WATER SUPPLY CHALLENGES IN URBAN AND RURAL AREAS OF EASTERN CAPE

BY

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DECLARATION

I, Mpumelelo Dolo, hereby declare that this dissertation, except where indicated in the text, is the candidate's own work and has not been submitted in part, or in whole, at any other University or University of Technology.

This research on the Water Supply Challenges in Urban and Rural Areas of Eastern Cape was conducted in various cities of Eastern Cape, South Africa and registered at the Durban University of Technology under the supervision of Professor Dhiren Allopi.

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ABSTRACT

Water is regarded as the most important substance found on earth. There is no substitute for it. The daily running of production businesses, industrial firms and agricultural production that help sustain the economy of countries are largely dependent on the availability of water for them to function. The importance of water cannot be over emphasised. The food which is consumed daily depends on water; it can therefore be safely concluded that without water there would be no food, and without food there would be no life.

Despite the importance of water in relation to human life, animals and plants, research studies show that the its availability becoming increasingly deficient around the globe. Water levels of major dams and rivers around the world are dropping, limiting the supply of potable water to those dependent on them. Global warming is one factor that is influencing the dropping of water levels, through evaporation. Other factors include climate change, drought and population growth.

In South Africa, the government has been fighting a continuous battle of trying to address the backlog of water infrastructure, particularly in the areas which were disadvantaged by the apartheid government. These areas include rural areas, small towns (semi-urban) and townships. The Eastern Cape province in South Africa is top of the list from a backlog point of view.

Rural dwellers migrate to urban areas for various reasons such as better education, better health care, job opportunities and more efficient services. Water supply is one of the services which is more adequately supplied in the cities compared to the rural areas. Even though the supplied water in the urban areas of the Eastern Cape is not the best standard when compared to other cities around the country or the world, it is still at an acceptable standard. Thus, this study was conducted to seek ways of improving the supply of water in the urban and rural areas of the Eastern Cape. The availability and the quality of water differs between the urban and rural areas. The purpose of this study was to seek ways of bridging the gap between these areas while improving the standard of water supply in both rural and urban areas. While working towards improving the lives of the Eastern Cape people, the study also seeks to promote water preservation and awareness to the people of the province.

In order to find better alternatives which have been tested in various places around the world, an in-depth literature review was conducted in the study. This functioned as an effective

comparison of what is obtained in different places around the world and the context of this study, which is the Eastern Cape.

A survey method was used to gather data regarding the problems surrounding water supply and options that could be adopted to remedy those problems. The survey was conducted in the form of a self-observation assessment, questionnaire for households in urban and rural areas and interview sessions with prominent government entities and local technical service providers. The survey covered the whole spectrum of individuals and groups that play a major role in the supply and usage of water. The study was conducted within three municipalities of the Eastern Cape. These municipalities cover approximately two-third of the Eastern Cape considering the size of population in those areas. The municipalities covered by the study were: Amathole District Municipality (ADM), Buffalo City Metropolitan Municipality (BCMM) and OR Tambo District Municipality (ORTDM).

The findings from the study showed that indeed the standard of water supply between urban and rural areas was not equal. This relates to the purification methods, the convenience of collecting water by users, the quality of infrastructure being constructed (due to good or poor monitoring during construction) and the quality of the water as well as operation and maintenance response from the various service providers. Moreover, it was found that there was an acceptable level of awareness by citizens when it comes to using water, and precautions to save it were being taken by some. However, some dominant factors such as poor management, poor infrastructure resulting in leaks, climate change, run-offs and population growth were putting a strain on the existing water resources which is not coping with the increasing demand by people.

Recommendations made in the study to balance the supply of water in rural areas and urban areas include: improving the purification of water so as to achieve a standard quality within the Eastern Cape; that rural areas be allowed to have an option of having yard or house connections, particularly those who are willing to pay rates at a scale suiting their class or standard; and that water service providers make it their responsibility to extend reticulation networks if there is expansion or development of more houses in rural areas in order to keep the distance minimal to standpipes.

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LIST OF ACRONYMS

ADM	Amathole District Municipality
BCMM	Buffalo City Metropolitan Municipality
BWTW	Butterworth Water Treatment Works
CoGTA	Cooperate Governance and Traditional Affairs
CSIR	Council for Science and Industrial Research
DM	District Municipality
DWS	Department of Water and Sanitation
EC	Eastern Cape
IDP	Integrated Development Plan
MIG	Municipal Infrastructure Grant
NWA	National Water Act
ORTDM	OR Tambo District Municipality
UCT	University of Cape Town
UNESCO	United Nations Education Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
UNCCD	United Nations Convention to Combat Desertification
UNWWAP	United Nations World Water Assessment Programme
USGS	United States Geological Survey
RDP	Reconstruction and Developmental Programme
VIP	Ventilated Improved Pit
WHO	World Health Organization
WSA	Water Service Authority
WSP	Water Service Provider

LIST OF SYMBOLS

%	Percentage
m^3	Cubic meters
a	Annum
l	Litres
d	Day
n.d	No Date
kl	kilo liters (1000 liters)
Nr	Number

CHAPTER 1

INTRODUCTION

Water is regarded as the most important substance on earth. Plants, animals and human species depend on it for survival. Research show that, not everybody in the world has access to potable water for general daily use. The Eastern Cape province in South Africa is regarded as one of the areas that has challenges when it comes to water supply to its communities, be it there is no water infrastructure installed or insufficient water sources. Research shows that about 25% of the Eastern Cape population does not have access to clean drinking water (Naidoo, 2016). This is the highest percentage of people having no access to clean water in comparison to all other provinces in South Africa.

1.1 Background

The Eastern Cape is one of the largest provinces in South Africa. It is predominantly made up of rural areas and semi-urban areas (small towns). The fact that it is dominated by rural areas makes it one of the poorest and most under-developed provinces. The general infrastructure services i.e. roads, water, sanitation and electricity in these rural areas are in a poor state and in some rural areas these services do not exist at all. One of the reasons for this problem is historical; the apartheid government gave preference to the urban areas when it comes to development. Forming part of these urban areas is the townships. The history of these townships is that they started after the urban areas were built and established. These townships were developed for the convenience of workers/labourers. These labourers moved from the rural areas to townships in order to cut costs for transport and be closer to factories and businesses which were in the urban areas.

The researcher himself grew up in a rural area and moved to an urban area for work purposes. It was revealing to see the differences pertaining to water supply between these two areas of study within the Eastern Cape. These differences became the driving force to pursue the study towards the improvement of water supply in both urban and rural areas. The Amathole District Municipality (ADM), Buffalo City Metropolitan Municipality (BCMM) and OR Tambo District Municipality (ORTDM) were chosen as the areas that best represent suburban and rural areas in the Eastern Cape.

Since the end of the apartheid era the government has been in a battle to address the water backlog in the rural areas of the Eastern Cape. However, the process has been extremely slow due to never ending problems that also require government's attention, such as the deterioration of existing infrastructure. The insufficiency of water generally in the whole world has become a well-known problem particularly for those departments dealing with the supply of water to communities, factories and production industries. However, awareness by ordinary citizens, who use water daily, is limited, a fact that does not do water providers and water resources any favours. This lack of awareness results in the misuse of water even during periods where water is limited i.e. in times of drought.

While the government is providing resources in order to address the issue surrounding water supply in the rural areas, there are constant issues that are becoming a problem in the urban areas, such as water quality (in terms of turbidity, chemical and biological parameters) and failure of infrastructure. The standard of water in the rural areas compared to that of urban areas is far below par in relation to convenience. People in the rural areas still need to walk long distances to fetch water, while in the urban areas water is available inside people's homes.

1.1.1 General water situation

In the same way that there has been an electricity crisis in South Africa in recent years, water is a crisis too, and not just for the Eastern Cape, but is a challenge for all provinces in South Africa, and more broadly is a crisis in the world in general.

1.2 Problem statement

The gap in standard of water supply between rural areas and urban areas is very high. This is easily identified when it comes to convenience with which water is supplied to these two areas. The human settlement planning and design standards provided by the Council for Science and Industrial Research (CSIR) (Council for Science and Industrial Research [CSIR] 2005) for water supply in rural areas stipulates that one tap should serve 25 to 50 households (approximately 300 people) with an anticipated distance of not more that 200m from the furthest household to the tap. In the case of urban areas, there are house connections, however households are required to pay for their water connection.

These differences show further in the quality of water (in terms of turbidity, chemical and biological parameters). The method of treating raw water in urban areas is more thorough

compared to the much simpler method of cleaning water practiced in the rural areas. This is evident when one considers the illnesses caused by water pollution. Many villages in rural areas of the Eastern Cape have no access to clean water at all and end up sharing water with animals from rivers, weirs and dams (see Appendix 12, Figure 18).

Over and above the mentioned problems, it is difficult to make any improvements to the obvious water issues highlighted due to poor management of water infrastructure by water service providers. This is associated with many factors such as:

i. Incompetent staff
ii. Political interference
iii. Technical skills shortage
iv. Increased population
v. Variability of weather patterns

The state of management in the water sector has been heavily criticized during the dry season in the Eastern Cape. The Eastern Cape was struck by drought in 2015. Although there had been decent rain, it had not been enough to make a significant difference to the water levels in rivers and dams by mid-year of 2018. This drought seemingly caught everyone by surprise, especially those who were responsible for supplying water to communities and industries. The ADM and parts of ORTDM were declared disaster areas when some of the ADM supply dam levels fell below 10% (South Africa, 2016). This reveals that there is a problem of awareness of people regarding water crises and strategies to save water in both urban and rural areas.

1.2.1 Rural area water requirement

The manner in which the water is being supplied in the rural areas is far below the standard of that found in urban areas. This is related to the poverty of people in rural areas, where a single standpipe serves a group of people within a long walking distance. The poverty of rural dwellers prompted the government to supply water for free so there are no water tariffs applied in rural areas.

However, the rural poverty situation has been improving slowly, following the easy access and equal education for all South African provided by the democratic government post-1994. The percentage of employed people in rural areas has increased. Due to that, many people in rural areas started doing water illegal connections to their residences as their lifestyle began to change. These illegal connections are done by unskilled people, resulting in massive water

leaks.

As much as there is improvement in water supply compared to two decades ago, and a decent number of rural areas have been networked with potable water, there is still a massive number of people who rely on raw water from rivers, springs or boreholes (Naidoo, 2016). Water accessibility is of great concern in the Eastern Cape, with a very high percentage of people having no access to water compared to all other provinces in the country (Naidoo, 2016).

1.2.2 Urban area water requirement

The water situation in most urban areas of South Africa is generally at an acceptable level in comparison to that of rural areas or even other cities in other countries around the world. Under the apartheid government urban areas were given preferential treatment when it comes to development of any kind. This was the case in the urban areas of the Eastern Cape as well, where generally urban areas have water infrastructure that was constructed decades ago by the old apartheid government.

However, there are current issues too surrounding the supply of water in urban areas. The taps in urban areas are running dry for various reasons. The infrastructure in place is no longer able to cope with exponential population growth and the increase in industrial demand because of increased economic development. Also, the quality of water being supplied is not consistent. The failure rate of the infrastructure versus the person power and adequate skills available is an issue in urban areas, resulting in loss of water through unattended leaks.

Townships are typically classified as middle-class, as many residents cannot afford the lifestyle in urban areas, although their standard of living is higher than people in rural areas. They are provided with water at a reduced rate to accommodate their income. This group of people are normally closer to the urban areas (cities). For this reason, they are catered for by the water supply sources in the urban areas.

These townships grow large rapidly and put massive strain on the water supplies of urban areas, which are normally not planned and designed to take on huge additional numbers of people. It has been a mistake by many town planners, engineers and relevant officials to establish these townships without taking into consideration the provision of major services such as water and sanitation. This situation is the same in some parts of the Eastern Cape, where some townships were developed without identifying potential sources of water for them.

1.2.3 General demand of water

Water demand for a particular area differs from other areas, depending largely on population size, lifestyle of the area (i.e. the standard/class of living). For this reason the anticipated daily consumption of water is different, as illustrated in Table 1.

Table 1: Water demands

Average per capita water requirements for different categories of settlements	
Category of Settlement	**l/d per capita**
Medium-sized town	150 - 200
Small town (include water needs for animals and small gardens)	200 - 250
Coastal towns (permanent residents)	200 - 250
Coastal towns (Seasonal visitors)	80 - 130
Rural villages	60 - 100
Farm villages (including water for animals and small gardens)	100 - 150

Source: Hay *et al*. 2012

Table 1 illustrate variances in water demands for different areas, in different regions. The consumption of water by these regions mainly depends upon factors such as the climatic conditions, level of service, socio-economic conditions, wet industries, institutional capacities and consumer behaviour (Hay *et al*. 2012). From the table it is evident that rural areas (rural villages) are similar to medium-sized towns in relation to the consumption of water per capita per day, and medium-sized towns are fairly similar to coastal towns (permanent residents) that utilise the most water. The townships are part and parcel of these medium size towns and coastal towns in the Eastern Cape.

1.2.4 Water losses

It is estimated that South Africa is losing about 36.8% of water through poor infrastructure management, which is associated with shortage of skilled water professionals, and incompetent people occupying managerial positions (Watson and Moloi, 2015). Local schemes which mainly focus on supplying water to rural areas operate without designated operations and maintenance plans and drought response plans in place (Hay *et al.* 2012). This is still the general situation even today, as was reported by Minister of Water and Sanitation, Nomvula Mokonyane during her answering of questions in the Western Cape Water Security Indaba (Deklerk, 2017).

According to Dr Cilliers, head of African Future and Innovation at the Institute for Security Studies, the drought that hit South Africa in 2015 was the worst in 23 years, while at the same

time the demand for water has been growing dramatically (Chernick, 2016). Meanwhile, the more water is being networked to the people in need of it, the more it is getting wasted due to poor maintenance, management of existing infrastructure and irresponsible water usage.

Table 2: Calculated water losses in the Eastern Cape

Town	Population	Water consumption	Unaccounted for water	
		Million m^3/a	Million m^3/a	%
Adelaide	12191	0.73	0.43	60
Bedford	8769	0.53	0.12	22
Alice, Middledrift	52000	3.67	1.15	57
Sutterheim	24672	1.29	0.56	44
Mthatha and surrounds	137589	22.10	~12	55

Source: Hay *et al*. 2012

Table 2 shows data obtained from a 2011 statistic for random towns within the Eastern Cape. It illustrates in percentage terms the water loss calculated in a few towns of the Eastern Cape. According to the table, the water management situation is dire, with several towns indicating that over 50% of water abstracted does not reach the end-user. This is a reflection of the poor infrastructure in the province.

1.3 Research question

The main question that the study attempted to answer was: how can the water supply in urban and rural areas of the Eastern Cape be improved?

For the study to fulfil its main objective, it sought to answer the following sub-questions:

i. Who is responsible for water conservation?
ii. What are the rightful measures to be practised that will contribute to water conservation?
iii. What measures are to be practised to avoid water crises?
iv. What can be done to improve the ailing water situation of the Eastern Cape?

1.4 Project aim

The aim of this study was to improve the situation of water in the Eastern Cape through addressing the problems that are making the supply unacceptable and/or impossible.

1.5 Research objectives and outcomes

The general objectives of this study were to identify problems contributing to the poor supply of water in the urban and rural areas of the Eastern Cape. In doing so, the study hoped to contribute to efforts to improve the supply of water to the people of Eastern Cape as a whole. The following is the summary of objectives related to the aim of the study:

i. Promote water conservation and ways of conserving it.
ii. Promote effective maintenance strategy of water infrastructure.
iii. Identify ways of supplying clean drinkable water of acceptable quality in both urban and rural areas.
iv. Educate people about water in general / promote awareness about water.
v. Identify a variety of ways of sourcing water and looking after water sources.
vi. Bring about interventions to address water shortages, particularly during drought periods.

1.6 Research justification

Generally, water supply is an issue worldwide, with many people around the world not having access to potable water. Countries like Afghanistan, Ethiopia, Chad, Cambodia, Laos, Haiti and many underdeveloped countries are unable to supply potable water to half their population (Lindastcyr, 2012). Natural disasters and wars are among the reasons why these countries have such water supply complications, which ultimately contributes to bad economic transformation in those countries.

The Eastern Cape is not different to these aforementioned places. It is mainly made up of rural areas, small towns with a few big cities. These small towns barely occupy the status of a city and are commonly surrounded by townships. The fact that the province is dominated by rural areas makes it one of the poor and under-developed provinces in South Africa.

Detailed justifications for the areas to be covered by the study are presented below.

1.6.1 Rural areas

The Eastern Cape lags behind other provinces of South Africa in terms of rural development. The standard of service supplied in the rural areas is generally low in relation to infrastructure quality achievement. The design and construction of water infrastructure in the rural areas is unsatisfactory. Incompetency and nepotistic (so called “connections”) appointments are the

major factors that contribute to the failure to achieve a satisfactory quality of work.

Figure 1 is a photo of reservoirs in Mjanyana village in the town of Idutywa. These reservoirs are over two decades old, and during the days of their functionality people would walk from the surrounding area to fetch water from the taps that were around these reservoirs. A wind turbine was used to pump water from underground to these reservoirs.

Figure 1: Typical Reservoir built within the houses in Idutywa, Eastern Cape

Today's situation is similar in that taps are established around the village in such a way that people do not have to walk more than 200m to a tap. That brings to the fore the issue of inconvenience for rural dwellers who are forced to walk long distances in order to access clean water, which becomes even more difficult for old or disabled people.

Boreholes are commonly used as the main source of water supply for these rural areas. Borehole water depends on surface water infiltrating the ground into the groundwater. However, the quality of this borehole water is not consistently monitored, considering that chemicals can easily end up in the groundwater.

Apart from quality issues around this underground water, there is also an issue of unreliability as it cannot be reliably determined how long it will last before it is depleted. When this happens, rural dwellers are forced to once again use un-purified water from nearby small dams and rivers. The inconvenience of walking long distances to fetch water from rivers is still happening

even today. The human settlement planning and design standards provided by the CSIR (2005) stipulates that in rural areas there should be one tap per 25 to 50 households (approximately 300 people) with an anticipated distance of not more that 200m from the furthest household to the tap. This distance becomes impractical where the rural dweller starts developing and moving away from the tap.

Even so, many people in some rural areas are still without access to potable water. This is associated with, but not limited to, the following reasons:

i. Poor infrastructure in rural areas
ii. Incompetent contractors constructing water services in the rural areas
iii. Not enough water sources in these areas

1.6.2 Urban areas

The inconvenience of fetching water is not an issue in urban areas as they have in-house connections, unlike rural areas. Due to this convenience, and the better quality of water, people tend to flock to the urban areas to benefit from such privileges. This becomes a problem for the water infrastructure because it carries too much strain and ends up collapsing.

The deterioration of the old infrastructure combined with poor maintenance contributes significantly to water loss. Even though the quality of water in South Africa is generally found to be acceptable according to the World Health Organization (WHO) standards, there is some level of inconsistency among various places within South Africa, which is also the case in the Eastern Cape's urban areas.

Due to the collapse and deterioration of infrastructure within urban areas, there is a delay in supplying water to those other areas that do not have water at all, particularly the rural areas. This is largely caused by the never-ending maintenance of the aging water infrastructure, where large amounts of money are spent on maintenance, money which could arguably have been used to put up new infrastructure. Even with such regular maintenance there are persistent water challenges that result in water supply difficulties associated with the limited skills of the maintenance teams

1.6.3 Townships

Similar to urban areas, townships are having a high rate of development. In the Eastern Cape, development of townships has been seemingly unplanned. Government officials and politicians

respond to the protests of informal settlement dwellers who demand housing, and they start developing Reconstruction and Development Programme (RDP) houses without due consideration for the other services that are required once the houses are completed.

