustainable use of water, people have to take more responsibility for water conservation. The government must have awareness campaigns and education programmes to teach people on how to use water sustainably.

- **Poor tendering processes for project contractors**

During an interview with community leaders, they indicated that some contractors use ordinary materials that are not expensive, yet, they claim lots of money from the government. The interviewees also indicated that poor quality of tendered projects were caused by unqualified water supply project contractors; for example, in the case of the water supply project to Makhado area from Nandoni dam and the water project from Nandoni dam to Giyani. Due to lack of proper knowledge of the project, the beneficiaries are still without water, even up today. It is due to this poor tender system and oversight on the part of the inspectors from the Department of Water Affairs. New tender was earmarked to remove the ordinary pipelines that had been used before; this is still pending. Another example is at Tshififi village where a borehole was due to be erected to supply water to the community, however, the project is still incomplete (researcher's field survey).

In conclusion, this chapter has presented data collected from respondents as well as its interpretation. The research study established that the community is facing water supply challenges due to - lack of funds to repair old infrastructures and improve the water supply system, lack of water infrastructure to supply the growing population, power failure that is occurring in South Africa, unemployment is high because it is caused by the collapse of economic activities which require substantial supply of water. The findings also showed that there is an increase in number of infectious diseases caused by poor supply of water.

CHAPTER 5: DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 Introduction

This chapter presents a brief description of the study finding based on the aim and objectives of the study. It also provides a discussion, recommendation and conclusion on what can be done to improve water distribution in rural villages as informed by data collected at Bunzhe and Tshififi villages in the Thulamela Local Municipality under Vhembe District Municipality.

5.2 Discussion of the study findings

A thorough analysis of data revealed that Thulamela local municipality has numerous challenges related to the distribution of water to local communities. Data collected was discussed based on the five objectives which were outlined in Chapter One. The responses on objective one, about the causes of water supply challenges in the Thulamela Municipality, majority of the respondents complained that the municipality is failing to supply them with adequate water. Some indicated that they get water from communal taps in the street while other indicated that they received water from boreholes in the community. On objective two which sought to determine water supply capacity at Thulamela Municipality, respondents indicated that there are three big dams with sufficient water capacity but the Municipality is failing to distribute water. Respondents highlighted that Thulamela Municipality does not have adequate capacity to distribute water to all villages.

Objective three focused on examining the efficiency of water supply infrastructure at Bunzhe and Tshififi villages. Respondents indicated that the municipality does not have sufficient water supply infrastructure for the two villages; this results in water supply challenges. The fourth objective focused on the impact of water supply challenges at Bunzhe and Tshififi villages. The data confirmed that there is significant impact of water supply challenges at Bunzhe and Tshififi villages as the municipality is failing to supply adequate water. Small business owners, such as those who do bricklaying and car washing complained that their businesses are seriously and negatively, affected by the water supply challenges. The last objective was on possible strategies to alleviate water challenges and its impact in the study area. The researcher recommended strategies which the municipality can use to alleviate the challenge of water supply at Bunzhe and Tshififi as well as other rural villages in the Thulamela Municipality in Vhembe District and other rural villages in Limpopo Province.

5.3 Recommendations

This chapter gives a summarised overview of the recommendation and study conclusions. It also attempts to identify areas for upcoming research on the matter of water supply challenges. From the analysis the researcher gives recommendation on strategies that can be implemented to improve water supply at Bunzhe and Tshififi villages in the Thulamela Municipality. It is hoped that the following recommendations will assist in improving water supply infrastructures in the Thulamela Municipality.

5.3.1 Provision of financial resources

Financial resources should be provided in order to enhance water supply to the rural villages in the Thulamela Municipality. The national and provincial governments should make sure that they provide more funds to the Thulamela Municipality to buy water pipes, pressure pumps, to drill boreholes and to buy water equipments that can replace the old infrastructure. In addition, Vhembe District Municipality aims to provide every household with a yard water connection by the end of 2020 but currently this seems impossible because the Municipality has limited staff and lack of funds to achieve these purposes (Vhembe IDP, 2018/19-2021/22).

5.3.2 Maintenance of infrastructure

The Municipality has to ensure that old infrastructures are replaced especially main pipes that supply water from the purification plants to the reservoirs in villages that are found in the Thulamela Municipality. The study shows that the major problem was the non-upgrading of the old pipes that are supplying water to the Tshififi village. Quality materials must also be used as they last longer and save on repeated installation cost. The research recommends that water officers in the Vhembe District should involve the community members to assist them in water maintenance to ensure that there is efficient water supply infrastructure. Thulamela Municipality should drill more boreholes, wells and implement other techniques to conserve water.