Due to such circumstances, governmental officials become compelled to squeeze infrastructure services for these townships from the services of nearby urban areas, as they are normally in close proximity to urban areas or cities. This results in the following challenges:

i. Inadequate/insufficient supply of such services e.g. water and electricity
ii. Frequent infrastructure failure
iii. Continuous maintenance which ultimately leads to the exhaustion of finances
iv. Massive strain on water sources

1.6.4 Overall review

In summary, the main problems in rural and urban areas with regards to the supply of potable water are different, but at a certain point, they have an effect on one another. The fact that both urban and rural areas depend on the same governmental entities to supply them with water results in imbalance of the water supply, considering the fact that one area is of higher standard than the other, and the economic focus is more on urban rather than rural areas. However, once people in the rural areas perceive the favoritism, they become impatient and begin to protest and show their frustration. The bias in provision of services between rural and urban areas means the urban areas receive services of better quality which creates the economic instability and big gaps in terms of access to services within same province and country.

In the post-apartheid era, there has been a great improvement in water supply, with very few water-borne diseases being reported compared to two decades ago. This demonstrates that the quality of water has improved greatly over the years. Fewer people lack access to potable water these days, but the process of attending to those with no access to clean water has been extremely slow, particularly in the rural areas. The shadow of non-ending infrastructure troubles in areas that already have water makes it nearly impossible for the officials to make the time and financial means available to attend to those with no water at all.

1.7 Scope and limitation of study

The study was conducted in the Eastern Cape province of South Africa. In conducting the study, the researcher engaged with different dwellers residing in rural areas, urban areas and

townships of the province. On completion of the questionnaire data collection, interviews were conducted with various officials from governmental entities and private companies.

The study focused solely on water related issues in and around the rural and urban areas of the Eastern Cape. Most of the information was obtained through questionnaires and interviews conducted within these communities and related officials, but information was also gathered through observation while visiting these areas.

1.8 Assumptions

The information provided by those who participated in the survey was assumed to be trustworthy, as the individuals who were approached by the researcher were old enough to know about the water related information of their respective areas.

The interview questions were drafted with the intention of eliciting response(s) from the relevant water related officials i.e. municipal water infrastructure officials, local civil engineers, technicians and technologists. These were presumably the individuals who are part and parcel of planning, constructing and looking after the complete water infrastructure.

1.9 Hypothesis

Even though the study was conducted in specific areas of the Eastern Cape, the scenarios encountered in these areas could be used as guidance for other areas of the Eastern Cape, or even outside the Eastern Cape.

The information gathered was also obtained from a limited group of people, however the facts gathered from them, together with literature review provided were substantial and adequate to provide the required details.

1.10 Research methodology

According to Rajasekar, Philominathan and Chinnathambi (2013), research methodology is a systematic way to solve a problem. The authors further explain that the aim of a research methodology is to set out a plan of research so that the appropriate knowledge can be gained. The advanced Learner's Dictionary of Current English states that research is "a careful investigation or inquiry specifically through search for new facts in any branch of knowledge." (Oxford Advanced Learner's Dictionary of Current English, 2015).

In completing the study, a mixed method was adopted, whereby qualitative as well as quantitative research methods were used. This method is defined by some researchers as a triangulation method, where two or more methods are combined in a study of the same phenomenon (Jick, 1979). By adopting this method, the target was to enhance the validity and reliability of information gathered.

1.10.1 Qualitative and quantitative research method

Quantitative research is based on the measurement of quantity or amount. Kothari (2004) identifies quantitative research as being applicable to phenomena that can be expressed in terms of quantity. Qualitative research, on the other hand, is concerned with qualitative phenomenon, i.e. phenomenon relating to or involving quality or kind (Kothari, 2004). According to Jones (2004), qualitative research methods focus on discovering and understanding the experiences, perspectives, and thoughts of participants, whereas quantitative research method attempt to maximise objectivity, replicability of findings and are typically interested in prediction.

Different researchers use different methods when researching about a certain phenomenon in order to improve the accuracy of their judgement. Similarly, in this study, the mixed method was adopted in order to bring about conclusive and convincing outcomes on the water situation of the Eastern Cape.

According to Creswell (2008), the main advantage of using a mixed research methodology is that the combination of qualitative and quantitative approaches can provide a better understanding of the research problem or issues compared to either research method alone – the strengths of one covers the weaknesses of the other and vice versa. Combining both methods broadens the avenues one looks at while researching.

Table 3: Qualitative vs quantitative ways of collecting data

Qualitative data	Quantitative data
Instruments	Interviews
Checklists	Observations
Records	Documents
	Audio-visual materials

Table 3 illustrates the tools that are relevant to the respective methods of collecting data during research, all of which were used in conducting this study.

This study on "Water supply challenges in the urban and rural areas of Eastern Cape" used both strategies, qualitative and quantitative. Through quantitative approach, the researcher was able to measure the severity of the situation, through counting the number of people or number of villages dependent on a particular size of reservoir that supplies them with water and villages with no access to water at all. On the other hand, the qualitative approach to the study focused on the general behaviour of people towards water and quality of water and water infrastructure. Further to that, it reveals ideas and how other people think in relation to water services.

As indicated in Table 2 above, 50% of water supplied to people does not reach end users in the Eastern Cape. More broadly in South Africa, it is estimated that 37% of water is lost through physical leakage (McKenzie, Siqalaba and Wegelin, 2013). Hence the application of a qualitative research approach in the study was important, in order to stimulate, positively, the behavior of people at large, and more specifically their behaviors in relation to the handling of water.

1.11 Observations, opinions and past experience

i. **Observation:** various conclusions were made from physical observation of the areas visited. These observations did not include anyone's opinion or input but were solely the author's impression of the area in relation to water infrastructure and water supply.
ii. **Opinion:** opinions were drawn out of the responses from the questionnaires and interviews created for the study. This was part of qualitative research approach, where people also put forward their opinions and feelings about the situation of water in their respective areas.
iii. **Past experience:** some information reported in this dissertation was derived from the past experience of the researcher who has worked in the water construction industry. This experience was advantageous because it made it much easier to relate to and understand the situation that the researcher came across while visiting different water sites.

1.12 Conclusion and knowledge contribution of the study

According to Kothari (2004), a research study is a scientific and systematic search for pertinent information on a specific topic. The author further elaborates that research involves defining and redefining problems, formulating hypotheses or suggested solutions; collecting, organising and evaluating data; making deductions and reaching conclusion; and, carefully testing the

conclusion to determine whether they fit the formulating hypothesis. In summary, research is a search for knowledge through objective and systematic methods in order to find solutions to a problem in a chosen area. Engaging in a research is not only a way of finding a solution to a particular problem but it is also a tool for building knowledge and efficient learning (Zarah, 2017).

1.13 Terminology

The main words or terms which have been used in the study are explained here with the purpose of elucidating the research's specific objectives and the dissertation as a whole.

Aquifer: A layer or section of earth or rock that contains groundwater.
Bias: A tendency to yield one outcome more frequently than others, often as a result of having or showing unfair tendency to select people or location over others.
Groundwater (underground water): Any water naturally stored underground in an aquifer, or that flows through and saturates soil and rock, supplying springs, boreholes and wells.
Randomisation: A method of chance alone, by which the study participants or study area are selected for the purpose of the study.
Research: To study (something) systematically, gathering information and increasing knowledge and discovering new facts, reporting detailed and accurate information.
Runoff: Water originating as rain or snow that runs off the land into streams, eventually reaching oceans, inland seas or aquifers unless it evaporates first.
Sampling: A process through which study participants or locations are recruited to take part in a study.
Standpipes: A communal tap placed at a distance of not more than 200m from the furthest beneficiary.
VIP toilets: Ventilated Improved Pit toilets are rural toilets which incorporate enhanced sanitation and health aspects of pit toilets.
Water Boards: Government authorities who act as intermediaries to distribute raw and potable water across vast distances to multiple users (the regional water supply schemes). They are primarily responsible for provision of bulk water, but some also provide reticulation, e.g. Rand Water, Amatola Water and many more.
Water Cycle: The cycle by which water evaporates from oceans, rivers, dams and any other bodies of water, accumulates as water vapour in clouds, and returns to oceans, river, dams and other bodies of water as rain and snow, or as runoff from this precipitation or as groundwater.

Water Consumption (Water Use): is the total amount of water withdrawn from its source to be used, be it for drinking, irrigation or any activity that utilises water.

Water Scarcity: A term used by water engineers to refer the situation in a particular area in which the annual availability of internal renewable fresh water is 1000 cubic meters or less per person.

Water Resources: Water resource refers to any point where water can be attracted for the purpose of supplying water to the people e.g. dams, rivers, weirs, boreholes, springs and rain water storage tanks.

Water Service Authorities: Government authorities that are responsible for the provision of water services, draft water service development plans and who ensure that water related acts are being applied accordingly.

Water Service Providers: This refers to persons/entities with permission to operate as a water service provider. They are responsible to oversee the supply of water to water end users, read water meters, and operate and maintain water infrastructure network.

Water Stress: Condition in which the annual availability of internal renewable fresh water is less than 1667 and greater than 1000 cubic meters per person in the population.

1.14 Overview of chapters

The following is a brief overview of the structure of this study:

Chapter 2 – Literature review

This chapter takes a look at the water challenges on a greater scale. As mentioned before, this study is limited to the Eastern Cape, but in this chapter, the challenges of water are examined on greater scale, and thereafter scaled down, until they focus back to the area of study. The literature review researches the reasons behind the water supply challenges in various areas. Furthermore, it compares the urban and rural areas with regards to the challenges of water supply.

Chapter 3 – The imbalance of water supply in the Eastern Cape

This chapter discusses the differences in water supply of urban and rural areas. It identifies the most important aspects one area has which can be adopted by another area for the purpose of improving the supply of water. In discussing these differences between the two areas, recommendations and mitigation suggestion are put forward so as to provide alternatives that

can contribute positively to both areas.

Chapter 4 – Data collection and research methodologies

Chapter 4 looks at methodologies applied when conducting a survey. It further elaborates on the data collection methods, and the background of the areas visited. A questionnaire and interview schedule were the tools used by the researcher to collect data from the participants.

Chapter 5 – Results: discussions of interview and questionnaire responses

In this chapter, responses obtained from participants, who were local water users, governmental individuals, engineers, technicians and technologists were broken down and analysed accordingly. The responses were the views and opinions of the participants regarding the water supply of their respective area, which either they reside in or they work in. The main focus of the questionnaire and interview was to gauge the situation of water supply in the Eastern Cape. In doing so, it was also comparing the urban and rural areas on their water supply, so as to create an economic balance and close the gap on the standard of water supplied to these areas.

Furthermore, the questionnaire and interviews sought to encourage improved management of water, through specifically asking about the operation and maintenance of the water infrastructure, quality of water supplied and lastly the behaviour with regards to responsible ways of using water.

Chapter 6 – Research findings, analysis and interpretation

Chapter 6 presents an analysis of responses acquired from the questionnaires and interviews conducted within the Eastern Cape. The main objective of this chapter was to identify and discuss the interventions that were working in various areas visited while conducting the research and offer these as possible solutions to be practised by other areas to resolve similar problems. Another important aspect of this chapter is that not only it identifies the bad and good practises of various areas, departments or individuals, but it also educates regarding what can be done to mitigate or avoid similar circumstances in other areas.

Chapter 7 – Major key players to rescue the water situation

Taking into consideration the deteriorating situation of water, this chapter provides the key individuals, departments and sectors that have the potential of mitigating the situation. It describes the involvement of these individuals, departments and sectors within the cycle of

water supply and what precise action they can take to mitigate the situation.

Chapter 8 – Conclusions and recommendations

This chapter presents the summary of findings, conclusions and recommendations arising from the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

According to Kim (2015) a literature review not only surveys the research that has been conducted in the past, but it also appraises, encapsulates, compares, contrasts and correlates various scholarly books, research articles, and other relevant sources that are directly related to the current research. Lie (n.d) further elaborates about the literature review as being the basis of a study which provides background particularly in a research paper or a thesis.

2.1.1 An approach to the literature review

The importance of water is discussed in this chapter, noting that countries with bad and good economies perform according to either the advantage of having enough water or the disadvantage of having insufficient water. It looks at interventions these countries have put in place to remedy the challenges surrounding their water supply. The importance of water on earth can never be emphasised enough, and the literature review reflects on its contribution towards the economic development of various countries.

This chapter examines the work of other researchers with regards to water in general and its supply to end users such as communities, industrial sectors, production firms or agricultural sectors. The issues surrounding the effective treatment of water ultimately contributes to the quality of water supplied from a water treatment works to end users. In that regard, this chapter briefly discusses the treatment in relation to the quality of water supplied to the dwellers of both urban and rural areas in the Eastern Cape.

In writing up the literature review, an approach of comparison between urban and rural areas was adopted to compare their differences in water supply, water quality, and water operations and maintenance. The main purpose of the exercise was to identify the most suitable aspects that were being applied which could be adopted as standards within the Eastern Cape in order to bring about balance to the supply of water in the province.

The fact that some areas within the Eastern Cape, or even outside the province, manage to survive different seasons of the year without the disaster of water shortages, implies that they have been on the right track, taking into consideration the rainfall they get. Hence this chapter

reflects on the positive points of those areas, in order to develop advice to the problematic regions within the study area. This chapter also discusses the operation and maintenance of the water infrastructure and ways these could be improved. It further investigates in detail the operation of various components of the water sector and official bodies which are responsible for the supply of water to the different areas. Finally, the chapter discusses the reasons for the challenges of water supply.

2.2 The global water situation

Water flows through the three pillars of sustainable development, namely, economic, social and environmental (United Nations Education Scientific and Cultural Organization [UNESCO], 2015). The fact is that achieving poverty reduction, inclusive growth, public health, food security and dignified life is crucially associated with availability of potable water for all. Hence water is not just any substance but is characterised as an essential need for the survival of humans, plants and animals (Horspool, 2016). It is essential for life, but it is a finite and vulnerable resource which has quantitative and qualitative limitations (Lalzad, 2007)

Water is the source of life and development on earth. Life is tied to water, air and food, while food is tied to water (Lalzad, 2007). The demand versus supply, when it comes to water, is the most problematic issue which seems to be the reason for non-supply of clean water to some people. This is a situation where the number of people available are more than the available water.

According to World Water Council (2000b), the worst water crisis today is not just the availability of water for the billions of people around the world, but the management of the water that is available, which ultimately makes it difficult to provide water for those who have not yet been provided with clean water. Bigas, Morris, Sandford and Adeel (2012) state that the number of people in the world without reliable supplies of water are in the region of 1 billion. The poor management of water and lack of continuous maintenance of old infrastructure is the main reason why the water supply is not reaching the billion people who have never had an opportunity to taste clean water (Dolo and Allopi, 2017a).

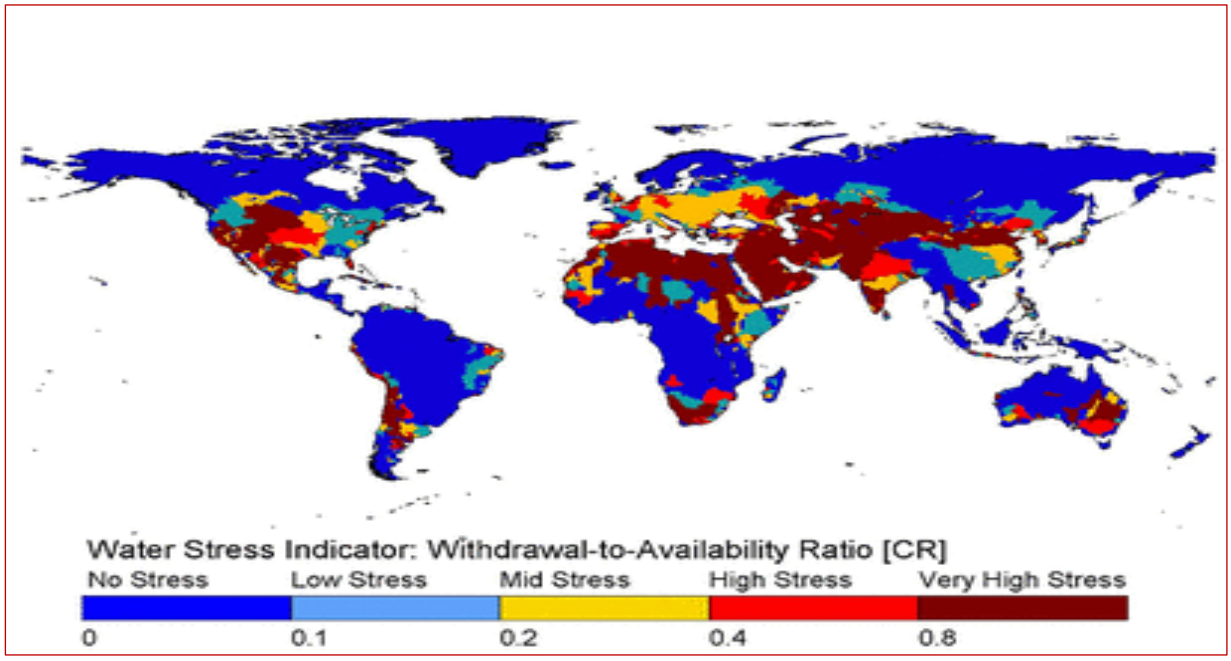

Figure 2: General indication of water stress analysis based on critical ratio
Source: (Rijsberman, 2004)

Figure 2 shows water stress around the world. According to Rijsberman (2004), it is very difficult to determine whether water is truly scarce in the physical sense at a global scale or is available but should be used better. Rijsberman (2004) argues that an estimated 4 billion people (more than half of the world's population), will be living in countries facing high water stress (criticality ratio greater than 40%) by 2025.

Similar to Rijsberman's findings, Lalzad (2007) estimates that approximately 48 countries will face water stress by the year 2025. According to Lalzad's (2007) findings, 40 of these countries are in the Middle East and North Africa, which correlates with Figure 2 which reflects Rijsberman's findings. Sub-Saharan African countries and Asia also under threat as the most vulnerable places when it comes to water supply (Global Research, 2014). According to Global Research (2014), the depletion of natural water resources is becoming increasingly high, raising the risk of water unavailability, which ultimately leads to poverty as water is directly linked to production and the economy of a country.

Water underpins health, nutrition, equity, gender equality, well-being and economic progress, especially in developing countries (Bigas *et al.* 2012). According to Bigas *et al.* (2012), water security is not the only problem the world is facing, but equitable water supply and water quality problems are also a major threat to developing countries around the world. Water of

bad quality is of no use, and extremely risky to human health and livestock.

Bigas *et al.* (2012) point to the widespread occurrence of surface and groundwater contamination that makes valuable water supplies unfit for basic use. These contaminations ultimately require high levels of purification and exhaustive monitoring of water contaminants. Contaminated water and poor sanitation are linked to transmission of diseases such as cholera, diarrhoea, hepatitis A, typhoid, and polio.

2.2.1 The available water on planet earth

According to Williams (2014), approximately 71% of earth is covered with water. The International Strategy for Disaster Reduction (2007) corroborates Williams's findings, and further identifies that this 71% of water is salty and unusable. The remaining 29% consists of contaminants and islands.

The United Nations Convention to Combat Desertification (UNCCD) (2013) points out that only 2.5% of water is regarded as freshwater which is accessible for human use, and the remaining 97.5% is unusable and ocean water. A graphical illustration of the water distribution of water on earth is shown in Figure 3.

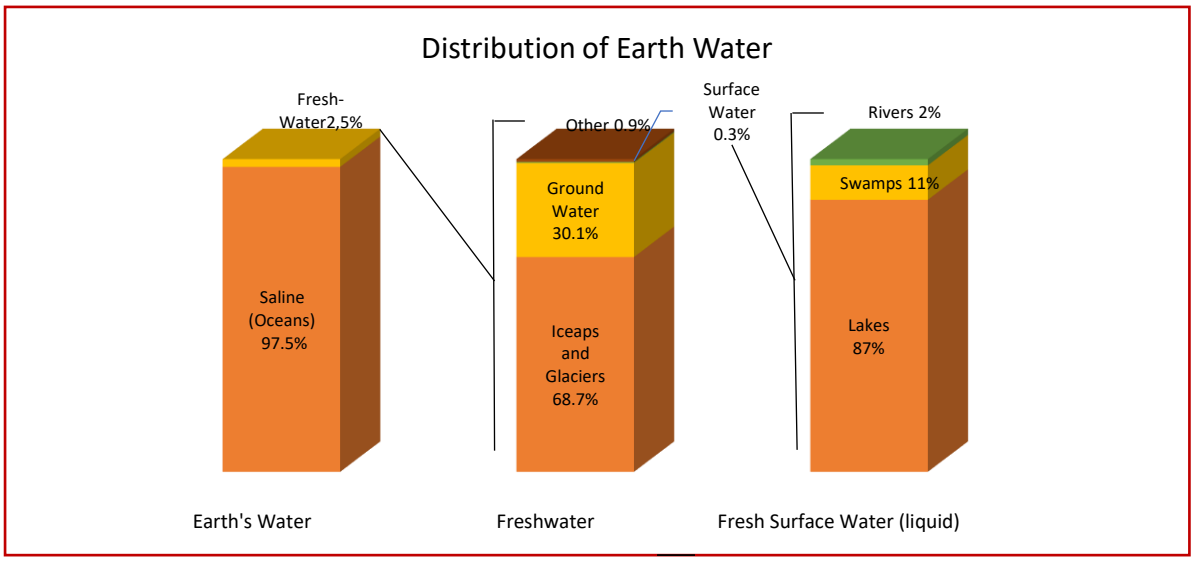

Figure 3: Earths' water distribution graphical illustration
Source: United States Geological Survey (2016) and United Nations Convention to Combat Desertification (2013)

Figure 3 shows that of the 71% of water that is available on earth, 97.5% is ocean water and only 2.5% is fresh-water (UNCCD, 2013). Of the 2.5% of freshwater, 68.7% is found in an ice-form, 30.1% is groundwater, 0.3% is surface water and 0.9% is other forms of water (e.g. vapour) (United States Geological Survey [USGS], 2016). The United States Geological

Survey (USGS) (2016) indicates that of the 0.3% freshwater available in a liquid state, 87% is found in lakes, 11% in swamps and about 2% of in running rivers. This analysis provides a picture of how little water is available for consumption, hence, everyone is encouraged to manage and use it sparingly.

According to the UNCCD (2013), the 2.5% of freshwater is not all usable, with only about 1% being usable in the ecosystem and for human activity. Figure 4 illustrates that 99% of water covering the whole planet earth is unusable (USGS, 2016). This unusable water includes oceans, seas, ice, saline water and atmospheric water as depicted in Figure 3 above.

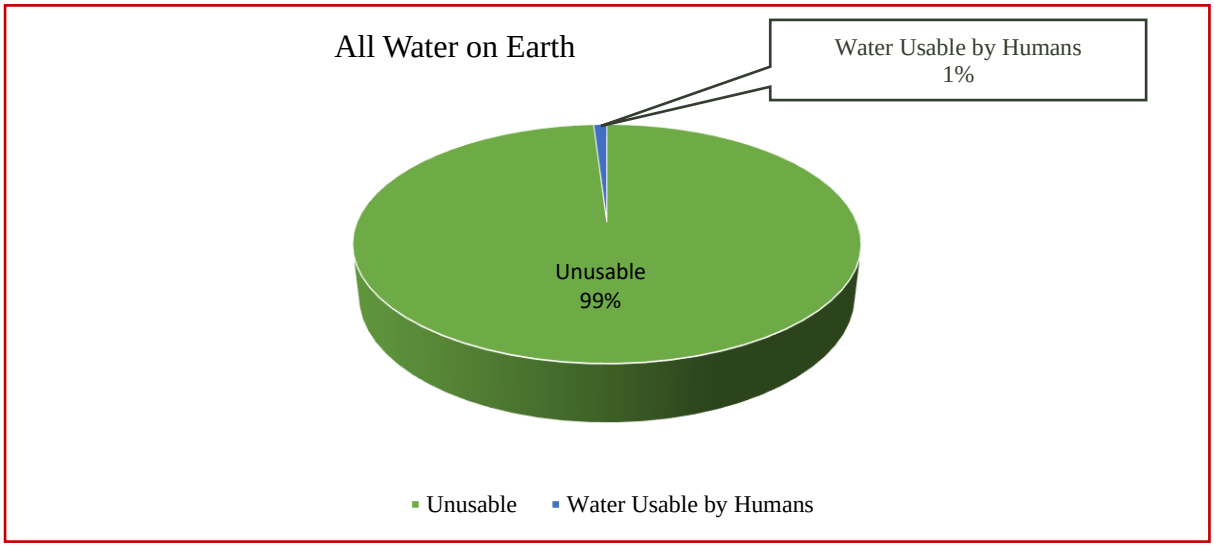

Figure 4: Overall earth water summary
Source: USGS (2016)

As illustrated in Figure 3, there is not a large volume of surface water, and this has to serve all activities such as irrigation, power generation, plants, animals etc. Water from lakes and swamps has a potential to seep through the ground surface and form part of underground water. The underground water is also pumped out through borehole drillings and becomes available for consumption.

2.2.2 Water, the backbone of life and economic stability

Lalzad (2007) states that water is the source of life and development on earth. Not only human life, but plants and animals are largely dependent on water for their existence on earth. The importance of water to human life is ranked second, after oxygen (Cooperative Extension Services, 2007).

According to Irina Nokova, the director general of United Nations Education Scientific and Cultural Organization (UNESCO), water and jobs are inextricably linked on various levels, whether we look at them from an economic, environmental or social perspective (United Nations World Water Assessment Programme [UNWWAP], 2016).

The inter-connection among factors surrounding water is a concrete bond that forms a cycle around all living species on planet earth (Dolo and Allopi, 2017b). Plants and animals which are dependent on water forms part of the food for humans eventually, and food production is directly linked to economic development and creation of jobs, and ultimately economic stability for most countries (Dolo and Allopi, 2017b).

It is estimated that over one billion jobs, representing more than 40% of the world's total active workforce, are heavily water dependent (UNWWAP, 2016). These jobs are found in agriculture, forestry, inland fisheries, mining and resource extraction, power generation, and water and sanitation, as well as in many manufacturing industries including, pharmaceutical and textiles. One third of a billion of other jobs are in some way moderately water dependent, meaning they would never function fully without the availability of water (UNWWAP, 2016). These moderate water dependent jobs include, construction, recreation, transportation and manufacturing industries such as wood, paper, rubber/plastic and metals (UNWWAP, 2016).

This implies that nearly 80% of the jobs constituting the global workforce are dependent upon having access to an adequate supply of water and water-related services, including sanitation (UNWWAP, 2016). The supply of water to these water dependent jobs creates a massive number of decent job opportunities for people who ensure that water is supplied smoothly and efficiently, be it through controlling and maintenance of water infrastructure or ensuring that water quality is achieved.

Countries with water scarcity, or which are affected by drought, usually have unstable to poor economies in general (Dolo and Allopi, 2017b). The agricultural sector is regarded as the largest consumer of water, through irrigation practices (Peterson and Klepper, 2007). Some of these countries are largely dependent on the agricultural produce they export to other countries, which ultimately plays a positive boost into their economies i.e. Burundi, Liberia, Somalia, Guinea-Bissau, Central African Republic and many more (World Factbook, 2017).

2.2.2.1 The economic indicators for the economic role of water

Water is crucial for any economy. Every industry, from agriculture, electric power production and industrial manufacturing to beverages, apparel, and tourism rely on water to grow and ultimately sustain their business. The business sector is sitting with a situation where the tanks are running dry; even worse, the future holds no promise of improvement, instead conditions are worsening. The majority of businesses spend a lot of money just to secure potable water for their day to day running of business. Water pollution is one factor that plays a pivotal role in relation to water scarcity, and many businesses have to make an effort to purify their own water before they can utilize it in any way.

The World Water Council (2000a) argues that economic progress has come at the cost of inflicting a severe impact on natural ecosystems in most developed and transitioning economies. Through the interest of developing and improving the economy, the surface water had rapidly decreased and underground water quality in almost all major urban centers in the developing world threaten human health and natural values (World Water Council, 2000a).

The association between water and economy is clear: in the absence of water, particularly during drought periods, food prices quickly react, beginning with farmers, meaning that crops, milk and meat become extremely expensive. The agricultural sector is a dominant industry in water usage, and the economy of many countries is largely boosted by the production of agricultural products. Table 4 illustrates how various places around the world are doing economically. In Table 4, the Gross Domestic Production (GDP) in relation to agricultural produce is presented.

Table 4: Indicators for the economic role of water

	BIP-Share of VA in %		Water Use in m^3 per 1000 USD		
	Agriculture	**Industry**	**GDP**	**VA Agriculture**	**VA Industry**
World	4	27	122	2317	93
Low Income	19	24	1044	3182	279
Middle Income	10	35	314	2268	189
Low & Middle Income	11	32	471	3182	203
East-Asia & Pacific	11	44	380	2238	221
Central Asia & Eastern Europe	9	30	420	2760	450
Latin America & Caribbean	6	36	130	1615	52
Middle East & North Africa	15	34	619	3544	102
South Asia	24	40	1399	5223	187
Sub-Saharan Africa	9	16	130	1169	45
High Income	2	26	36	884	58
European Union	2	26	28	491	54
United States	2	25	49	1338	98

BIP = Brookfield Infrastructure Partners
VA = Value Added
USD = United State Dollars

Source: Peterson and Klepper (2007)

The data illustrated in Table 4 is a typical indication of the importance of agricultural produce in the economy and how in South Asia, Middle East and North Africa large volumes of water are required for agriculture at a high dollar value (Peterson and Klepper, 2007).

According to Sanctuary (2007), poor countries with improved access to clean water services enjoy annual average growth of approximately 3.7%, whereas poor countries with the same capita income but without improved access to clean water have an average annual per capita GDP growth of only 1%. Availability of improved water and resource management not only boosts the country's economic growth, but also contributes greatly towards eradication of poverty (Sanctuary, 2007). The key factor for availability of water is the proper management of water resources.

Adequate storage of water means enough water for everyone till the next rains, but due to adverse social and environmental impacts, large dams have become controversial and have lost public support in many places (World Water Council, 2000a).

2.3 Reasons contributing to water scarcity

According to Lalzad (2007) there are five major drivers demanding a huge expansion of water

resources, namely: population growth, industrial development, expansion of irrigated agriculture, massive urbanisation and rising standards of living. Even with the mentioned factors that contribute to water strain, some specialists believe that in the 21st century the crisis of water is more related to poor management than to water scarcity and water stress (Tundisi, 2008), and through proper water management practises much of the water currently wasted could be saved (Tundisi, 2008).

United Nations Development of Economic and Social Affairs (2015) refers to water scarcity as a combination of human-made phenomenon and natural reasons. According to Peterson and Klepper (2007) there is enough water on earth to cater for everyone living on it, but due to un-even distribution among countries around the world the water is not available to everyone equally. High levels of contamination and pollution require extensive purification even of the freshwater available before it can be made available for end users.

Water scarcity can be elucidated as a scenario where demand for water exceeds available supply. The following are some of the reasons that are associated with water scarcity:

Climate Change

Climate change is the most unnoticed but biggest factor that plays a role in water scarcity. It is an ongoing phenomenon which contributes significantly to the decrease of water levels in dams, rivers, lakes and swamps. These water storing resources are the major contributors towards the supply of fresh water for purposes of human activities. With excessive heat, which is a result of the climate change, water resources begin to lose water through evaporation.

The increased temperatures which are the result of climate change are contributing towards the melting of ice, which ultimately gets washed into the ocean and becomes unusable (Morrison *et al.* 2009). The main sources of freshwater, namely, dams, rivers and underground water are significantly dropping in level due to excessive heat associated with climate change (Dolo and Allopi, 2017b). Climate change is the result of excessive greenhouse gas emissions that have a potential of contaminating freshwater during rain (acid rain), resulting in health risks and environmental unfriendliness (Huntington, 2017).

According to Huntington (2017), increased temperatures caused by climate change raise the rate of evaporation from both land and oceans, as well as enable the atmosphere to hold more water by about 4 percent for every 1-degree Fahrenheit increase. Excessive storms and minor

earthquakes occur due to such conditions, which ultimately causes water shortages as they destroy a variety of infrastructure including those of water supply.

Surface Runoff

Giambelluca (n.d) describes runoffs as the flow of water over the land surface, rills, streams and rivers. Surface runoff will either flow into the surface water body or wetlands or be stored in depressions that allow infiltration into the soil (New Jersey Stormwater Best Management Practices Manual, 2016). The minute the runoffs are washed into the sea, they become unusable.

The occurrence of runoffs cause the formation of surface channels and caves which are environmentally unfriendly. These caves create a path leading to larger rivers, then the sea. In open fields, where there are supposed to be wetlands, caves get developed, preventing the possible development and sustainability of wetlands. Machete (2011) regards natural disasters, floods and heavy rains as stimuli in the development of runoffs, where the water becomes undrinkable for some days after the occurrence of such events.

Surface runoffs could be important in a situation where they lead through channels to a storage dam, which is being used as a source of water for certain areas. Conversely, they become disadvantageous in a situation where they carry freshwater into the sea or into running rivers that lead to the sea. They are environmentally unfriendly as they tend to transport plants and animals. These surface runoffs have the potential of contributing towards water pollution/contamination, particularly in a situation where farmers use chemicals and fertilizers to kill insects that feed on their crops. With slight showers of rain, the surface runoff is likely to transport these fertilizers and chemicals into the rivers, dams and weirs that are used as water sources.

Poor Water Management

Water management does not necessarily refer to water suppliers only, but it also refers to water users. It cannot be denied that large volumes of water could be saved through proper management of water. The Water Service Act 108 of 1997 states that all water services institutions (water services authorities/providers and boards) must take reasonable steps to achieve every citizen's basic right to water supply and basic sanitation (South Africa, 1997). To arrive at a common goal of using water sparingly and save as much water as possible, a

collective effort and dedication by water service providers, water users, water boards and the Department of Water and Sanitation needs to come into effect.

In South Africa, water supply is the responsibility of district municipalities, working hand in hand with the Department of Water and Sanitation. These governmental water institutions are seemingly struggling when it comes to proper management of water supply. One of the reasons for this could be that these institutions have been infiltrated by politics and individuals have become too busy protecting their job security rather than service delivery and management of existing infrastructure. Such infiltration results in improper appointments which are politically motivated rather than job competence motivated.

The awareness of the end-users about the water situation of their respective areas is at times limited. Water end users are unfortunately unaware about water levels dropping around the globe from various big dams and rivers. For example, the South African government issued a statement on the 7th of June 2017 about the drastic drop of water levels in dams around the country as a whole (DWS, 2017a). The decrease of water sources has not only been a South African problem. In 2015, Frankel (2015) reported about the sources of freshwater being depleted in various countries around the world, and the underground being sucked to the extent that it was running dry. According to Frankel (2015), these sources had already passed their sustainability tipping point, meaning more water was being removed than replaced during the decade-long study period. If people have been aware of such findings, perhaps their attitudes and behaviour could have been altered towards the usage and management of water.

The Republic of South Africa boasts impressive regulations and legislations which were put in place after the fall of the apartheid regime. Even so, the respective governmental institutions which are supposed to monitor and apply these regulations and legislations do not perform as expected. The Parliamentary Monitoring Group (2008) held a meeting to consider the implementation assessment of the National Water Act of 1998 (South Africa, 1998) and reported that the Act was a progressive and sound piece of legislation which was acknowledged internationally, but its downfall came in enforcement and implementation (Parliamentary Monitoring Group, 2008).

Drought

Drought is one of the major threats among natural hazards to a person's livelihood and socio-economic development (International Strategy for Disaster Reduction, 2007). It is not a

frequent event, but in its occurrence, it is fatal to people, plants and animals. The severity of its occurrence is felt for a long period as the recovery from it stretches for years before things are back to normal.

Even though today's technology has improved to the extent that it is possible to have a year-long forecast of precipitation, which enables one to have a clear idea if the year is going to be dry, normal or rainy, it still happens that drought catches everyone by surprise. There are no interventions in place by government to avoid deaths and excessive inconvenience caused by natural disasters such as drought prior to their occurrence, instead governmental authorities/institutions become eager to act when faced with such situations, but as soon as normalcy returns, the eagerness wanes (Dolo and Allopi, 2017b).

Economically, the effects of drought are even more severe. It prevents development from continuing, and hinder businesses, particularly crop and meat farmers. It compels them to drill their own wells and to buy water tanks just to store enough water. The produce of the farmers gets affected as the livestock die from thirst and from wild fires that are frequent during dry periods. Prices reach sky high and it is difficult for farmers to be able to sustain their businesses. At the end the consumers are the ones who suffer the most as the unexpected costs are transferred to them and they are forced to pay more to maintain the correct diet.

Poor Water Infrastructure

The collapse of old infrastructure is one of the contributors to water scarcity. Large volumes of water get lost through leaks. Researchers believe that if water that is lost through leaks could be saved, drought would never be as severe as it normally gets. South Africa alone is reportedly losing about 37% of its freshwater a year through leaks (Watson and Moloi, 2015). Montreal is estimated to lose about 40% of its water a year (LaBrecque, 2015). Schaper (2014) wrote that in Manhattan, the estimation is that 2.1 trillion gallons of water of water is lost every year through poor infrastructure. Taking into consideration the large percentages of water losses in these different countries, it can be deduced that if this water was being stored, it could have made a big difference towards avoiding water scarcity.

Large amounts of money are invested in maintaining and repairing collapsing infrastructure, making the process of supplying water to those without it extremely slow. The appointments of incompetent contractors to construct these water infrastructures, such as water pipelines and reservoirs, has a negative effect when it comes to the quality of work, as they tend not to last

the required life span. This is particularly problematic in rural areas where monitoring of construction activities is limited.

Increased Population

The population is increasing while water storage capacities are being kept at the same volume which results in water scarcity. Apart from birth rate, which increases the population of the world, there is a rural to urban migration which affects all cities of the world (Dolo and Allopi, 2017b). In South Africa this movement has resulted in development of townships around the cities and towns in the country. The driving force behind this movement are job opportunities, access to quality education, clinics, and better access to services such as water, which is reasonably clean within these cities and towns (Dolo and Allopi, 2017b).

The population increase within the urban areas ultimately puts massive strain on urban/city services. The common mistake by relevant authorities is that when a new township is being developed there are no measures put in place to find new water sources or increase the capacity of the storage being used. Instead, these townships are squeezed into existing urban supplies, resulting in a strain on urban services (Dolo and Allopi, 2017b). The existing water resources cannot handle the increased size of the population because they were not originally designed for such capacity. In as much as urbanisation has disadvantages, for businesses it is an opportunity, as they get to expand their businesses with a broader customer base. With such improvements in the business sector, they increase their production to cope with the increased population, which ends up demanding more water for production purposes i.e. agricultural sector, farming.

Water Pollution

Water pollution is a human phenomenon which prevents water from being used. Polluted water requires intensive purification before it can be supplied and utilised by end users. Woodford (2017) argues that water pollution in the 21st century has doubled in comparison to the 20th century. He associates this with the increase of population which jumped from 1 billion to over 7 billion in the world. The increase in population means more development as the economy has to be sustained relative to the population demands.