5.3.3 Appointment of skilled managers and workers

The government should employ skilled workers including qualified engineers, water scientists, managers, technicians and artisans. The appointment of these professionals will assist in enhancing supplying water to the villages in the Thulamela Municipality. In addition, when there are concerns

with water supply, Thulamela must fix the problem immediately and provide water to the community. For example, in South Africa and other parts of Africa water engineers are very few and this indicates that more training in water profession must be done as soon as possible (Cashman *et al*., 2010: 63). The Thulamela Municipality should ensure that people with appropriate qualification and skills are employed in order to make sure that there is efficient water supply; for example, in the Thulamela Municipality, people should not be employed on the basis of political affiliation.

The government should organize more capacity building programmes for both department of water officers and community members to provide them with adequate skills and abilities to handle any challenge related with water to enhance efficiency of water supply. Thulamela Municipality should train the community members in the field of water management on how to open water in the reservoir, how to maintain a leakage tap, to replace a rubber in a tap and other activities.

5.3.4 Rooftop water harvesting

The households should be encouraged to collect more water during heavy rainfall to ensure that there is always water supply for domestic use and for gardening. This water is collected by placing tanks or drums under the gutters for water to get into them. Rooftops harvesting structures in buildings are designed to collect rainwater to solve the water supply problems in countries, for example, in Bangladesh (Thomas, 1998). According to Krishna (2003), the most significant benefit of rainwater harvesting is that the water is totally free, the only process is for collection and use. The other advantage of rooftop water harvesting is that it is near and it reduces surface run off.

5.3.5 Provision of efficiency water supply infrastructure

The Thulamela Municipality with the aid of the Integrated Development Plan must make sure that there is proper water infrastructure that can supply water to the communities. Some of the water pipelines are too small to supply enough water to the reservoir, therefore, there is a need to replace them with large-size pipes. At Tshififi village the reservoir is too small compared to the current population. The reservoir was built more than 30 years ago and was meant to supply 600 households, when one compares it with the current population it is now unable to meet the demand..

5.3.6 Efficiency of water supply and tap water

The study found that there were few streets water taps; these are below the RDP standard. Villagers responded that for a month or more, they will be without water. Some of these water taps were too old and they need maintenance. This means that the municipality must install other streets taps and also install water taps in each and every household. When water taps are installed they will be able to bring economic development through enabling the communities to get involved in agricultural projects, it will also save their time wasted in searching for water and they would maintain good and healthy bodies.

5.3.7 Efficiency of water supply and borehole

The study recommends that Thulamela Municipality should drill borehole at Tshififi in order to provide water to the growing population. There is insufficient water supply infrastructure at Tshififi and in most cases people spend more than a month without any water. The boreholes that are available are old and they need maintenance. At Bunzhe there are no reticulation pipelines as a result people depend on one borehole that provides insufficient water. The Municipality must make sure that it provides communities with water pipelines as well as a reservoirs.

5.3.8 Community involvement

Community participation must be given first priority because the government has been created for the people and therefore it must serve them. When the Municipality is taking any decision, it must consult the community. When the municipality involves the community in decision-making the Municipality can have progress, however, some of the respondents indicated that the municipality does not involve them in making decision. The respondents even stated that there was no tank with water that brings them water when there is none. Communities should be made aware of their rights and responsibilities to participate in the Integrated Deveopment Plan (IDP) meetings, budget review meetings and they must also be involved in important gatherings that discuss about water supply to the communities. This can be achieved through consultation with the government officials, municipality officials and community structures. Thulamela Municipality is responsible for ensuring that the community is involved when the Integrated Development Plan is being developed; that is the right time that the Municipality should engage the communities so that they can come with their views about an efficient supply of water to them. Thulamela Municipality should make sure that ward councillors who are servants of the community, should always convey feedback of the resolution

taken at municipality meetings to the community. The Municipality should also ensure that there is mutual cooperation between the ward councillor and other stakeholders in the community, for example, the ward councillor of ward 16 should attend the meetings held at Tshififi, Bunzhe villages and the headman should also attend the meetings convened by the ward councillor.

5.3.9 Water supply infrastructure

The inefficient water supply infrastructure in the Thulamela Municipality has been taken as a major challenge that make it difficult to supply water to the rural villages in the Thulamela Municipality. Thulamela Municipality has three dams that supply water to the rural villages in the Thulamela Municipality. The challenge that the dams pose to the Thulamela Municipality is that they are too old to cope up with the demand of the growing population and the storage capacity is below the required demand; for example Thathe Vondo regional water scheme has storage capacity of 52 000 and was expected to supply water to about ± 588 000 population. Thathe Vondo regional water scheme is situated between latitude 22^0 $38^{'}$ and 30^0 $31^{'}$ longitude. The 95% of the population served by the scheme are rural areas and only 5% of the population is used by the Thohoyandou urban area. Thohoyandou consists of 167 villages except Malamulele rural township. At the present moment the scheme is experiencing demand overload (Phuthu, 2012). The storage capacity does not meet the required water demand. The Department of Water Affairs should increase the design storage capacity of Thathe Vondo dam to 120 Mld. The Vondo dam should be renovated without destroying the old one so that they can both provide enough water to the community.

5.4 Conclusion

The researcher concludes by looking at what respondents had detailed in order to make sure that there is constant supply of water at Bunzhe and Tshififi villages. This is possible mainly by increasing storage, managing the use of the available water sources and drilling more boreholes. The research dealt with these by looking at the following objectives: identifying causes of water supply challenges, determine water capacity, ascertain the efficiency of the current water supply infrastructure and impact of water supply challenge.

5.4.1 To identify the causes of water supply challenges at Thulamela Municipality

The first objective was to investigate the causes of water supply challenges. The study established that water supply system had been noticed before 2004 since then the provision of water has become unreliable. The increase in population has caused the demand of water to exceed the water supply. The study also concludes that lack of funds is also causing water supply challenges. More money is needed to buy water pumps, pipelines, valves and other materials to ensure that there is a sufficient supply of water to the communities in the Thulamela Municipality, for example most of the Municipalities in the Vhembe District Municipality had invested their monies into VBS (Venda Building Society) account and its collapse has had a negative impact on the provision of water to the rural villages within Vhembe District. In order to overcome the causes of water supply challenges, Thulamela Municipality must show in its IDP plan that water supply must be a priority over other services.

5.4.2 To determine water supply capacity at the Thulamela Municipality

The second objective was to determine water supply capacity at the Thulamela Municipality. From the findings it was noted that Thulamela Municipality has many sources of water including rivers such as Luvuvhu, Mutshindudi, Dzindi, Mvudi and others. There are big dams such as Thathe Vondo, Damani and Nandoni dam. Nandoni dam is a big dam but it is distributing 60 Ml/d which is very low. The Department of Water Affairs has to increase the design capacity of these dams to 120 Ml/d so as to supply enough water to the villages. Even though water is available, rural villages do not have access to water as a natural resource. On top of that residents are still walking or travelling long distances, more than 200 meters, to fetch water. In order to overcome these problems, the government should employ more water scientists and managers to enhance water supply in the Thulamela Municipality.

5.4.3 To examine the efficiency of water supply infrastructure

From field observation, most of the infrastructures such as Thathe Vondo purification plant, water pipelines, reservoirs, boreholes and taps are ageing. The ageing infrastructure affects the efficiency of water supply to the communities. The government should invest more money in upgrading the water infrastructure including purification schemes, reservoirs, water taps and use large water pipelines that can supply more water to the reservoir. The Thathe Vondo regional water scheme needs to be upgraded because the scheme can not cope with the available population and some of

the pipelines need to be replaced because they are out-dated. The other way to overcome water supply challenges is that the Thulamela municipality should outsource services from the private service-providers. The reason behind this is to reduce the issue of maintenance and labour administrative cost. The importance of encouraging private sectors is that: it creates employment, uses skilful people and influences efficiency supply of water to the rural villages.

5.4.4 To assess the impact of water supply challenges

The fourth objective was to assess the impact of water supply challenge. The study established that many hours were spent in fetching water from the street taps and even from neighbouring villages. This has a negative impact in aspects like the bricklaying projects, gardening, learners arriving late at school and it promotes the spread of contagious disease like coronavirus (COVID- 19) as there is less water to wash hands. The study showed that females are the most affected group since they are involved in domestic work in the households. Household members spend lots of money to get enough water depending on the size of the households.