Polluted water is a health risk. According to a WHO survey, 80% of all diseases in developing countries are water born (Farid, Baloch and Ahmad 2012). A lot of funds are exhausted in

trying to make polluted water usable, through purification plants.

Development is necessary for economic growth, even though it results in massive water pollution. Urban water is mostly polluted due to the fact that there are a number of factories and industries within urban areas. Woodford (2017) suggests that water pollution is a problem that people need to adapt to and live with, as development is also a necessity for economic progress. Agricultural, domestic and industrial wastes are pointed out as the major water pollutants, with sewerage being the biggest pollutant of fresh water when discharged into it (Owa, 2013). Many people prefer using underground water, but the reality of the situation is that fertilisers, pesticides, and herbicides which are used to boost agricultural produce, slowly infiltrate the underground water aquifer's natural ecosystem, making the water toxic and dangerous (World Water Council, 2000a). This situation occurs in both urban areas and rural areas, but the pollution is even greater in a situation where there are not sewer treatment plants, hence rural areas are at greater risk.

Owa (2013) argues that water pollution has a dual effect on nature, in the sense that life would not continue without it, and at the same time if it is not handled with care it can result in death i.e. particularly when it results in contamination. According to Owa (2013) there are approximately 14 000 deaths each day due to drinking of contaminated water in areas of developing countries which have no means of treating their sewerage.

These facts are corroborated by the World Water Council (2000a) which has identified water quality as potentially the biggest emerging water problem in the industrial world, with the traces of chemicals and pharmaceuticals not being adequately removed. According to the council, leaks of nuclear waste into aquifers and surface water are not being brought under control, especially in the transition economies of Central and Eastern Europe.

Other Factors

Other factors that contribute to water scarcity are the development of plants and forests that do not necessarily have a positive contribution towards nature and the environment at large. Many trees are praised for positive attributes such as preventing erosion and runoffs, but there are some trees that are not necessarily needed within the ecosystem due to their distinctive negative effect of drinking too much water. Eichenseher (2012), refers to these kind of species as tropical and exotic plants.

Land-use which is associated with development has a significant effect on water scarcity, particularly when it comes to underground water. Winter *et al.* (1998) talk about the relationship between surface water and underground water, indicating that on many occasions underground water is nothing but the storage platform of the surface water, hence there are wetlands. With the development of malls and townships that type of storage is totally disrupted. Of the many important uses of underground water, Dolo and Allopi (2017a) identify underground water as a reliable source of drinking water particularly for rural dwellers. Ultimately these developments have the potential to change the flow patterns that lead either to wetlands or water resources.

2.3.1 Most water stressed countries

The above reasons behind water scarcity are applicable to all countries of the world. The only difference is that the seriousness of their consequences is not at the same level, and the effects differ from one country to another. Some countries experience more rain than others and some are wealthier than others, enabling them to slow down the severity of water scarcity (Dolo and Allopi, 2017b).

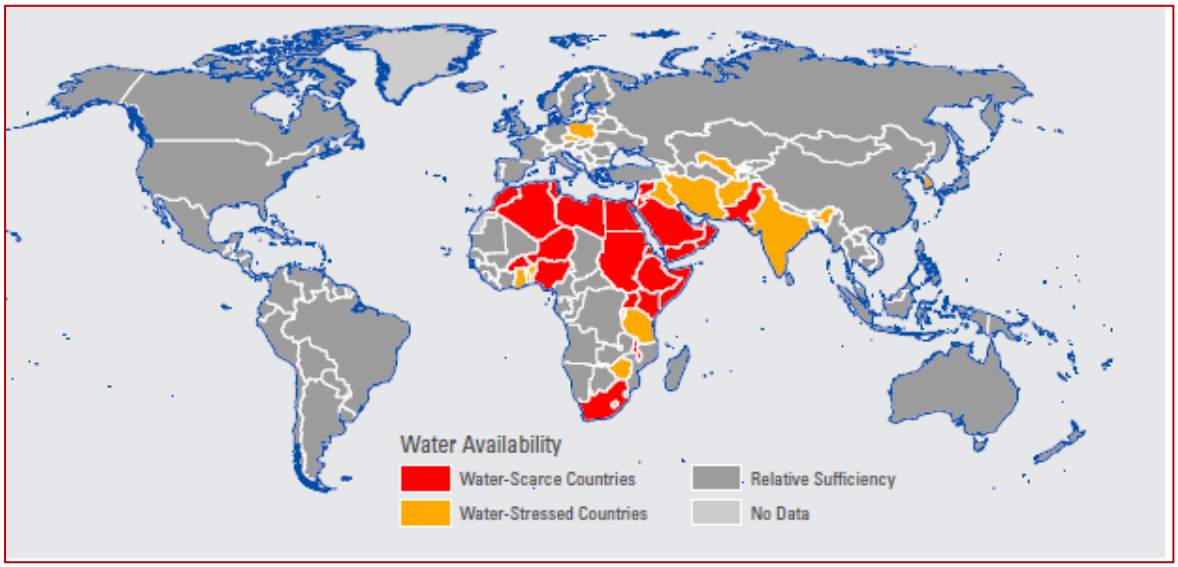

Figure 5: Water situation based from 2010 population figures provided by the UNPD for various countries around the world
Source: Mogelgaard (2010)

Figure 5 illustrates freshwater availability in relation to the 2010 population figures provided by the United Nations Population Division (UNPD). The dominance of water scarcity was relatively high in the Sub-Saharan African regions as see in the figure. This is associated with

insufficient water sources such as dams and water infrastructure within these countries. The economy of water scarce countries is usually in a dire state, with lives being lost through hunger and thirst (Dolo and Allopi, 2017b).

These countries are dominated by wars, resulting in much bombing which ultimately dismantles the infrastructure put underground and underneath buildings. Their economic condition is not improving as their focus is not on developing water resources, rather they are going back and forth fixing demolished buildings. Finances are being used in maintaining old and collapsing infrastructure, and it becomes impossible to develop new ones. As a result, these countries with water related problems perform poorly when it comes to businesses that are more dependent on water i.e. agricultural produce.

There is not conclusive information to provide reliable findings in relation to the water situation in all the areas shown in Figure 5. In spite of this lack of evidence, the reality is that the world water situation is changing for the worse rather than for the better.

Rapid economic growth is a major contributor to water scarcity, where developing countries which are more focused on sustaining their economy tend to use massive volumes of water in development and production. A developing economy requires buildings and factories to be built, and those activities have potential of polluting water. Secondly, more production takes place which means more water is being utilised, and the irrigation rate in agriculture is increased to coincide with production demand.

Bhaduri et al. (2012) identify the production of biofuels as another huge water consumer, through direct withdrawals for irrigation and the industrial process of feedstock conversion, and indirectly by increasing water loss through evapotranspiration that would otherwise be available as runoff and groundwater recharge.

Besides human activities that negatively affect water resources and result to excessive usage of available surface water or excessive extraction of underground water, there are also natural phenomena are beyond the control of humans. These phenomena include floods and droughts. According to UNESCO (2011) these phenomena are the result of global warming which is happening around the world. Abraham (2017) refers to global warming as warming of the world as a result of heat trapping greenhouse gases emitted by humans. In other words, one can argue that even though these phenomena are natural, they are the result of human activities although their impact takes decades to be noticeable. The excessive heat and rise of sea levels

do not bring about normal rain, causing floods that result in damage to infrastructure and loss of lives (UNESCO, 2011).

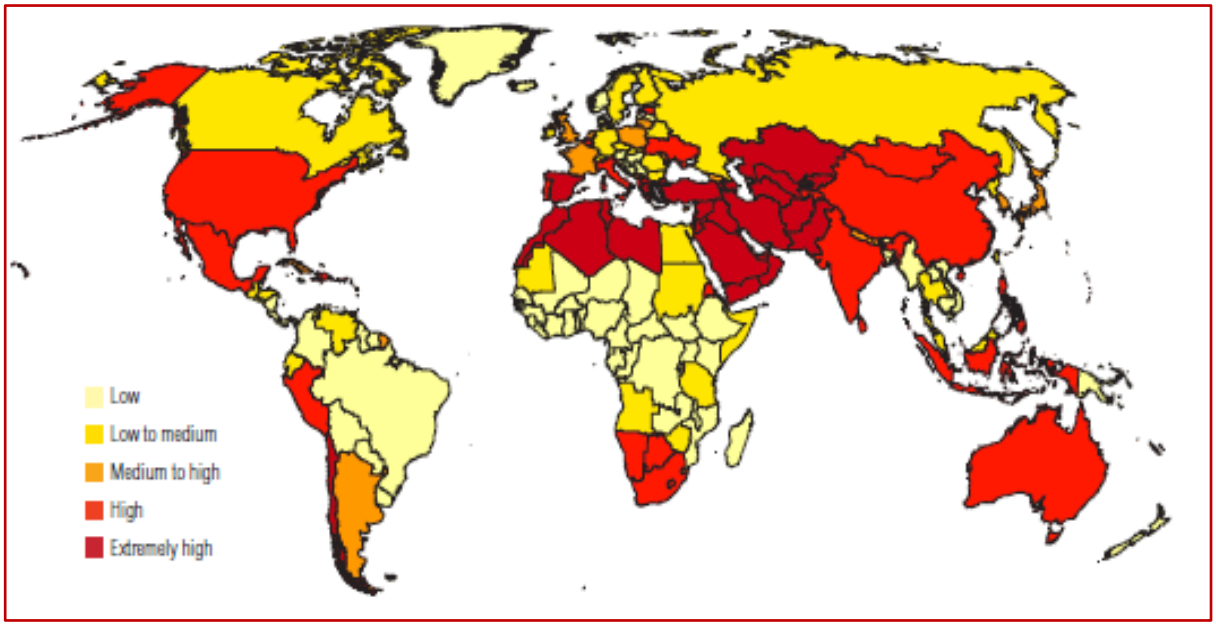

Figure 6: Illustration of water scarcity by 2040 under the business as usual scenario
Source: Young, Lou and Reig (2015)

Figure 6 shows the forecast of water scarcity by year 2040. It is understood that there are certain factors within different countries that could contribute to the worsening situation of water availability, but those could not really be predicted. This forecast was only based on obvious scenarios like the climatic change, a country's economy and population (Young, Lou and Reig 2015).

When comparing Figure 5 and 6, there is no improvement whatsoever when forecasting to year 2040, instead additional countries will end up in a bad state as well, unless they can act decisively to preserve water while it is still early. The scale at which large countries are growing their businesses such as the agricultural industry is having a negative effect on freshwater supply in those countries. Hence, in some areas indicated in Figure 6 above, one would imagine that water is not a problem, but the utilisation is just too high for the water resources to cope and sustain themselves (Dolo and Allopi, 2017b).

2.4 South African water overview and its water policy

In reference to Figures 2 and 5 above, it is evident that South Africa is one of the areas with

high stress to very high stress of water availability. South Africa is regarded as a semi-arid stressed country with an average rainfall of approximately 450mm which is far below the 860mm of the world's average annual rainfall (Basson, 2011). With South Africa being a developing country, the insufficiency of water is hampering the rate at which growth and development is taking place. According to Greeff (2010), Southern Africa is the 30th driest country on the planet, and recent statistics indicate that South Africa is already utilising about 98% of its available water.

Remedial actions to prevent the worsening water situation within the country are not in place yet, even the few that are happening are not reaching every water user. Some external factors which impact water resources are limiting the water cycle system. These include the extraction of sand from major rivers. Some major rivers are jointly utilised with neighbouring countries e.g. the Orange River and Limpopo River (Chevallier, 2014).

Moving away from the apartheid policies and laws, the democratic South Africa established integrated policies. In South Africa it is a human right to have access to potable water. Below is a discussion on the water governing policies set in a democratic South Africa.

The National Water Act (NWA) (No 36 of 1998) (South Africa, 1998): This is a framework for the way in which water resources must be protected, used, developed, conserved, managed and controlled. Through the NWA the government aimed to become the custodian of all water resources in the country, while establishing equal distribution and improving water management. In the past the government was more concerned about developing the economy so most of these resources went past different groups of people, particularly rural areas, to supply urban areas. The NWA policy sought to create a window of opportunity for the previously disadvantaged group of individuals in order to improve the socio-economic situation while contributing to national economic development (Ukwandu, 2009).

The NWA transformation meant protection of water resources such as catchment areas, dams and rivers which were of great importance, while establishing procedures for achieving the basic human needs and the ecological reserves. Many attributes that relate to water management (e. g. pollution prevention) are addressed by the policy. This is an indication of how broad the act is and covers all aspects related to water supply, water conservation, water utilisation and water management.

The Water Service Act (WSA) (108 of 1997) (South Africa, 1997): The makes provision for the right of access to basic water and sanitation. Similar to the NWA, the WSA put in place different requirements so as to establish the goal of supplying water to all people of South Africa irrespective of class, race and gender. One of the requirements is that every water service authority must prepare a Water Service Development Plan (WSDP) for its area of jurisdiction. According to the WSA, these authorities have the duty to provide access to water services.

The act ensures that water quality standards are achieved by water service intermediaries. Additionally, it monitors the implementation and performance of various water service authorities responsible for supplying water to end users.

The two mentioned acts are the main pillars that govern the supply of water from its raw state to its purified state till it is supplied to the end users. South Africa has put up great policies that regulate the usage of water. In trying to abide by these policies, the South African Government has done tremendous work to provide potable water to disadvantaged communities situated in the rural areas across South Africa and that process is still in progress.

2.5 The water situation of the Eastern Cape

According to Statistics South Africa (2016), the supply of clean water in South Africa has increased from 60.9% in 2002 to 92.5% by year 2015. However, the Eastern Cape comes out as the province with the lowest percentage of people with access to potable water. With regards to water supply, the RDP and subsequent plans and strategies have enabled great progress in supplying citizen of South Africa with improved water since 1994 (Cobbing, 2013).

The unserved citizens of the Eastern Cape are mostly residing in rural areas. Muller *et al.* (2009) argue that South African water resources are limited while they need to support, a growing economy of the country. Besides the issue surrounding water resources in South Africa, there is an issue of water not being distributed evenly among the nine provinces.

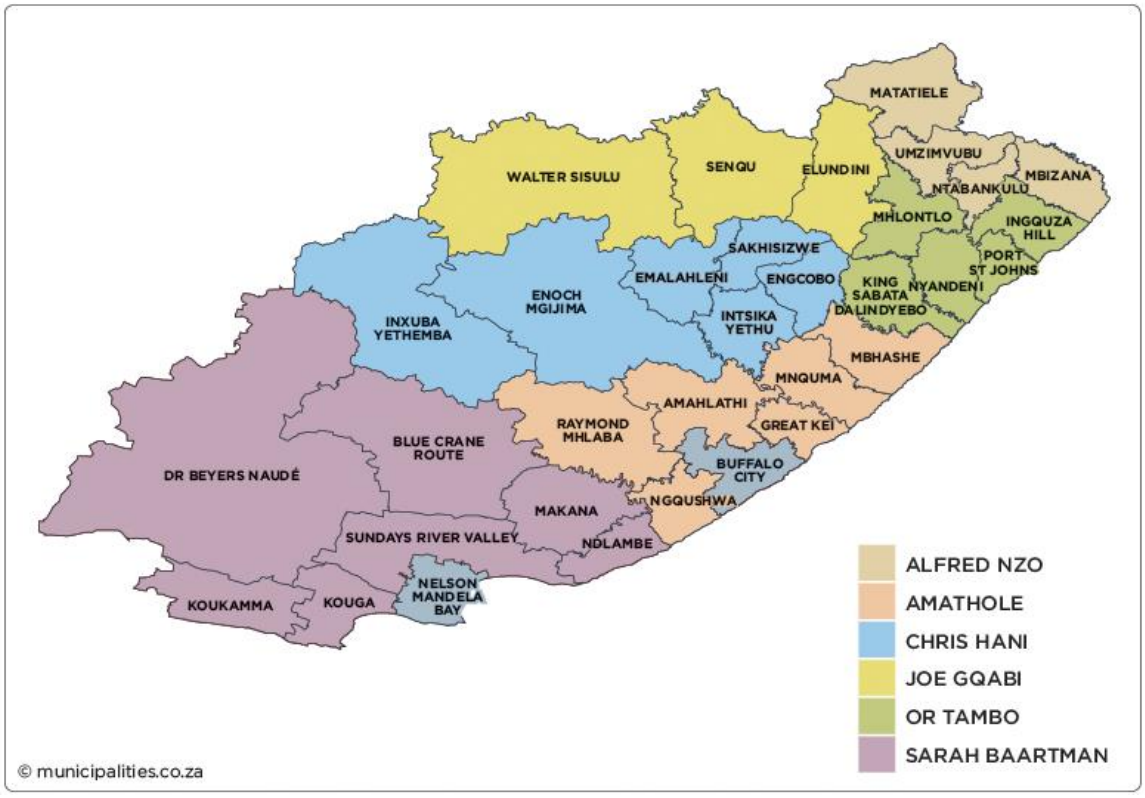

Figure 7: Municipalities that make up the Eastern Cape

Eastern Cape is the second largest province. However, it secures the bottom spot in terms of supplying clean water to its people (Naidoo, 2016).The Eastern Cape has two metropolitan municipalities (Nelson Mandela Bay Metropolitan Municipality and Buffalo City Municipality), six district municipalities (OR Tambo DM, Chris Hani DM, Alfred Nzo DM, Amathole DM, Joe Gqabi DM and Sarah Batman DM), and 38 local municipalities (Hamann and Tuinder, 2012). Hamann and Tuinder (2012) describe the Eastern Cape as a mountainous area which is characterised by short and deeply incised rivers flowing parallel to each other out to sea.

Eastern Cape is divided into coastal and inland regions. According to the CSIR (2004), the coastal region has a mild temperature condition ranging between 14 and 23 degrees Celsius, while the inland areas experience slightly more extreme conditions with temperature of 5 to 35 degrees Celsius. The variation of topography within the Eastern Cape has a major effect on how significant the difference between the weather for inland and coastal regions is.

In the Eastern Cape, dams are the main source of water supply, particularly in the urban areas. Rural areas dominantly utilise underground water with the use of borehole structures, and they

use springs and weirs. Cobbing *et al.* (2015) state that underground water is a valuable resource with reasonable potential, particularly in the rural areas and semi-rural areas with the biggest water supply backlogs. However, various local authorities within South Africa generally are increasingly considering underground water as unreliable and difficult to exploit.

In as much as South Africa needs drastic transformation when it comes to water supply of its disadvantaged population, the Eastern Cape is at the lowest percentage of potable water supply of 75% compared to other provinces such as Western Cape having 99.4%, Free State 99.3%, Northern Cape 99.1%, Gauteng 98.6% (Naidoo, 2016). The major difference between Eastern Cape and the other provinces is that the Eastern Cape is more rural than any other province. Due to urban areas being centres of attention when it comes to economic scaling, they were fortunate enough to be serviced and taken care of while the rural areas continued to lag.

In the Eastern Cape, the district municipalities are the Water Service Authorities (WSA) and Water Service Providers (WSP). The OR Tambo and Amathole District Municipalities are identified as category C2-Municipalities since they are largely rural (ORTDM, 2016 and ADM, 2015). These two municipalities are the biggest municipalities in terms of population size, and, due to that, they are flagged as the biggest water consumers. According to each municipal Integrated Development Plan (IDP) report, all the municipalities within the Eastern Cape indicate a drastic change with regards to access to potable water when comparing the figures of a decade ago with recent findings.