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Appendices

Appendix A: Household questionnaires (Tshififi and Bunzhe villages)

RESEARCH QUESTIONNAIRE

This questionnaire is meant for academic purposes, therefore information (data) acquired will not be used for any other purpose. The intended participants are the residents of Bunzhe and Tshififi villages. All the information will be treated with confidentiality.

Title: Investigation of water supply challenge in the Thulamela municipality: A case study of Bunzhe and Tshififi villages

Researcher's name: Nemalamangwa Ndishavhelafhi Respondent No…….

INSTRUCTIONS

Answer all the questions.

Gender:

Male	
Female	

Please mark with a cross next to the question

Section A: Socio-demographic information

1. Under which age group do you belong?

<20	
20-39	
40-59	
>60	

2. What is your marital status?

Single	
Married	
Divorced	
Widowed	

3. Are you the head of the household?

Yes	
No	

4. How many household members are there in your family?

1	
2	
3	
4	
5 and above	

5. For how long have you been living in this village?

1 year	
1-4 years	
5-8 years	
9-12 years	
12 years and above	

6. Which educational level did you achieved?

No formal schooling	
Primary school	
Secondary school	
Tertiary education	

7. What is your employment status in this household?

Unemployed	
Self employed	
Employed	

Other (Please specify) ……..

8. What is the total income in this household?

None	
R400-800	
R800-1600	
R1600-R3000	
R3000-5000	
Over R5000	

9. What is the current source of income for the household?

None	
Child support grant	
Allowance from relatives	
Salary (formal)	
Wage (contract)	
Pension	
Disability benefit income	

Other (Please specify) …….

Section B: Causes of water supply challenge

1. Do you experience water supply challenge in your village?

Yes	
No	

2. If yes, for how long have you been experiencing water supply challenges?

Less than 1 year	
2 years	
3 years	
4 years	
5 years	

3. What do you think are the causes of water supply problems in your area?

Disparity	
Modification of landscape	
Surface run off	
Population growth	
Local Municipality failure	
Lack of proper infrastructure/reservoirs	
Broken/ damage infrastructure	
Low water pressure	
Poor maintenance	
Power outage	
Lack of finance	

Section C: Water supply capacity of Thulamela Municipality

1. Does water system capacity meet or exceed the minimum two hours total flow requirements for a fully developed service area?

Yes	
No	

If yes, is this a standard agreement? .....

2. Where do you get water from?

Tap water	
Borehole	
Spring	
River/Dam	

3. If piped water, where is it located?

Inside the yard	
Outside the yard	

4. What is the status of water supply infrastructure?

Functional	
Broken down	
Collapse	

5. When was the tap installed?

Before 2004	
2004	
2005	
2006	
After 2006	

6. How many liters of water do you consume in your household?

Below 50 liters	
50-100 liters	
100-150 liters	
150 liters and above	

7. What is the size of the containers that you carry to fetch water?

5 Liters	
20 Liters	
40 Liters	
100 Liters	
200 Liters	

Other specify……..

8. Is the water adequate to meet all your household needs?

Yes	
No	

9. If no, what is the reason?

Water point is too far	
Water point is low yielding	
Queuing time is too long	

10. How far is the water source from your home?

Less than 200m	
More than 200m	

11. How long do you queue at water point to get water?

Don't queue	
Less than 10 minutes	
10-30 minutes	
30 minutes-1hr	
1hr-2hrs	

12. Is the water consistently flowing in your tap?

Yes	
No	

13. Who usually fetch this water?

Adult woman	
Adult man	
Female child under 15 years	
Male child under 15 years	

14. How often do you fetch water for domestic use?

Everyday	
Twice a week	
Once a week	
Once a month	

15. Who is the owner of the pipe?

It is mine	
It is for municipality	
It is for my neighbour	

Section D: The efficiency of water supply infrastructure

1. Is there efficiency of water supply infrastructure? e.g. Taps or pump

Yes	
No	

2. If there is efficiency, how many hours per day is water supplied to taps:

16-24 hours.	
8-16 hours	
Less than 8 hours	

3. What do you think are the major challenges here?

Poor maintenance	
Municipality	
Leakages	
Power outage	

4. Briefly explain how efficient is the water infrastructure in your village?

……

……

Section E: The impact of water supply challenge

1. How are you affected by water supply challenge in your area?

No enough water for domestic use	
No enough water for livestock	
No enough water for business	
No enough water for gardening	

2. Does the water supply challenge has a negative impact in the development in your community?

Yes	
No	

3. Which development project in the community is affected by water supply challenge?

Building houses	
Bricklaying project	
Cash crop project	
Bridges	

Other (Please specify) ……

4. What are the economic development are mostly affected by the water supply challenge?

Failure for job creation	
Outdoor recreation	
Tiling	
Car wash	

Other (Please specify) …….

5. What do you think are the impacts of water supply challenge in your village?

.....

.....

.....

6. What kind of services are missing in your area

Water	
Electricity	
Housing	
Education	
Streets	

Section F: Possible strategies to alleviate water challenge

1. Are there any adjustments that you have made within your household as a way to alleviate water supply challenge? If yes, what are they?

Reduced water usage	
Rooftop catchment	
Water reuse	
Practice monoculture	
Construction of harvesting schemes	

2. What do you think the municipality should do to address to the water supply challenge?.....
.....

3. What did community members do to address water supply problem in your village?
.....

Appendix B: Research questionnaire for Key Informant interview in Thulamela Municipality

Causes of water supply challenge

1. Are you satisfied with the performance of Thulamela Local Municipality in terms of water supply in your village?

2. In your opinion, how bad is your community affected in terms of insufficiency water supply infrastructure?

3. What do you think are the causes of water supply problems in your area?

Water supply capacity of Thulamela Municipality

1. What is the main water supply capacity at the Thulamela Municipality?

2. What type of water services does the Thulamela municipality provide to the communities at Bunzhe and Tshififi Villages?

3. Does the available water supply capacity meet the maximum daily demand requirements for a fully developed service area?

4. Is the water sufficient for domestic consumption?

5. Who is responsible for water services delivery in the Thulamela Municipality?

6. How often does this municipality supply water to Bunzhe and Tshififi villages?

7. Briefly explain why the municipality has not been able to supply water to the studied area effectively?

8. How are these problems going to be addressed?

The efficiency of water supply infrastructure

1**.** Are community members satisfied with the water supply at the Thulamela Municipality?

2. How old is the water supply infrastructure?

3. Does the Thulamela Municipality have any maintenance schedule on water supply? If yes, how does it work?

4. What is the kind of planning on the part of the Thulamela Municipality authority which can bring the effectiveness of water supply?

The impact of water supply challenge

1. What are the main problems which the municipality faced in different villages at the Thulamela Municipality in terms of water supply challenges?

2. How are the problems going to be addressed?

3. How does challenge of water supply infrastructure affect the availability of water, households and villages?

4. How do water supply challenges affect the community?

5 Are there any disease outbreaks that have been reported related to water supply challenges?

6. What are the negative impacts of water supply challenge in the development of your area?

Possible strategies to alleviate water challenge

1. What role do the village authorities play in addressing these problems?

2. Is there anything that the municipality officials or councillors should do in order to alleviate the problem of poor water supply?

3. Are the key stakeholders such as the government, farmers and community doing enough to address water supply problems?

4. What recommendations do you think should be done to reduce water supply challenge?

5. Do you think there are ways of promoting water conservation in this area?

6. What is your view about your community and water supply challenge?

Appendix C: Research questionnaires for Key Informant interview at Bunzhe and Tshififi villages

Causes of water supply challenge

1. Are you satisfied with the performance of Thulamela Local Municipality in terms of water supply in your village?

2. In your opinion, how bad is your community affected in terms of insufficiency water supply infrastructure

3. What do you think are the causes of water supply problems in your area?

Water supply capacity of Thulamela Municipality

1. What is the main water supply capacity at the Thulamela Municipality?

2. What type of water services does the Thulamela municipality provide to the communities at Bunzhe and Tshififi Villages?

3. Does the available water supply capacity meet the maximum daily demand requirements for a fully developed service area?

4. Is the water sufficient for domestic consumption?

5. Who is responsible for water services delivery in Thulamela Municipality?

6. How often does this municipality supply water to Bunzhe and Tshififi villages?

7. Briefly explain why the municipality has not been able to supply water to the studied area effectively?

8. How are these problems going to be addressed?

Section C. The efficiency of water supply infrastructure

1. Are community members satisfied with the water supply at the Thulamela Municipality?

2. How old is the water supply infrastructure?

3. Does the Thulamela Municipality has any maintenance schedule on water supply? If yes, how does it work?

4. What is the kind of planning on the part of the Thulamela Municipality authority which can bring the effectiveness of water supply?