Table 5: Percentages of household with access to potable water in various district municipalities of Eastern Cape

Names of water service providers	Population	Proportion of households with minimum level of basic services (including RDP STD: 200m away from households) (%)	Blue drop (%)
ADM	892 637	65	80
OR Tambo DM	136 4943	49	43.69
Chris Hani DM	795 461	69	83.4
Alfred Nzo DM	801 344	46	52.4
Joe Gqabi DM	349 768	54	75
Sarah Baartman DM	450 584	58	55
Buffalo City Metro Municipality	755 200	78	91
Nelson Mandela Bay Metro Municipality	1152 115	94.6	90.11

(Source: Statistics SA (2011); ORTDM (2016); ADM (2015); CHDM (2017); SBDM (2015) (; Naidoo (2016); Del Fava (2016); Department of Water Affairs (2011)

Table 5 is an illustration of households who have access to potable water. These households include those with taps in the yards, taps inside the house and at an RDP standard. The Buffalo City Metropolitan Municipality findings of the 2001 IDP report show that the access to water was already at a high percentage. The development of townships in the surroundings of these metro municipalities has always been the only reason these metros have not been able to achieve a 100% supply of water to the dwellers of the metropolitan.

OR Tambo is one of the district municipalities with bad service provision when it comes to water supply, taking into consideration that, Statistics South Africa 2011 figures indicated in Table 5 above, show that OR Tambo District Municipality has a large population of 136 4943.

Another challenge facing the municipalities of the Eastern Cape is the quality of water. In 2008 the Department of Water Affairs introduced the blue drop programme to monitor the quality of water from water sources to the tap of end users (Department of Water Affairs [DWA], 2015). The rural areas of the Eastern Cape are the ones that have always shown poor quality of drinking water in comparison to urban areas. For instance, OR Tambo District Municipality which has been identified as a more rural municipality had the lowest blue water levels figures of 22.2% in 2010 It improved to 43.7% in 2011 but remained the lowest in comparison to other district and metro municipalities. This could be a result of insufficiency of water treatment plants, which do not exist in some rural areas.

The quality of water in South Africa is deteriorating due to many factors such as industrialisation, population growth, urbanisation, development and global climate change. The mere fact that there are limited water treatment plants in various areas of the Eastern Cape, makes it impossible to achieve minimal blue drop requirements. Results supplied by Democratic Alliance in 2010 indicated that, small towns (semi-rural) and rural areas scored less than 33% on their blue drop (Democratic Alliance, 2010). Part of these poor performing water schemes include Amathole District Municipality and OR Tambo District Municipality which consists of high numbers of people who are mostly rural dwellers.

2.6 Water resources and service providers in the Eastern Cape

In the Eastern Cape, district municipalities are the ones responsible for water supply to the end users. The situation was not the same 11 years ago when water under the province was the responsibility of the local municipalities and/or Amatola Water Board. A few groups of people, particularly farmers, owned private boreholes and were not being supplied by the

municipalities. The trend of boreholes in the province has since been growing due to unpredictable water supply by the responsible authorities.

Various urban areas in the Eastern Cape share water services with townships since these townships are very close to the urban areas, and therefore get treated as urban dwellings when it comes to service provision such as water supplies.

Water supplies in the Eastern Cape are largely dependent on dams, rivers and water vendors as sources. There has been a drastic improvement of usage of underground water, particularly in the rural areas, where underground abstraction of water is being used through borehole systems. However, the quality of groundwater remains an issue. According to Waste (2010), WHO discovered that over 140 million people in 70 countries around the continent are affected by arsenic pollution in groundwater.

River streams are heavily disturbed with mining of river sand. Development requires mining of sand from nearby rivers. This is done illegally in rural areas, where communities mine sand for their small activities such as extending or building their new houses. The quantities of sand being mined by these local individuals does not amount to severe river stream destruction, however, local contractors have also identified an opportunity to mine sand to sell or perhaps construct in nearby projects and hide behind these communities, while avoiding government authorities. To acknowledge the cultural background, the Department of Natural Resources and Minerals has sought not to penalise or act on local dwellers who live close-by these rivers for the sake of good relations as they do not do much harm when extracting this sand. Instead, these government authorities have opted to give advice on the best or most suitable ways the locals can mine the sand i.e. not to focus on same spot when mining the sand, as that has a potential of changing river stream or trapping aquatic animals.

With the inclusion of contractors in mining of the river sand, the regenerative capacity of rivers falls behind and ultimately destroys the rivers and their ecosystem. Authorities have managed to apprehend a few of these contractors and applied hefty penalties to send out a message, even though the fight has not been completely won.

2.7 The danger of living in a planet with no water

Taking into consideration the fact that 71% of the planet is water, and only 29% is dry land (Mcintyre, 2012), there should be enough water for everyone on earth to drink, cook and do all

other necessary activities that require water. Instead, the situation is becoming the opposite, in the sense that the demand for water is exceeding the number of people on the planet. According to Zabarenko (2011), water use has been growing more than twice the rate of population increase in the last century.

This is a clear sign that if things continue as they are, future generations will live in a completely dry land. Zabarenko (2011) argues that, even though the greater portion of earth is water, the water is salty, and there will be no water to sustain development by the time the population reaches 9 billion, probably by mid- century.

According to Blee (2013), approximately one in eight of the world's population does not have access to potable water. Considering the reasons already discussed as being behind water scarcity, the situation is predicted to worsen. Water resources are not prioritised, making it impossible to have adequate storage facilities, which means that even after decent rains around the world, not much water gets conserved. The existing water resources end up diminishing as they aren't getting maintained and becoming silted i.e. dams and rivers. The National Water Resource Strategy set by Department of Water and Sanitation of South Africa was set to control equitable and sustainable access and use of water by all South Africans while also sustaining water resources (DWA, 2013). However, these strategies have very little input on most water resources.

The danger of living in an inadequate and non-purified water situation is that it results in unhealthy living circumstances. According to the World Water Council (2000a), 3 to 4 million people die of waterborne diseases, with more than 2 million children dying of diarrhoea. In addition to that, lack of clean water or accessibility to water generally results in malnutrition, where there is lack of proteins, vitamins, minerals, and other micronutrients in their diet (World Water Council, 2000a).

2.8 Conclusions and recommendations

2.8.1 Conclusions

With reference to the findings gathered in the literature review, the whole world is on the brink of living in a water-scarce planet. Various factors contribute in different degrees to water scarcity. Some of these factors are irresponsible water usage, poor water management, human activities that results in global warming and ultimately to climate change. The afore listed are

the major contributors to the issue of water scarcity.

The extent to which developed and developing countries extract water is becoming greater and greater, putting intense pressure on water resources. According to DeNicola *et al.* (2015), the improvement of lifestyle, which is associated with accessing jobs, has a way of putting strain on water resources, as people upgrade to outside taps and do in-house plumbing, which includes installation of geysers, shower, dishwashers etc.

It is evident that the supply of potable water in South Africa has improved significantly in comparison with two decades ago, though it cannot be dismissed that as time passes there are great challenges that are making it difficult to achieve 100% access, as is the case in the entire world as well. The global changes are having a significant impact on how the climate change behaves, making a negative impact which is adding to the problem of water scarcity. Climate change plays a pivotal role in the occurrence of droughts, storms and excessive heat which have negative impacts on water scarcity.

The importance of access to clean water cannot be overemphasized. The economy of any country is at risk of collapse without access to purified water, as it enables development, production, and day to day domestic activities. The economies of many countries are dependent on agricultural produce which is entirely dependent on water for irrigation.

With South Africa falling in the mid-numbers of countries with access to water, the situation is not entirely in a dire state, but it is not at a state where one can be comfortable with the state of water. Even with great improvements carried out by the democratic government regarding water supply in South Africa, the Eastern Cape is lagging behind by a huge margin.

The government has managed to provide approximately 75% of Eastern Cape with potable water (Naidoo, 2016). The remaining 25% backlog is mainly in the rural areas. Due to the poverty of rural dwellers the government has been providing the RDP standard supply of water, where communal taps have been provided and water supplied for free. That has been going on for the past two decades, but the problem with this structure is that as times goes on, people in the rural areas have managed to secure jobs, and some have managed to raise their standard of living through government grants. That has put water supply in the rural areas under intense strain, as these people started putting up illegal connections and do plumbing in their houses to support their change in lifestyle. Boreholes can no longer cope with the supply of these rural areas, as they were not designed for high level water usage.

The gap between urban and rural areas in the Eastern Cape is exceptionally high with regards to water supply, considering the quality of water supplied, and the difference in distance one must walk in either area to fetch water.

2.8.2 Recommendations

Considering the issues surrounding the supply of water, various contributions from the affected, the involved and the beneficiaries could make a huge difference if they would work hand in hand in addressing the aforementioned issues. The following is a summary of recommendations made in reference to the findings in this chapter:

i. The Water Service Authorities should take it upon themselves to ensure that all the regulations put in place by government are adhered to, if there is any hope of turning the situation of water scarcity around. The WSA need to ensure their subordinates take responsibility for their duties.
ii. Water Service Providers should take it upon themselves to ensure that the installed system is operating accordingly and that all the maintenance issues are attended to on time to avoid excessive water loss.
iii. The respective governmental entities responsibility for development of policies need to do revisions considering the lifestyle changes of citizens in both urban and rural areas.
iv. For any noticeable change to happen, water consumers should take it upon themselves to take cautious care of government supplied water. That includes reporting any leaks in their areas, considering methods of preserving water and using water sparingly with a mentality that it is a limited resource. Generally, caring water users have delegated committees that citizens report to when there are water related issues in their area, the government need to promote this practice in both urban and rural areas.

CHAPTER 3

THE IMBALANCE OF WATER SUPPLY IN THE EASTERN CAPE

3.1 Introduction

Eastern Cape has two big cities namely Port Elizabeth and East London, other than that, it comprises small towns. These two cities are the only ones having the stature of being recognised as the metropolitan municipalities due to their size. The small towns are also categorised as urban areas in this study, however, there is a difference in the level of supply of services between urban areas in the metropolitan municipalities versus the urban areas in the small towns within the Eastern Cape.

In the vicinity of these urban areas, there are rural areas. The water supply to these rural areas is far less than that of the urban areas in terms of adequacy. This is a common scenario around the globe, where the superiority of affordability plays a major part when it comes to water supply. This scenario escalates to the level of countries, where countries with good economies have better access to water of good quality, and countries with unstable to poor economies have poor infrastructure and bad water quality. Countries with good economy have the potential of becoming the biggest freshwater polluters, due to their large industries and agricultural firms e.g. United States, China, Russia and India.

The extent of pollution caused by factories, agricultural industries and oil spills is unmeasurable. Toxic chemicals which are carried by running surface water through rivers, lakes and runoffs end up underground, where most rural areas extract water for their domestic use. Alternatively, these chemicals are carried to the dams and rivers that are being used by rural dwellers who do not yet have piped water systems. Due to this, these rural dwellers become the unfortunate victims of drinking such contaminated water, where there is no proper water purifying plants and any water infrastructure for that matter in some of these rural areas.

Eastern Cape is dominated by rural areas, it is thus considered the second poorest province in South Africa (Statistics South Africa, 2014). These rural dwellers are unable to better their lives without the convenience of accessing clean water. In fact, some rural areas do not have water infrastructure at all and are fully dependent on river, weirs, and rain water.

3.1.1 Background

The Eastern Cape is situated in the South-East of South Africa, bordering Free-State and Lesotho in the North, KwaZulu-Natal in the North-East, the Indian Ocean along its South-Eastern borders, and Northern Cape in the West (Hamann and Tuinder, 2012). The province was given the name "Eastern Cape" after 1994 when South Africa transitioned from the apartheid regime; previously this region was divided into Transkei and Ciskei (Hamann and Tuinder, 2012). It is a province with rich history when it comes to politics, as iconic political heavy weights such as Nelson Mandela, Oliver Tambo, Tambo Mbeki, to name a few, have come from this province.

Even with such political greats and powerful leaders, Eastern Cape still identifies as one of the poorest provinces in the South Africa (Hamann and Tuinder, 2012). The apartheid government which ruled the country before 1994 prioritised urban areas when it came to development and service delivery, so this imbalance was inherited by the democratic government. Prior 1994, urban areas had proper infrastructure installed for service such as sewer and water. The problem today is that even though the current government is trying to provide the same infrastructure for the rural areas to achieve a balanced society within South Africa, this is not happening quickly enough due to factors such as:

i. Some people in the rural areas are too poor to afford to pay rates that will ultimately maintain the infrastructure once it is installed.
ii. The infrastructure in the urban areas is currently too old and deteriorating, meaning it needs more attention as urban areas are the centre of attention when it comes to economic growth and development.
iii. The funds get exhausted in operation and maintenance of existing infrastructure, which are predominantly in the urban areas.
iv. Water resources and more infrastructure in the urban areas require expansion due to more development occurring in the cities and towns, as migration takes place in urban areas.

The rural areas of the Eastern Cape have long been under-developed. In the zone between the urban and rural areas there has been a constant growth of townships in the surroundings of the cities and small towns around the Eastern Cape. These townships are therefore incorporated into urban areas when it comes to services such as water and sanitation which then further delays the supply of such services to rural areas, as townships are normally closely located to

urban areas.

3.2 The differences in water supply in the Eastern Cape

The spatial differences in water supply in the Eastern Cape are extremely high. The affordability scale between urban and rural areas determines the kind of water that are ultimately supplied to each area. Table 6 lists the major differences between urban and rural areas.

Table 6: Differences regarding water supply in urban and rural areas

Urban areas	Rural areas
*There are proper house connections	*There is either no water or there is a communal standpipe (at 200m away from house).
**Water is sourced from either dams or rivers then purified in a well modernised water treatment plant to meet the required health standards before being supplied to the end users.	**Water is sourced from boreholes, weirs or springs to a storage reservoir.
***Quality of water is accurately monitored before being supplied to the end users,	***Water quality is not properly evaluated before being supplied to the end users, and no quality examinations are done from time to time.
****Well-Constructed and well-maintained water infrastructure.	****Poorly constructed and poorly maintained water infrastructure.

*The house connection in urban areas versus the situation of no water or communal standpipes in the rural areas determines the degree of inconvenience that rural area dwellers go through in order to access water for their daily activities. In urban areas, people do not have to leave their houses in order to access water whilst in the rural areas, people must walk several meters to fetch water, and some are not necessarily even fetching clean water – they walk distances to fetch water whose quality poses a health risk from rivers.

**It is suggested by some researchers that water in urban areas is more polluted than that in rural areas due to high levels of development and factories around urban areas (Sakazaki and Nakamura, 2005). Therefore, urban water requires thorough water purification before being made available to end users for consumption. Fortunately enough, urban areas are already furnished with advanced water treatment plants that assist to achieve required quality standard, but in rural areas there is no water treatment plants to conduct thorough purification of water before it is used. In most cases the water service providers are dependent on recommendations made by borehole testers to identify quality (e.g. chemicals) found underground in the process of borehole drilling.

***Furthermore, the quality of water for drinking in the urban areas is taken for various tests within the treatment plants to see if it meets the minimum quality standards before it is released to end users. In the rural areas, there is no proper testing of water before it is made available to end users. A once off test particularly during feasibility stage of the project is done, and it sets the standard of soil chemicals and hazardous substances available, which then determines what interventions are required to treat the borehole water when in operation. However, the possibility of later infiltration of various chemical and hazardous substances is never considered, until there are cases of illness associated with borehole water.

****The issue of well-constructed and well maintained water infrastructure in the urban areas is associated with skilled water service providers, engineers, contractors and monitoring by governmental water service providers. In the rural areas, however, inexperienced contractors are appointed with the aim of developing them, but that compromises the quality of work being done. Government authorities and water service providers are not as visible as they are in urban areas (this is due to the inconvenience of travelling to rural areas, with bad roads and long distances).

Figure 8: Fetching water from a communal standpipe point using a donkey kraal (photo taken in Ndabakazi village -Butterworth)

Figure 8 is an illustration of what rural dwellers have to go through to fetch water from communal standpipes. Some use wheelbarrows and some go further and use their luxury vehicles due to distances they have to travel to fetch water (see Figure 19 of Appendix 12). As mentioned before, the standpipes should be positioned in such a way that no one in a village walks over a distance of 200m as per guidelines for human settlement planning and design (CSIR, 2005:16). The problem arises in a case where the village starts to expand, and people develop houses further away from the standpipes and eventually end up being much further than 200m meters from the standpipe.

The operational and maintenance units of the district municipalities (water service providers) in most cases do not have sufficient funds to construct long reticulation water pipes to accommodate such developments in rural areas. Rural dwellers therefore resort to illegal connections, which cause massive damage to water infrastructure and water loss through poor work done by unskilled workers. All of these put massive strain on water resources used to supply water in rural areas, as it is standard that rural water is supplied free of charge.

This is a different scenario to urban areas, where people access water inside their houses with relatively no struggle. However, these urban dwellers have to pay high rates for this convenience.

Considering the damage to the infrastructure and loss of water resulting from the illegal connections in rural areas, it is pertinent to ask if these rural dwellers conducting illegal connections can perhaps afford to pay rates considering their living standard has improved to the extent that they now making these connections?

3.2.1 Townships

In the zone between urban areas and rural areas are the townships. According to Pernegger (2007), many townships can be categorised as middle class as they consist of dwellers who have access to jobs in the nearby cities, but their level of disposable income is less than those in cities. These townships are built in the vicinity of urban areas/cities, so when it comes to service delivery such as water supply, they are supplied as part of the cities they are close to. Due to the standard of affordability of township dwellers, their rates are lower than those of urban areas. Due to the fact that they are made part and parcel of nearby suburbs and cities, they are therefore categorised as urban dwellers in this study.

3.2.2 The issue of sanitation in urban and rural areas

The issue of sanitation and its treatment is significantly different in urban versus rural areas. In rural areas, there are no sewer treatment plants whatsoever. Therefore, the government has developed several pit toilets (VIP toilets) as a means of bringing dignity to the lives of rural dwellers. However, just like water supply, the construction of VIP toilets has not reached everybody in the rural areas of the Eastern Cape, and some people have developed their own pit toilets which are relatively high risk and unhealthy.

Some rural areas are still using bushes and nearby caves to relieve themselves. In that way, they increase unhealthy conditions as runoffs and rains wash all the defecation into the nearby dams and rivers, which other rural dwellers are dependent on for drinking and other domestic uses. Through such circumstances, water borne diseases such as cholera and diarrhoea are created, and regularly become fatal in various rural areas.

In urban areas, the situation is totally different. There are proper sewer treatment plants used to purify sewer released from urban dwellings. Water released at the final stage of sewer treatment is released to the nearby rivers, and ultimately collected again in a river to go to a treatment plant (water cycle process). It is thoroughly purified in the water treatment plant to meet minimum Department of Water and Sanitation (DWS) and WHO standard before being

made available for use by urban dwellers. It is extremely rare to get any water-borne diseases from urban supplied water.

3.3 The challenges of water supply in urban and rural Areas

The imbalance of water supply between urban and rural areas comes with various challenges that ultimately affect everyone, irrespective of the area they reside in.

Urban Areas

The convenience experienced by urban area dwellers regarding access to potable water is perhaps one of the reasons leading to movement of people from rural areas to urban areas (urbanisation). Some of these rural dwellers assemble at informal settlements particularly nearby townships and city surroundings to get closer to the better life which is being experienced in the urban areas.

With the expansion of townships, the government is compelled to supply these township dwellers with basic services such as water. This puts massive strain on urban water resources and infrastructure.

As townships develop this means more work for water service providers as they now have more water infrastructure to look after. The funds easily get exhausted as operation and maintenance costs increases with the increase of infrastructure. A lot of money ends up being spent in the maintenance of existing infrastructure, rather than going to those few people in the rural areas who do not have access to potable water at all, hence it is difficult to address the imbalance between urban and rural areas.

Rural Areas

When compared to apartheid days, the South African government has significantly improved the supply of potable water in the Eastern Cape. However, the process of doing this has been very slow. Even today, there are still several villages sharing water sources with livestock.

Due to the low standard of living and affordability in the rural areas, potable water has been supplied for free since 1994. The government has managed to improve some lives of rural dwellers with the supply of potable water. This is in line with South African legislation which promotes the supply of basic services, such as water and sanitation to all its citizens. By basic water supply in rural areas, the government refers to the infrastructure necessary to supply 25

litres of potable water per person per day from a source within 200m of a household and with a minimum flow of 10 litres per minute (in the case of communal water point) or 6 000 litres of potable water supplied per formal connection (in the case of house connection) (National Treasury, 2011).

The water scheme is the responsibility of the municipal operational and maintenance unit, which does not normally do major construction extension, rather prioritises maintenance of the existing schemes as finances usually embroils this governmental unit. This factor becomes a disadvantage in the case of expanding rural areas, as they end up with no water or have to walk long distances to communal standpipes.

Because the Eastern Cape is well known for its mountainous terrains, the 200m does not suit everyone, as it is impossible to climb up and down mountains with a full 25 litre bucket of water. This shows the degree of inconvenience facing rural residents. Disabled people are completely uncatered for, and where they are expected to use a communal standpipe, they are forced to get other people to fetch water for them, sometimes for a fee.

Based on these reasons, illegal connections in the rural areas have been growing drastically. Evidence shows that some rural dwellers can afford to buy themselves material to do illegal connections. However, these connections are poorly done by unskilled individuals, and this results in massive leaks which contribute to water scarcity. With a combination of other water scarcity contributors such as climate change and drought, the leaks that are the result of illegal connections contribute towards depletion of water sources, specifically boreholes, as they are normally the water source used in rural areas.

Additionally, when direct connections are made to the house, more water will be used than it was anticipated and designed for. Householders are likely to connect washing machines, geysers and many more appliances using water, and ultimately the household uses far beyond the 25 litres per person per day the government has planned to supply for free to these rural dwellers.

3.4 Recommendations

Rural areas have long been lagging behind in accessing decent services that are found in the urban areas. The South African government is in the process of integrating rural areas with urban areas, or at least trying to change the dignity of rural dwellers by supplying decent

services to the rural areas. In doing so, they are hoping the rate of urbanisation will decrease, thereby making cities more manageable. As Professor Richard Carter, the chair of Rural Water Supply Network (RWSN), points out, enabling everyone to have access to a safe water supply close to their home does not require rocket science, considering the level of service that is currently being supplied in rural areas (Flowers and Danert, 2012). This implies that the integration and intended improvement in relation to water supply to rural areas will not succeed unless drastic changes by water users, water service providers and water service authorities occurs.

A similar approach to supplying services in urban areas needs to be applied in rural areas in order to bring some balance to service delivery. In urban areas, high water tariffs that eventually assist in the supply of services and maintenance of infrastructure are being paid, therefore the government needs to take into consideration applying rates to rural areas as a means to reduce water wastage and enforce responsible water usage by rural dwellers, as well as generate income for the supply and maintenance of infrastructure.

As part of the solution, government needs to open doors for people in the rural areas to apply for house connections at a reasonable rate that will suit their economic circumstances. Apart from compelling water users to use water responsibly, the water service providers need to invest on transferring of skills to rural people so that they can manage their water supplies and be able to deal with new technology. Rural dwellers will then be able to fix minor leaks themselves.

The most important aspect is for the water service providers and other government authorities to have an open relationship with water users, where they are able to bring their suggestions and opinions. This also refers to the rural areas who are still in need for water. They should be encouraged to submit their proposals and suggestions for appraisal and possible consideration by government. By doing so, these proposals would make life easier for water service providers when they have to request for a government grant and financial support to construct water infrastructure.

3.5 Conclusion

Large volumes of water get lost through leaks which are the result of illegal connections made by rural dwellers trying to bring water into their houses. Once these connections are made, water get misused due to the convenience of water being supplied for free. Making rural

dwellers who want house connections pay for water would enforce them to use water responsibly. Noga and Wolbring (2013) point out that where payments are being made for consumption of water, the attitude of people towards using water automatically changes as they know they will pay for their misuse.

However, not everyone in the rural areas can afford to pay for house connections. In such instances therefore, the RDP standards standpipes would serve the purpose, where at least people will have access to potable water.

Trying to better the lives of rural areas through supply of decent water service will have a positive impact on rural areas, as people will not find it necessary to move to urban areas, where rates are high, and the standard of living is much higher. The government should take steps to promote rain harvesting, where willing individuals particularly from water challenged areas, could be financially assisted to buy tanks to have conservation storage and not be entirely dependent on government for clean water.

CHAPTER 4

DATA COLLECTION AND RESEARCH METHODOLOGIES

4.1 Introduction

According to Rajasekar, Philominathan and Chinnathambi (2013), a research study is an investigation aimed at finding a solution to scientific and social problems through objective and analytical analysis, with the aim of gathering new and useful information on a particular topic. The driving factor of research is to make a difference through a particular topic being researched. A methodology to be executed in gathering a research distinguishes how the information will be gathered e.g. information could be based on past experience, obtained from journals, books, survey questionnaires etc. Depending on the forms to be used in conducting experiments, training and skills transfer is one of the advantages of conducting research.

The objectives of this study included:

i. Promoting water preservation and bringing about ways to preserve it.
ii. Educating people about water and promoting awareness about water.
iii. Promoting effective maintenance strategies of water infrastructure.

The listed objectives give a clear indication on how knowledge, skills transfer, and training could have been achieved whilst conducting the research.

The primary methodology adopted to suit the study was a mixed method research, comprising qualitative and quantitative research methods. Mafuwane (2012) refers to Sale *et al.*'s (2002) comments with regards to the combination of qualitative and quantitative methods, that together they share a unified logic, and the same rules of inference apply to both. The author further indicates that the combination of both approaches provides a variety of perspectives from which a particular phenomenon can be studied, and they share a common commitment to understanding and improving the human condition, and a common goal of disseminating knowledge for practical use. Mixed methods research brings the benefit of using both numerical and theoretical aspects, while running them parallel in finding conclusive findings on what the study is about.

Brief (2012) uses an example to explain the difference between the two methods: the qualitative research method as a method focuses on determining the nature of the impact of a disaster upon

the affected population ("How" and "Why" questions), whereas the quantitative research method provides a guide to understanding the magnitude and scale of the humanitarian crisis by providing a numeric picture of its impact upon affected communities ("How many" "How Much" questions).

Through the quantitative research approach in this study, the severity of the water situation in various areas of the Eastern Cape was determined, for instance, water infrastructure and analysing its frequency of failure in specific areas. On the other hand, the qualitative research approach helped develop an understanding of what lay behind these problems related to water supply within the Eastern Cape. It also motivated the corrective measures while digging deeper in the findings to understand the motives that result in poor performance of water supply in the Eastern Cape.

This chapter focuses on the manner the whole study was executed in respect of qualitative and quantitative approaches. The chapter outlines not only the theoretical view that supports the findings of other researchers, the experience of this researcher and observation of the areas of study visited, but also refers to questionnaire and interview data which were used to gauge the situation of water supply in the urban and rural areas of the Eastern Cape. A comparison approach between urban and rural areas was used to set the standard of an acceptable scenario in relation to water supply.

4.2 Research design of the study

Rajasekar, Philominathan and Chinnathambi (2013) refer to research designs as the various approaches to be used in solving the research problem, sources and information related to the problem, and time frame and the cost or budget. Research design not only formulates a systematic plan for approaching a research project, but also provides a foundation for the entire research, detailing processes to be followed to achieve specific objectives required by the research.

A research design helps to identify the methods to be used in collection and analysis of data. At the same time, it formulates a specific plan that precisely answers the research question, while identifying important aspects that are pivotal in the planning of the entire research i.e. research site, participants, research method, timeline etc.

The major objective of the research was to ensure that the supply of water in both urban and

rural area of Eastern Cape was effective, at reasonable convenience and acceptable quality. The first consideration taken was the fact that the current standard of water being supplied in urban and rural areas was imbalanced. Therefore, the study covered a wide area within the Eastern Cape in order to establish conclusive outcomes of the general water situation of the province at large.

Considering the fact that some areas have only minor water supply related problems, the study therefore covered those areas so as to establish the correct practises they have in place to keep water supply problems to a minimum. The following is a general overview of the areas the study covered during the survey:

i. Rural areas (with access to water and with no access to water at all)
ii. Townships
iii. Urban areas (cities and suburban areas)
iv. Water treatment plants (for rural schemes, small towns and urban areas)
v. Various water sources (e.g. dams, weirs)

These various areas formed the basis of observation of the water supply to respective areas visited. These observations, together with the interviews and theoretical findings which formed most part of the literature review brought a strong confidence to the findings of the study.

Various sources such as published academic journals, google scholar, dictionaries, online journals, blogs, newspapers, and textbooks were the backbone of the theoretical part of the study. The survey together with the theoretical findings managed to paint the picture of the importance of water, not only to human life but to the ecosystem generally, where economic stability was indicated as crucial to achieve balance in different societies. In addition, it managed to drive the study to emphasise its objective of making a change in areas with different standards in the Eastern Cape. Terre-Blanche, Durrheim and Painter (2006) argue that in a research design a plan or structured framework is meant to execute the research as well as indicate the research pattern, highlight the purpose of the study, the method employed, and the situation within which the observation occurs.

In this study, this was achieved through literature gathered, interviews and questionnaires performed, and various sites visited (areas with water and without water).

4.2.1 Research paradigm

The research paradigm is the driving factor that pushes the researcher to conduct the research. It is a philosophy of viewing things at a different angle to how they were previously viewed or how they were being implemented. Creswell (2007) argues that a research paradigm is a basic belief that compels one to undertake research. The author further elaborates that this belief is initiated by a philosophical assumption, which involves bringing one's own ideas or beliefs that ultimately translates to a research study.

In reference to the topic of the study, the driving force behind completion of the study through the mixed research method was to establish theoretical and statistical facts around water supply in the urban and rural areas of the Eastern Cape. The researcher observed the imbalance between the two areas and tried to bring about an acceptable standard of water supply in both areas. More importantly the study was driven to create awareness in the water service authorities and water users about using water responsibly to rescue or at least relieve the water resources in the water scarce province of the Eastern Cape.

4.3 Questionnaire survey and design

In the process of gathering information that assisted in providing substantial results, interview and questionnaire methods were implemented. These methods ensured that the survey reached every level of water user, supplier and relevant authority.

A generic questionnaire and interview were prepared for both urban and rural areas, suitable for minimal level of knowledge regarding water and surrounding water infrastructure. It is often the case that one department does not realise its internal failures, and rather sees failures of the other departments. The questionnaire and interview were structured in such a way that they reached all water related sectors and the public in order to identify and determine what one sector would like to see changed by the other and vice versa.

These interviews and questionnaire targeted:

i. Professionals (engineers, contractors, water service authorities)
ii. Semi-professionals (funders i.e. Municipal Infrastructure Grant (MIG) workers, labourers)
iii. General public (water users, and stakeholders)

4.3.1 Target population and sampling method

The target population was the affected parties, the involved parties and the service providers. In the case of both urban and rural areas, a random selection of suburbs and villages were included for the questionnaires. The number of suburban areas chosen was equal to the number of villages, in order to have a balanced number of responses from either side and eliminate bias.

The number of urban areas and rural areas were balanced, and the number of participants in the questionnaire process consisted of equal numbers from either side (urban and rural areas). In order to attain conclusive results, the participants were required not to be very young or very old, e.g. the participants had to fall between the ages of 18 and 62.

A total number of 12 villages in respect of rural areas and 12 suburban areas in respect of urban areas were visited. A total number of 60 participants in each area participated specifically in answering the questionnaire. The interviews were conducted with water service providers or authorities i.e. Metropolitan Municipality, District Municipality, Water Service Providers, Engineers, Technicians and Technologists.

4.3.2 Delimitation

The study was geographically limited to the Eastern Cape province. The areas covered by the study included, the Southern Eastern Cape (former Ciskei), which was a little developed and contained fewer rural areas, and Northern Eastern Cape (former Transkei), which was poorly developed and dominated by rural areas, also, the Eastern side of the province, which is basically coastal, and lastly, the inland region of the province which is dominated by farmers and also underdeveloped.

Concrete information was obtained from various groups in the community, and different groups of professionals within the water sector.

4.3.3 Limitation

The study covered a wide area in order to provide results based on a variety of situations around the province. The questionnaire was conducted on uneducated and educated participants with knowledge of water supply of their respective area.

4.3.4 Questionnaire and interview

A standard questionnaire which examined how urban and rural dwellers responded to the same question was presented in each area. A prepared letter accompanied the questionnaire stating the details of the researcher, research title and objectives, and information intended to be covered by the questionnaire.

The letter which was presented to the participants prior to the handing over of the questionnaire is attached as Appendix 1 and the questionnaire is attached as Appendix 2. Forming part of the questionnaire is the observation section which was completed by the researcher. A letter requesting for permission to conduct a research in the area of Amathole District Municipality is attached as Appendix 3 and a letter granting permission is attached as Appendix 4. Another letter was sent to the city manager of Buffalo City Metropolitan Municipality requesting for permission to conduct the research (see Appendix 5), and an approval is attached as Appendix 6. A last letter similar to the one sent to the Amathole District Municipality was sent to the OR Tambo District Municipality and approval of that letter is attached as Appendix 7.

Interviews were conducted with professionals and semi-professionals within the water sector in government and private entities. Those included, local engineers and water supply services officials (municipalities) who had in-depth knowledge regarding water schemes of the areas visited during the survey. A prepared interview question for municipal officials is attached as Appendix 8 in reference of permission indicated above as Appendix 4, 6 and 7. For engineers, technicians and technologists, a letter requesting permission to conduct research at Aurecon SA is attached as Appendix 9, and an approval based on that letter is attached as Appendix 10 and lastly the interview protocol is attached as Appendix 11.

The questionnaire and interview were structured in such a way that they communicate a positive message on how one is supposed to handle water, considering that it is a scarce resource in the province.

4.3.5 Significance of the study

Potable water is crucial to life on earth, not only to human life but plants and animals depend on it too. Economic and social development as well as environmental sustainability would be halted if water becomes a non-existing resource on earth. It is therefore a priority agenda for governmental entities who are responsible for water supply that they ensure people have access to potable water.

Water of bad quality is unusable and unsafe as it results in water-borne diseases such as cholera and diarrhoea. The WHO (2015) argues that many children under 5 years and elders over 60 years die from water-borne diseases such as diarrhoea. This therefore confirms that water of poor quality is the main cause of such diseases.

Water resources are feeling the strain as many factors contributing to its shortage are becoming uncontrollable, hence the study brought motivation and awareness regarding the proper usage of water.

4.4 Data collection

Research is defined as a systematic way of finding and gathering information. Data collection is a systematic technique which allows particular information about the study to be collected. According to Chaleunvong (2009), the importance of collecting data systematically is that if data is collected haphazardly, it will be difficult to answer the research question in a conclusive manner, a scenario which can be avoided when a systematic approach is used.

Creswell (2007) visualises data collection as a process of engaging in various activities, which includes but goes beyond collecting data. These activities include locating a site or an individual, gaining information, exploring field issues, and storing data.

There are various data collection methods that could possibly be used in a study depending on the research methodology being used in that study. Below are techniques provided by Chaleunvong (2009) which were used in the study:

i. Using available information
ii. Observing
iii. Interviewing (face to face)
iv. Administering written questionnaires

The above listed data collection techniques made it possible and easy to accommodate a mixed method research which was used in this study. Through these techniques, the objectives were thoroughly explored.

4.4.1 Introduction

Qualitative method of collecting data is best suited for gathering available information, observation, and interviews, whereas quantitative methods of collecting data ultimately

translates to numbers and is best suited for surveys, questionnaires and group discussions.

As indicated under point 4.1, the study used a mixed method of research which is a combination of both qualitative and quantitative research methods. This basically meant all the data collection techniques identified by Chaleunvong (2009) were all applicable and were efficient in gathering of the information for this study.

4.4.2 Data collection approach and technique

In collection of data, a letter was first presented to the participants and a further explanation was done by the researcher about what the study entailed and objectives of the study. A questionnaire and interview were set in such a way that people could add their opinions over and above the questions asked in both the questionnaire and the interview.

Citing Glense and Peshkin (1992), Mafuwane (2012) outlines activities that take place during qualitative and quantitative approach modes. Table 7 below is a typical illustration of various approaches performed for both methods during a research process.

Table 7: Data collection approach applied

Quantitative approach	Qualitative approach
Begin with hypotheses and theories	End with hypotheses and grounded theory
Manipulations and control	Emergency and portrayal
Uses formal instruments	Researcher as instrument
Experimentation	Naturalistic
Deductive	Inductive
Component analysis	Searches for patterns
Seek consensus, the norm	Seeks pluralism, complexity
Reduces data to numerical indices	Makes minor use of numeric indices
Abstract language in write-up	Descriptive write-up

Source: Mafuwane (2012)

4.4.2.1 Structure and collection of the questionnaire

The questionnaire was structured in a way that required less technical knowledge. It was prepared for a general community with low education qualification but who have the basic knowledge of the water supply and its infrastructure. The purpose of the questionnaire for the community was to give them an opportunity to table their views and opinions with regards to water supply and indicate their satisfaction about the water suppliers and authorities

responsible for providing water to them.

A random selection of villages in rural areas and suburbs in urban areas was used. That also applied to participants who took part in the study. All questionnaires were conducted in a one on one situation with the participants.

4.4.2.2 Structure and collection of the interviews

According to Easwaramoorthy and Zarinpoush (2006) an interview is a conversation for the purpose of gathering information that involves an interviewer (who coordinates the process of the conversation and asks questions) and an interviewee (who responds to those questions). During the interview process the interviewees are given an opportunity to voice their feelings and thoughts with regards to questions being posed.

The interviews were conducted in a one on one procedure with the respective officials. The interview question was emailed to the participating respondents prior to physically meeting them. An appointment for interviews was arranged through an email with respective participants.

4.4.3 Validity and reliability

Considering the fact that the study comprised both qualitative and quantitative research methods, the validity and reliability of the study was much broader than in a situation where only one of the research methods was applied. The qualitative research element in the study introduced the concepts of trustworthiness, dependability, transferability and credibility into the study (Mafuwane, 2012). De Bruin (2011) refers to validity as the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of interpretations and actions based on test scores. The author further refers to reliability as a concept of consistency and replicability over time, where particular assessment giving more errors is deemed unreliable and vice versa.

In order to ensure the validity and reliability of the content of the questionnaire and interview, they were both reviewed by the relevant supervisor assigned by Durban University of Technology. In the process of conducting the survey, both questionnaire and interview questions were read out and thoroughly explained to the participant in their preferred language in order to bring proper understanding to the questions posed.

4.4.4 Ethical considerations

Ethical considerations are of outmost importance when conducting a research study in order to treat participants in a manner suitable for their culture, beliefs, physical conditions and situation. Akaranga and Makau (2016) define ethics as a branch of philosophy that deals with the conduct of people and guides the norms or standards of behaviour of people and relationships with each other. Important ethics that were considered in this research study were as follows:

4.4.4.1 Permission

Prior to conducting a survey (questionnaire and interview) a consent letter was written to the relevant governmental officials responsible for the various water schemes to be visited, requesting for permission to access the areas and conduct a survey. Written approvals from Amathole District Municipality, Buffalo City Metropolitan Municipality and OR Tambo District Municipality were obtained, giving a go ahead to visit all of their water schemes and conduct a survey. The letters of permission for each governmental entity are provided in Appendixes 4, 6 and 7.

4.4.4.2 Anonymity and confidentiality

Anonymity refers to keeping secret the information the respondent conveys during a survey, by refraining from using names in any way that will result in identification of a particular respondent. According to Akaranga and Makau (2016), once the researcher indicates to the participant that information will be kept confidential, that creates a room of comfort and honesty by the participant.