Section D. The impact of water supply challenge

1. What are the main problems the municipality faced in different villages at the Thulamela Municipality in terms of water supply challenges?

2. How are the problems going to be addressed?

3. How does challenge of water supply infrastructure affect the availability of water, households and villages?

4. How water supply challenges affect the community?

5 Are there any disease outbreaks that have been reported related to water supply challenges?

6. What are the negative impacts of water supply challenge in the development of your area?

Section E: Possible strategies to alleviate water challenge

1. What role do the village authorities play in addressing these problems?

2. Is there anything that the municipality officials or councillors should do in order to alleviate the problem of poor water supply?

3. Are the key stakeholders such as the government, farmers and community doing enough to address water supply problems?

4. What recommendations do you think should be done to reduce water supply challenge?

5. Do you think there are ways of promoting water conservation in this area?

6. What is your view concerning your community and water supply challenge?

Appendix D: Ethical clearance

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Mr NE Nemalamangwa

Student No:
9503020

PROJECT TITLE: **Investigation of water supply challenges in Thulamela Municipality: A case study of Bunzhe and Tshififi villages.**

PROJECT NO: **SES/18/GGIS/19/0612**

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr TM Nelwamondo	University of Venda	Supervisor
Mr MJ Mokgoebo	University of Venda	Co - Supervisor
Mr NE Nemalamangwa	University of Venda	Investigator – Student

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: December 2018
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: .....
Name of the Chairperson of the Committee: Senior Prof. G.E. Ekosse

UNIVERSITY OF VENDA
DIRECTOR
RESEARCH AND INNOVATION
2018 -12- 07
Private Bag X5050
Thohoyandou 0950

University of Venda
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TELEPHONE (015) 962 8504/8313 FAX (015) 962 9060
"A quality driven financially sustainable, rural-based Comprehensive University"

Appendix E: Permission Letter from the municipality

VHEMBE DISTRICT MUNICIPALITY
PRIVATE BAG X5006, THOHOYANDOU, 0950
TEL: 015 960 2000, FAX: 015 962 1017
Website: www.vhembe.gov.za