In the study the respondents were assured that their names and job titles would be dealt with in the strictest confidentiality. The respondents were further promised that the information they were to give was going to be used for academic and knowledge dissemination only.

4.4.4.3 Voluntary participation

The community members who took part in the questionnaire were made aware that they were not obliged to take part in the research and that at any stage of the questioning they could exercise the right to withdraw their participation without any penalties whatsoever. A consent form was given to and explained to the participants who took part in the survey and signed by them.

The same applied to the interview, a consent letter was sent prior to the occurrence of the interview. Before the commencement of the interview, it was explained to the participant that at any stage if they felt uncomfortable with the interview, they could withdraw and there would be no penalties or consequences for doing so.

4.5 Conclusion

The research method (mixed method) chosen for the collection of data and completion of study posed many benefits such as gathering knowledge and other people's ideas and experience, while it also took into consideration literature on studies completed by other researchers. The mixed method used in the study allowed the researcher not only to pose questions to the participants but also to educate and make them aware where necessary, through the questionnaire and interview prepared for them. A sense of responsibility, particularly by water service providers was emphasised in the prepared interview. However, the water users were also made aware on matters to consider in order to achieve the required way of handling water.

The importance of putting other people first was emphasised in this chapter, particularly in the data collection section, where ethical issues took a central role in collection of data, in order not to create a stressful or frustrating situation during the survey process. The importance of gathering reliable and valid information was key. This was achieved through explaining and promising participants that the information they shared would not be published and that their names would not be made public.

A randomisation process of selecting areas and participants was applied in both urban and rural areas. This was done to avoid a bias in the study and create balance in gathering of information.

CHAPTER 5

RESULTS: DISCUSSIONS OF INTERVIEWS AND QUESTIONNAIRE RESPONSES

5.1 Introduction

This chapter presents the results from the respondents of interviews and questionnaires arising from the data collected in urban and rural areas within the three municipalities of the Eastern Cape namely, Buffalo City Metropolitan Municipality, Amathole District Municipality and OR Tambo District Municipality. The responses to the questionnaires and interviews are summarised to gather quantitative findings and perhaps to support qualitative findings covered in the literature review of the study.

A collective effort by Water Service Providers, Water Boards, the Department of Water and Sanitation along with technical support for the water infrastructure and cooperation from water users is the only solution that could possibly address the problems associated with water supply in urban and rural areas of the Eastern Cape. The structuring of the interviews and questionnaires sought to deeply engage all involved stakeholders/parties so that the emerging findings could contribute to bringing about change to the water supply situation.

Interviews (Appendix 8) were prepared in such a way as to accommodate Water Service Providers within the province. Thus, interviews were conducted with Buffalo City Metropolitan Municipality water engineering officials, Amathole District Municipality water engineering officials and OR Tambo District Municipality water engineering officials. This provided a platform to gather views and suggestions of those responsible for providing raw and potable water for water users.

With regards to the questionnaire (Appendix 2), there was a section for recording of observation by the researcher so as to categorise the areas where the study was being conducted. Another section was for both urban and rural participants to complete based on their experience of the water situation in their respective areas.

5.2 Structuring of questionnaire and interviews

5.2.1 Distribution of the questionnaires and percentage rate of response

In drafting the questionnaire, various factors were taken into consideration. Considering the fact that the study involved rural dwellers in the Eastern Cape, the questionnaire had to be able to accommodate the level of knowledge and education of people who do not have any formal education. Secondly, due to the size of the Eastern Cape, the questionnaire was conducted in various municipalities that represented the core areas the study wished to focus on i.e. urban areas and rural areas.

A single set of questions was prepared such that it was answered by both urban and rural participants (Section B). There was also a section to be answered by the researcher (Section A) with his observations of the situation with regards to water supply and infrastructure of each area of investigation.

Table 8: The number of questionnaires distributed to participants and the number of responses

	Urban areas Nr of participants	**Nr of returned responses**	**Return rate (%)**	**Rural areas Nr of participants**	**Nr of returned responses**	**Return rate (%)**
Nr of participants in BCMM	500	478	96%	0	0	0%
Nr of participants in ADM	500	458	92%	750	694	93%
Nr of participants in ORTDM	500	466	93%	750	688	92%
Total Nr of participants in each area	**1500**	**1402**	**93%**	**1500**	**1382**	**92%**

In Table 8, it is to be evident that Buffalo City Metropolitan Municipality did not consist of rural areas, only townships which were included under urban areas, because they normally use same source of water. A total number of 1500 participants in both urban and rural areas were either mailed or handed questionnaires i.e. 3000 altogether. Altogether 1402 (93%) were returned from urban areas and 1382 (92%) were returned from rural areas.

The majority of the questionnaires were hand delivered to participants, at which time questions were translated and thoroughly explained to the participants, particularly in the rural areas.

5.2.2 Distribution of the interviews and the percentage of responses

Similar to the questionnaire, the interviews were also done in two separate sections. Section A of the interviews was for Water Service Authorities/Providers be it governmental entities or private entities. Section B of was for Service Providers who were engineers, technicians or technologists, irrespective of whether they were established as consulting firms or construction companies.

Table 9: Number of interviews distributed in reference to Section A of Appendix 8

Water Service Providers	Number of participants	Number of respondents	Percentage rate (%)
OR Tambo District Municipality	10	10	100%
Amathole District Municipality	10	10	100%
Buffalo City District Municipality	10	10	100%
Total Number of Participants	30	30	100%

Table 9 is an illustration of the number of officials from different governmental entities who took part in the study. An equal number was interviewed in each entity, so as to ensure that the representation of areas was equal.

Table 10: Number of interviews distributed in reference to Section B of Appendix 11

Category	Number of participants	Number of respondents	Percentage rate (%)
Engineers	8	6	75%
Technicians	6	6	100%
Technologist	7	6	86%
Total Number of Participants	21	18	86%

Table 10 is an illustration of a number of interview questions mailed out to the indicated participants and the percentage of feedback received. These participants were all in the Eastern Cape working within the municipal areas of the study area. As presented in Appendix 9, participants were also employees of Aurecon Consulting Engineers. The importance of equal number of participants was disregarded due to the fact that these participants at some point perform the same functions and were all categorised as professionals.

5.3 Questionnaire analysis

5.3.1 Section A: Observation

Three municipalities namely OR Tambo District Municipality, Amathole District Municipality and Buffalo City Metropolitan Municipality were visited in conducting the survey. Eighty percent of the areas visited in the ORTDM were rural and the remainder were urban areas comprising small towns and surrounding townships. In ADM, 75% were rural and 25% were urban areas and lastly, in BCMM the whole area visited comprised suburbs and townships which were both categorised as urban areas for the purposes of this study. Figure 9 is a graphical illustration of the type of areas studied.

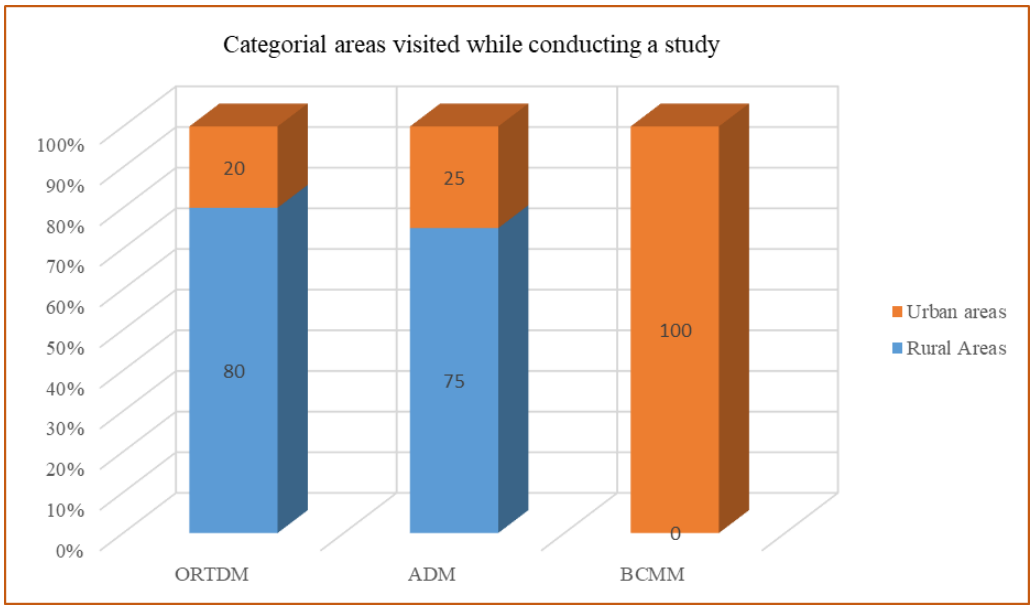

Figure 9: Type of area studied

5.3.2 Section B: Questionnaire

The questionnaire consisted of numerous questions that sought to investigate the water situation of the areas visited, the general state of income of the communities, the reliability and access to water.

5.3.2.1 Demographic characteristics

Table 11 shows the gender and age distribution of the participants. As the participants were randomly selected, but nevertheless the results show that there were more older people in the rural areas than in the urban areas. One can expect that the middle age group (from 31 till 60) are more knowledgeable of general ongoing activities within their respective societies,

therefore the information from the questionnaire was well informed pertaining to the water situation of the study areas considering the age of the participants.

Table 11: Age and gender statistics

Category	Gender		Age (years)					
	Male	Female	< 20	(21 - 30)	(31 - 40)	(41 - 50)	(51 - 60)	> 60
Urban Areas (Nr)	589	813	98	365	393	308	168	70
Rural Areas (Nr)	525	857	55	249	290	332	359	97

Table 12 illustrates the difference in level of education and income scale between rural and urban areas.

Table 12: Education level and monthly income scale between urban and rural areas

		Rural (Nr)	Urban (Nr)
Education Level	No formal education	304	42
	Primary education	636	84
	Secondary education	373	365
	Tertiary	69	911
Monthly Income	< R3000	677	98
	(R3000 - R8000)	304	266
	(R8000 - R15000)	83	435
	(R15000 - R25000)	152	336
	(R25000 - R35000)	111	126
	> R35000	55	141

Factors influencing such wide differences in education between the two areas include low income to the large percentage of elderly respondents in the rural areas. The elderly group in rural areas were mainly dependent on government grants. Government projects such as Expanded Public Works Programme rural gravel maintenance programme contributed extensively to income in the rural areas. There was basically no home with zero income due to government grants.

Table 13 reflects the marital status and years in which the participants have been residing in their respective areas. Many participants have been permanently residing in rural areas for a period of 15 years and more, unlike in urban areas, where a large number of people have been less than 5 years residing in the same place. This might be due to the fact that the level of

education in urban areas is higher than that of rural, making it easy for urban dwellers to change places of residence in cities due to flexibility in acquiring new jobs.

Table 13: Marital status and years of residence

		Urban Areas	Rural Areas
Marital Status	Single	508	422
	Married	532	679
	Divorced	218	94
	Widowed	144	187
Years of Residence	< 5yrs	677	164
	6 - 15yrs	387	187
	15 - 30yrs	193	445
	> 30yrs	145	586

5.3.2.2 Access to potable water and water sources being used

The study found that some rural areas were still dependent on rivers, dams, springs and rain for water. On the other hand, all areas visited in the urban areas had access to water even though some urban dwellers had minor water related complaints such as leaks. Figure 10 illustrates the percentage of people with access to water in urban and rural areas. Of all participants who took part in the study, 1402 (100%) of participants had access to water in the urban areas and 1064 (77%) had access in the rural areas.

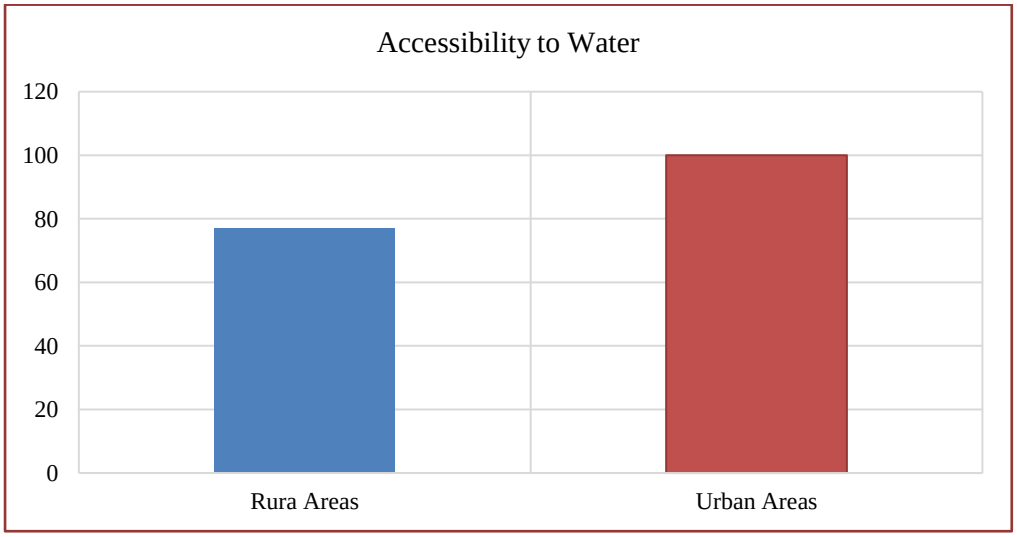

Figure 10: Percentage indication of access to water between urban and rural areas

Falling under the category of urban area, the Idutywa Township was the only area not reticulated with water pipes and taps. Each household in this township was provided with a 2500 litre water tank which came with each house when they were handed over to beneficiaries

after they were constructed (See Figure 21 of Appendix 12). In some rural areas, people still use donkeys to fetch water from nearby dams and river and are also dependent on river water to wash clothes (See Figures 16 and 18 of Appendix 12).

A total of 318 (23%) participants indicated that they had no access to potable water whatsoever, and they were solely dependent on rain water (tanks) or otherwise nearby springs and rivers. Out of these 318 participants, 29 indicated that even though they did not have access to potable water, the infrastructure was installed in their village 6 years ago but after the diesel generator which was the source of power for the borehole was stolen, no further efforts were made to restore the water supply.

With regards to infrastructure in both urban and rural areas, the findings were common that the infrastructure belonged to the District Municipality.

5.3.2.3 Water tariffs and convenience to access potable water

All citizens residing in urban areas had access to water for the past 20 years. In the case of townships which were developed in the past 5-6 years, the beneficiaries were supplied with a reliable supply of water during the housing handover e.g. water tanks that get refilled from time to time.

In the case of water tariffs, urban area dwellers were all paying for water. Within the urban areas the range of paying for water tariffs was: 75% of urban area dwellers were paying below R250 per month, and the remaining 25% was paying between R255 and R400 per month. Both the 75% group and 25% group were utilising approximately 60 to 120 litres per person per day.

In the case of rural areas and in relation to 77% of the group that had access to potable water, 85% of those respondents had water for between 5 to 15years, and the remaining 15% of respondents had access to water in the past 5 years. To all these rural dwellers, water was being supplied for free. On average rural respondent were using approximately 50 to 80 litres per person per day.

Results show that 91% of urban dwellers accessed their water in the house where they had proper plumbing allowing them to have either inside baths or showers, and 9% of these in urban areas, particularly in some townships, had yard connections. In the case of rural areas, there were no house or yard connections. The taps were at a communal point, where people were at a distance of between 50m and 800m away from the standpipe.

5.3.2.4 Reliability and satisfaction about the supply of water

Water reliability and satisfaction refers to the likelihood the availability of water in a particular area, and satisfaction of the users in relation to the quality of water.

In urban areas, 939 (67%) respondent indicated that they never had issues with availability of water. These respondents were living in the city and surrounding suburbs of BCMM and within the city of ORTDM. The remaining 463 (33%) of urban areas that complained about having unreliable water were from small towns such as Butterworth, Idutywa and townships in the surroundings of the cities of the three municipalities.

In rural areas, 170 (16%) indicated that water was reliable, with 894 (84%) respondents indicating that water was not unreliable. These respondents indicated that they made their own measures to deal with the situation of unreliable water supply. According to some respondents, water was open for certain period of the day and closed at other times.

In question 14 of the questionnaire respondents were asked if they ever had water cuts/shortages and were asked to choose from the following options: (a) never, (b) once in a week, (c) 2 – 3 times a week, (d) over a week.

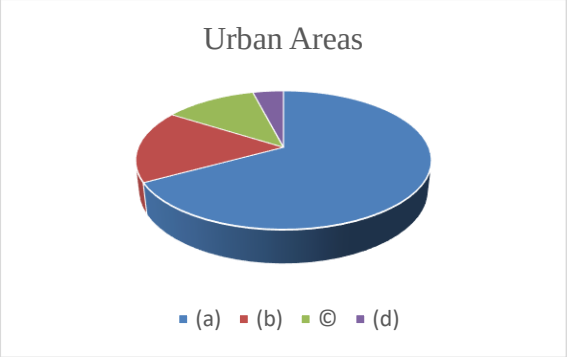

Figure 11: Percentage of reliability in urban water supply

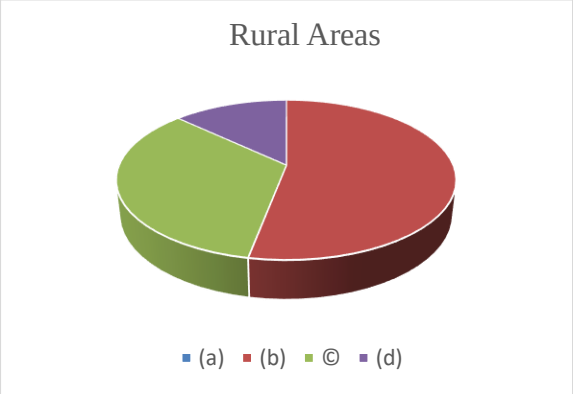

Figure 12: Percentage of reliability in rural water supply

According to Figure 11, the results of the respondents in urban areas were that 939 (67%) respondents had no issues pertaining to water cuts, 238 (17%) of urban respondents had water cuts once in a week, while 168 (12%) had water cuts 2 to 3 times a week, and lastly, 56 (4%) of these urban respondents had water cuts for over a week. Figure 12 illustrates results for respondents who were rural dwellers. Figure 12 indicates that 564 (53%) of respondents experienced water cuts once in a week. 362 (34%) and 138 (13%) had water cuts between 2-3 times a week and for over a week respectively.

In terms of satisfactory rating in relation to the quality of water as questioned in question 22 of the questionnaire, all urban area respondents indicated that the water quality they were being supplied with was 'Satisfactory'. This includes the Idutywa Township which was being supplied with water tankers by the municipality when their tanks were running empty.

Of the portion of rural residents who had access to potable water (77%), 766 (72%) had their water supplied by the municipality and indicated that the quality of the water they were drinking was 'Satisfactory'. The remaining 298 (28%) indicated that their water quality was 'Bad' associating the reason to taste. The 318 (23%) (out of the 77% that had access to potable water), 301 (23%) had to find water themselves and indicated that the quality of water they used was bad and they had to use filters in many instances, particularly when they fetched water from river and dams for drinking purposes.

5.3.2.5 Management and maintenance of water infrastructure

Generally, the water infrastructure in both urban and rural areas belonged to either the District Municipality or the Metropolitan Municipality. The supply of water to the end users and the operation and maintenance of various water schemes were all the responsibility of the District Municipalities and the Metro Municipalities in the areas visited for survey.

The response from urban area participants to question 17 and 18, showed a difference in opinions regarding the condition of infrastructure and their maintenance. In the urban areas 224 (16%) of the respondents indicated that the infrastructure was good, seldom requiring maintenance, 883 (63%) indicated that the infrastructure was fair, seldom requiring maintenance, and the remaining 294 (21%) which were mainly made up of small towns and townships indicated that the infrastructure was bad and frequently required maintenance.