Ref: 4/2/1
Enq: Ndou T.S
Date: 23 November 2018

ATTENTION: Nemalamangwa N.E

RE: APPLICATION TO CONDUCT ACADEMIC RESEARCH: YOURSELF

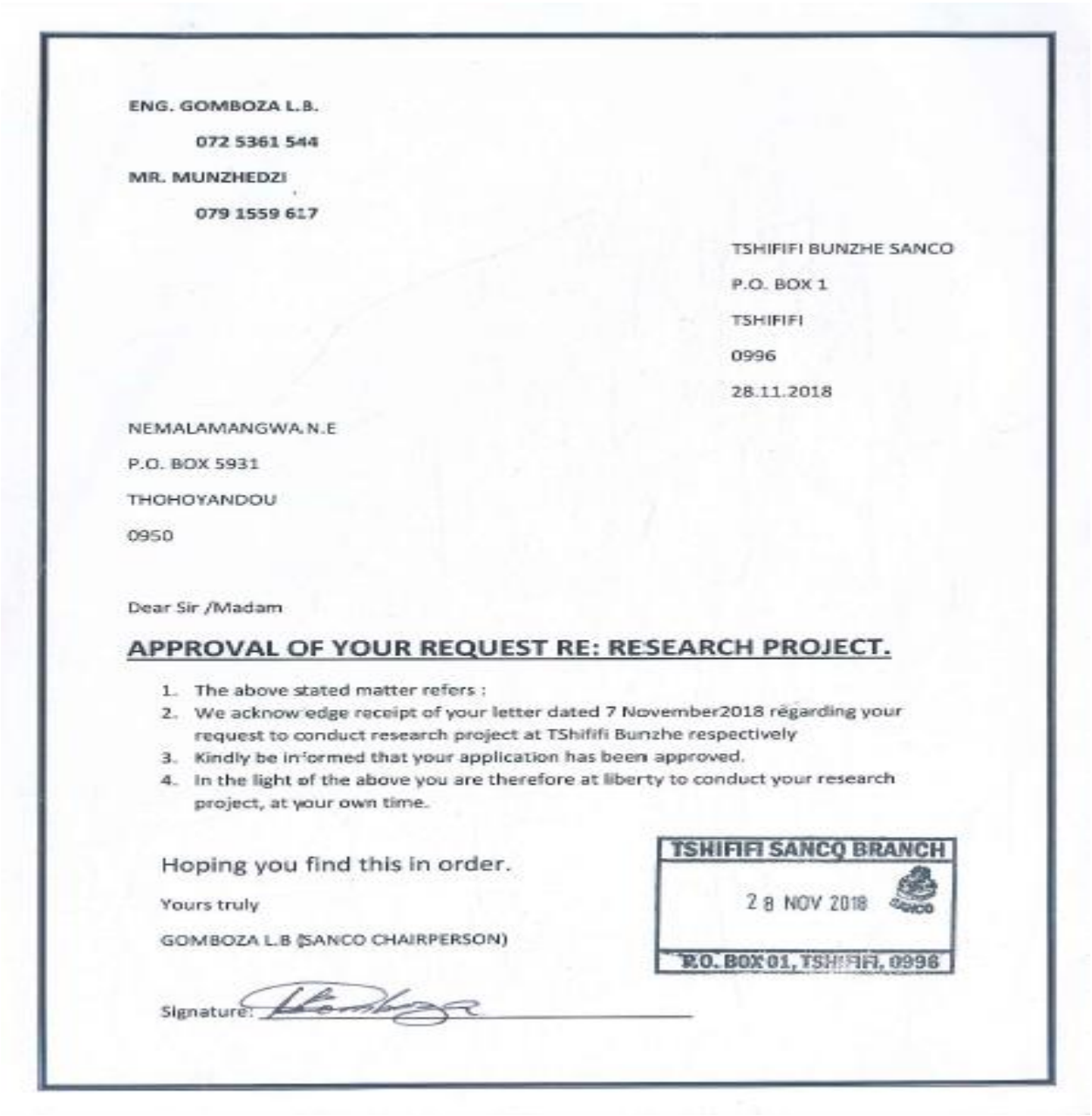
1. Your application dated 07 November 2018 refers
2. It is with pleasure to inform you that your request mentioned above is hereby granted to you.
3. Please contact General Manager Technical Services, Mr Nthutang Ofentse (074 914 4059 / 015 960 2117) in order to arrange the starting date.
4. Should there be anything you need clarity on, feel free to call our office at 015 960 3558/015 960 3541.

Kind Regards

ACTING MUNICIPAL MANAGER
NDOU T.S

23/11/2018
DATE

Appendix F: Permission Letter from Bunzhe and Tshififi



ENG. GOMBOZA L.B.

072 5361 544

MR. MUNZHEDZI

079 1559 617

TSHIFIFI BUNZHE SANCO

P.O. BOX 1

TSHIFIFI

0996

28.11.2018

NEMALAMANGWA N.E

P.O. BOX 5931

THOHOYANDOU

0950

Dear Sir /Madam

APPROVAL OF YOUR REQUEST RE: RESEARCH PROJECT.

1. The above stated matter refers :
2. We acknow edge receipt of your letter dated 7 November2018 regarding your request to conduct research project at TShififi Bunzhe respectively
3. Kindly be in'ormed that your application has been approved.
4. In the light of the above you are therefore at liberty to conduct your research project, at your own time.

Hoping you find this in order.

Yours truly

GOMBOZA L.B (SANCO CHAIRPERSON)

Signature:

TSHIFIFI SANCO BRANCH

2 8 NOV 2018

SANCO

P.O. BOX 01, TSHIFIFI, 0996

Appendix G: Letter to confirm language editing

24 February 2020

SCHOOL OF HUMAN AND SOCIAL SCIENCES
DEPARTMENT OF ENGLISH (ECS SECTION)

To whom it may concern

This serves to confirm I have been requested by Mr N.E. Nemalamangwa (Student Number 9503020) to proof-read his dissertation for Master of Environmental Science. He is a student attached to the Department of Geography and Geo-information Sciences in the School of Environmental Sciences.

The title of his dissertation is: **An investigation of water supply challenges in the Thulamela municipality: A case study of Bunzhe and Tshififi villages.** I have carefully read the dissertation focusing on proof-reading and editing, and then made appropriate suggestions indicated in track changes.

Yours Sincerely

Dr Mzamani Maluleke

Tel: 015 962 8291/ Cell: 0680707323

University of Venda

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