In rural areas, 223 (21%) participants indicated that the infrastructure was good with seldom

maintenance, 702 (66%) indicated that the infrastructure was fair with seldom maintenance and 138 (13%) indicated that the infrastructure was bad with regular maintenance, which they associated with vandalism, illegal connections and ageing infrastructure.

In respect of question 21, 1094 (78%) respondents within urban areas indicated that the maintenance response was within a day. These respondents were mainly residing in the suburbs or within the city of the metropolitan municipality and those residing within big cities such as Umtata and King Williams Town. A total of 308 (22%) in urban areas indicated that, their maintenance response took between 1 to 3 days to be attended to. These respondents were mainly within small towns and townships that are a distance far from the operational and maintenance offices of the district municipality.

In rural areas 106 (10%) respondents indicated that it took less than a day, for their water issues to be attended to, with 596 (56%) respondents indicating that it took between 1 to 3 days for the water issues to be attended to. One hundred and forty-nine (14%) respondents indicated that it took a week for their water issues to be attended to, with 213 (20%) indicating that it took over a week for their water issues to be attended to.

5.3.2.6 Confidence in the supplied water

Haavardsholm and Naden (2009) refer to confidence as being comfortable, relaxed and feeling secure in a particular thing or someone. All respondents residing in urban areas understood that prior to distribution of water there was an extensive purification of water in order to achieve a certain acceptable quality of water. The response to question 23 by urban participants, was a unanimous "No". However, the response to question 24 was that 645 (46%) respondents firmly preferred store bottled water, while 463 (33%) preferred tap water, and 294 (21%) were willing to use either tap or store bottled water.

Among the rural area responses there were cases of illness associated with water drank by respondents; 75 (24%) out 318 (23%) respondents who did not have access to potable water indicated that they had had illness associated with the water they used, and 242 (76%) had no cases of illness associated with water. In the case of 1064 (77%) participants who indicated that they were being supplied by municipality with water, only 32 (3%) participants indicated that they had illness associated with water. Even so, 500 (47%) indicated that they preferred store bottled water, while 330 (31%) preferred tap water, and 234 (22%) preferred both tap and store bottled water.

Among other things mentioned by both urban and rural participants was that the smell and taste of water were not consistent i.e. the smell and taste were either too strong or abnormal, also the amount of chlorine was sometimes visible in water giving a distinctive smell to the water.

5.3.2.7 Responsible water usage and means to save it

Respondents residing in both urban and rural areas, with governmental or self-supplied water, using taps or tanks, indicated that they took cautious care in usage of water and that when they were brushing their teeth, they made use of a glass or cup in order to use a controlled volume of water.

With regard to question 25, 785 (56%) participants in urban areas indicated that they used the shower when having a wash, while 365 (26%) indicated that they took baths and the remaining 252 (18%) washed using a plastic basin. In respect of 1382 rural participants who took part in the study, 1285 (93%) participants used plastic basins when taking a bath, and 97 (7%) participants took showers.

The responses to question 29 which was about ways of saving water were very similar from both urban and rural participants. The common stand out answers received from urban participants were:

i. When washing cars, they used buckets instead of hosepipes
ii. Collecting grey water from shower for flushing toilets
iii. Using water saving shower heads
iv. Regular self-maintaining dripping taps in the property
v. Rain harvesting – which then gets used for drinking and cooking purposes

The answers collected from rural participants with regards to water saving measures were:

i. Rain harvesting – which gets stored in tanks and numerous water buckets
ii. Usage of plastic basin to take a bath which uses less than 5 litres of water
iii. Using river water/raw water for garden watering

5.4 Interview analysis

5.4.1 Governmental entities and private service providers

The interviews of governmental entities and water service providers targeted water service providers that were responsible for the supply of water to end users. The participants were

targeted from within three water service authorities, namely ADM, ORTDM and BCMM

5.4.1.1 Source of water, water quality and reliability of water supply

There were various sources used for water supply by the three water service providers, namely dams, river abstraction, boreholes and weirs. Sources such as dams and river abstraction were used mainly for the supply of urban areas i.e. cities and their surroundings suburbs and townships, while in the rural areas boreholes and weirs were commonly used as source of water supply. The boreholes were either manually operated (using generator engine) or automatic operated (using Eskom supplied power).

According to the respondents from three water supply providers (municipalities), the quality of water they supplied in both urban and rural areas was reasonably good. Twenty-five (84%) participants rated the quality of water supplied at 8 out of 10 in relation to question 3 of the Interview Section A, while 5 (16%) participants rated the quality at an average of 7 out of 10. In respect of question 1, out of 30 participants who gave their feedback, 20 (66%) participants indicated that water in their respective work area was reliable while 10 (34%) indicated that water was not reliable as there were frequent water cuts taking place.

5.4.1.2 Responsibility of maintenance of water infrastructure

All participants representing water service providers responded similarly to questions 4 and 5 of the interview section A. They indicated that there were specialised task teams which consisted of qualified engineers and technicians (Operational and Maintenance Unit) which oversee all technical related issues of the water infrastructure, however limited funds were hampering their service delivery.

According to the participants, there were ward councilors who were part of the community, and it was their responsibility to report any water issues to the municipality to be attended to. Respondents from ADM and ORTDM indicated that in some of their water schemes particularly in remote areas (in rural areas), there were other people employed to look after the mechanical infrastructure of their water schemes, such as diesel generators. In such instances, these operators were the link between the water end users and the operation and maintenance team of the municipality to report any water related issues.

Among other reasons identified by the respondents for poor water infrastructure were:

i. Poor designs that did not work for some mountainous Eastern Cape areas.

ii. Poor construction which results to infrastructure life span cut short
iii. Regular maintenance by unskilled people, with insufficient funds exacerbated poor infrastructure.

According to the municipal respondents there was a database register of municipal assets from within the municipalities that reflected the condition of the municipal infrastructure, and any infrastructure requiring maintenance or replacement.

5.4.1.3 Condition of water infrastructure and ways to improve water supply

In reference to question 8 of the interview section A, 8 (28%) participants indicated that the bulk of their water infrastructure was good, while 16 (53%) participants referred to the infrastructure as fair and the remaining 6 (19%) participants referred to the infrastructure as bad.

Some of the ways to improve water supply mentioned by the participants included:

i. Ensuring efficient maintenance of water infrastructure.
ii. Improvement of water management.
iii. Provide training to the Operational and Maintenance team with enough allocation of funds for them to perform their duties.

Common complaints by urban and rural area respondents in accordance to question 10, were:

i. Issue of pipe bursts – According to the respondents, the reason for pipe bursts was due to ageing infrastructure and possible illegal connections particularly in townships which were continuously expanding due to informal settlements. Respondents mentioned routine maintenance as a solution to the problem, where old infrastructure would be replaced according to assessments conducted.
ii. Issue of water leaks – The respondents indicated that there were various factors contributing to these leaks such as illegal connections which are common and poor construction work which was poorly monitored by the municipality or municipal representatives. To address such an issue, the respondents indicated that it would take awareness of end users, and responsibility of the municipality whenever they have water construction jobs to appoint a competent service provider with enough funds allocated for full-time supervision of construction work.

5.4.2 Civil engineers, technicians and technologists

As indicated in Appendix 11, this interview section was meant to be undertaken by engineers, technicians and technologists who were working in the space of water engineering within the Eastern Cape. A letter requesting permission to conduct the research was sent to Aurecon SA, East London office (Appendix 9). An approval letter is as indicated in Appendix 10, with the interview questions that were e-mailed to the participants shown in Appendix 11. Table 10 is an indication of the number of participants who took part in the study.

The analysis of responses is grouped according to similarities of question e.g. questions 1, 2, 3 and 4 are grouped together in section 5.4.2.1, and questions 5, 6 and 7 were grouped together in section 5.4.2.2, and lastly, questions 8, 9 and 10 were grouped together in section 5.4.2.3.

5.4.2.1 General water situation and challenges encountered by engineers in the EC

There was a common view by all the participants that the government has made relatively good progress in terms of supplying potable water in both urban and rural areas. Even though there is still a gap between the two areas, the integration strategy being implemented by government means that many rural areas are getting an opportunity to get new water infrastructure installed.

Even though a number of respondents indicated that there was improvement in the supply of water in the Eastern Cape, room for improvement was highlighted by some participants, indicating that the government needed to provide an option of house connection for rural dwellers who were willing to pay rates suitable for low affordability standard people. The paying of rates was one of positive views taken from urban areas, where the misuse of water was limited due to the rates paid by urban dwellers. Another common view that was suggested by participants was that there needs to be a deployment of task unit to undertake water related issues in more remote areas in order to reduce long response time which can be days before water issues were attended to.

There were a number of responses received from respondents for question 3 of Interview Section B in Appendix 11. Below is the summary of responses received:

i. Too much competition in the construction industry that results in companies giving massive discounts when bidding for projects, a scenario that ultimately affects the quality of product provided by some of service providers (contractors).
ii. Political interference, which results in wrongful awarding of tenders.
iii. Insufficient qualified water engineers (contributing to poor designs and monitoring of

construction work).

According to respondents, the ultimate effect of the challenges facing civil engineers in relation to water supply of urban and rural areas were that the finished product (constructed work) gets compromised, with work being of poor quality and unable to service people for its planned lifespan. Funds get misused, resulting in a situation where service cannot further be escalated to some people who still need it, or perhaps improved for those who have it.

5.4.2.2 Key role players in water supply, infrastructure failure and input on civil engineers, technicians and technologists

According to the response from the participants, the water service providers which are the district and the metropolitan municipality in case of the Eastern Cape, are supposed to be the key players regarding provision of water to end users. The fact is that the municipalities get funded by national treasury and some government grants such as MIG from Cooperate Governance and Traditional Affairs (COGTA) to provide water infrastructure to all South African people in need of it, particularly those who have been disadvantaged before (e.g. rural areas).

Some respondent further took into consideration that, even though some stakeholders such as water users and civil engineers have a role to play regarding the efficient and sustainability of water and water resources, water service providers were the main players that could advise and motivate the other stakeholders to act accordingly in order to improve the water situation i.e. conservation and wise usage etc.

Improper repairs instead of complete replacement of defective infrastructure, and poor quality of work done by contractors were the common reasons pointed out by respondents as common causes of infrastructure failure. Another reason raised by the respondents was the fact that the ailing infrastructure is either maintained instead of being replaced or does not happen at all due to lack of funds allocated for operation and maintenance within the municipalities.

Fourteen (77%) respondents mentioned that drastic improvements in design were needed to suit the different areas of the Eastern Cape. A lack of technical personnel in governmental institutions (municipalities) results in impulsive approvals of work done for water service providers, and according to the respondents, if qualified technical personnel were available during the construction of the water infrastructure projects, it would be of great benefit to the

municipality and community as a whole in achieving quality work.

5.4.2.3 Water quality and its delivery to rural areas

According to 13 (72%) respondents, the quality of water supplied within the Eastern Cape was reasonably good, having gone through intensive purification. These participants mentioned the monitoring of pollution particularly by large firms in the urban areas as one way the quality could be improved, as some substances do not get cleaned out entirely through normal water purification process, till additional cleaning chemicals are added. On the other hand, 5 (28%) respondents referred to the quality of water supplied by municipalities as fair, particularly when taking into consideration the water supplied in the rural areas. As a means to improve the situation, the respondents mentioned the development of more raw water treatment plants particularly in the rural areas, where they do not exist at all.

There were numerous responses from the participants with regard to question 9 of the interview section B, which asked for possible reason for non-supply of water in various parts of the Eastern Cape. A brief summary and amalgamation of answers received was as follows:

i. Corruption, which results in funds not being properly spent and funds allocated for these rural areas ending up in the hands of wrong people.
ii. Political interference, where leaders put their home areas interests as priority instead of fair service delivery to all people in need.
iii. Poor monetary expenditure, where there are reports of funds being sent back to national treasury due to municipalities not having capacity to spend the money.
iv. Incompetent leaders who are given the responsibility to see to it that these areas get supplied with service such as water.
v. Never ending defects in areas that have already been provided with water, particularly urban areas. This results in excess funds spent on fixing old services rather than providing water to people who never had it before.

In respect of Question 10 of the interview section B, a common answer which came from 15 (84%) respondents was that the government, particularly municipalities need to practise the old way of having private representatives (consulting firms) adjudicating the appointment of service providers (contractors) in order to reduce corruption associated with government entities due to politics. The reasoning behind their answers was that private consultants were professionally registered persons who were registered with different engineering bodies such

as SAICE, ECSA and SACPMP. Their integrity and performance, therefore, would be monitored inline with those engineering bodies which emphasise honesty and fairness in execution of any kind of work. Secondly, the political pressure on these individuals would be less or virtually non-existent compared to government employees.

All respondents made mention of proper appointments which were not politically motivated in order to achieve desired goals. According to these respondents, quality of work was compromised where dodgy relationships were accommodated in the workplace between contractors and clients or consultants. Hence a proper screening to select a deserving candidate should be applied from the beginning till the end of a water infrastructure project.

5.5 Conclusions and recommendations

The mere fact that most questionnaires were physically handed over to the participants made the response figures very high. Interviews for municipal officials and engineers, technicians and technologist were e-mailed to the officials and quite a few possible participants never responded.

A summary of conclusions and recommendation based from the questionnaire and interview answers from the participants is as follows:

- The gender of participants between urban and rural areas was not of much importance. The gender status between these two areas was evenly distributed, although both urban and rural areas had a larger number of females compared to males (see Table 11). It was evident from Table 11 that the younger to middle age people were residing in urban areas, whereas the majority of people residing in rural areas were much older. This correlates with information reflected in Table 12, where it is evident that urban dwellers were more educated compared to rural areas and were therefore ultimately earning more money on a monthly basis. In respect of monthly incomes, it can be concluded that urban dwellers will paying rates for many more years because they are younger, while rural dwellers will probably reach pension stage sooner and monthly incomes will soon cease. However, a much-discounted portion of rates could be arranged for these rural dwellers considering the government grants they receive.
- In urban areas, a large number of people were not residing in one residence for a long time, whereas in rural areas the residents have been staying in same residence for many years. This could be translated to some sense of ownership for the water infrastructure,

where people in rural areas would take greater care of infrastructure as they would be well aware of it as an asset and they will bear the consequences if it fails, whereas in urban areas where residents know that they will leave the area anyway they might not bear the consequences of damages they could do to water infrastructure.

- Figure 10 illustrates the situation of access to potable water supplied by government in both urban and rural areas. Even though the percentages of people with access to water were seemingly high, the figure of people without potable water was exceptionally high in the rural areas. Meanwhile in the urban areas it seemed as if everybody had access to potable water. However, there were numerous challenges that prevented smooth supply of this water to people. In both areas (rural and urban) some people had to find alternative means to get water for themselves.
- It could be concluded from the findings that the standard of water supplied in the rural areas is below that of water supplied in the urban areas. Rural dwellers had to walk distances in order to access water, and these distances became even more as the villages expanded and became larger. The urban area water supply was plagued with its own water related issues such as high-water tariffs. The long distance to the communal water taps was one reason for illegal connections. Hence it is recommended by the study that rural dwellers be accommodated with house connections, with government imposing tariffs that correlate to the standard of living of rural dwellers.
- The water consumption between urban and rural areas was different, as was outlined in the findings, and the fact that rural dwellers had to walk long distances to fetch water, probably had an effect on how water was being used. On the other hand, the study revealed that water tariffs imposed in urban areas managed to promote usage of water in a sparing manner.
- The BCMM which covers the city of East London and surrounding townships had relatively few water cuts according to the respondents. It was revealed by the respondents that their supply dams had very good catchments and the dams were being maintained from time to time. This is the indication of how this one area does well to prevent water related complications. A positive idea could be drawn-out of a negative outcome, for example from the findings of the study it was highlighted how some urban areas experience water cuts even though the rain had been normal, and corrective measures could thus be practiced to prevent a similar situation.
- The variance of water standards between urban and rural area was not only based on

convenience of fetching water but also related to the quality of water they drink, where the findings indicate that a large number of respondents apart from those one who did not get supplied with water by the municipality were not entirely satisfied with the quality of water they drink. The level of water purification in rural areas was non-existent compared to urban, where water samples of supplied water were frequently checked for compliance. One reason for that might be that in most rural areas, boreholes were used as a source of water, and underground water was generally trusted to be pure and did not require intense purification before being used. However, the water service provider needs to consider a month to month verification of such since there is a high possibility of infiltration of dangerous substance from surrounding maize fields being treated with chemicals e.g. Dichlorodiphenyltrichloroethane (DDT) and chemicals from factories or spills from general and hazardous pollution.

- Water management was an issue of great concern, but it could be concluded that through correct appointments and dedication to delivery of services, the issue of improper supply of water could be a thing of the past. Both urban areas and rural areas experienced poor management when it came to water supply, but it was at different levels, due to the economic focus being more on urban areas. As recommended by the study, the solution to proper water management should begin with correct appointments from water service providers of engineers, and the presence of contractors on the ground. In that way, good quality of work can be achieved which will reduce water interruptions due to infrastructure failure and the life span of the infrastructure can be achieved with ease. Competent management should include establishment of an operational and maintenance unit doing routine maintenance depending on the status of the asset register (infrastructure assessment).
- According to the findings from the literature review, the quality of South African water is of a reasonable standard, but most respondents indicated that they preferred bottled store water. This was an indication that not everybody was confident in the supplied water. Some respondents from both urban and rural areas made mention of a chlorine smell and the milky colour of water they had been supplied with. Even though they assumed that was from purification of water, they were not entirely happy about it. The literature reports illnesses associated with water in rural areas, meaning an improvement was still required for people to have full trust in the water supplied by government.

- All participants who took part in the study answered the question regarding what means they used to practise saving of water. Findings showed that in both areas people were cautious about having no water and were making efforts to conserve what they were being supplied with. That was also proven by the number of respondents who were using water saving methods of personal washing.
- The general perception by respondents regarding the quality of their water (from the questionnaires and the interviews) was basically positive, but improvements were required to bring it to excellent as not everybody was entirely happy with the water being supplied. That proved the inconsistency of water being supplied in various areas within the Eastern Cape. The reliability was reasonable for the majority of respondents and only a few respondents answered that they had unreliable water supply.
- The municipal officials indicated that the operational and maintenance unit was suffering greatly due to insufficient funds to deal with maintenance issues. However, as one way to deal with improvement of infrastructure failure, respondents recommended that proper design and construction that increase life span of infrastructure and eliminate regular maintenance need to be adopted in future water infrastructure projects.
- In addition, it is recommended that water service providers (municipalities) try to work together with various governmental entities that contribute to the supply of water e.g. the Department of Water and Sanitation, requesting them to construct as many dams as possible while maintaining the existing ones, and on the other hand promote responsible ways of using water and preservation.
- Engineers, technicians and technologists which are generally the architects of water infrastructure networks and system, need to bring new ideas to reduce the failure of the water infrastructure i.e. design and construction monitoring.
- Water service providers need to play a go-between role where they ensure that water quality is being achieved by the deserving contractor who priced properly and qualified in terms of experience. According to respondents, governmental entities lack technical personnel to look after the completed water schemes. If this continues the failure of infrastructure will get worse rather than improve. Therefore, water service providers need to appoint more technical teams to deal with their water infrastructure as they are being constructed and completed.
- Similar to the findings of the literature review, the majority of participants indicated

that in some parts of the Eastern Cape the water quality was satisfactory to good, which cannot be said by some countries around the world. However, there was room for improvement to achieve more decent quality of water, as the blue drop system that measures the quality of water indicates that the Eastern Cape was still sitting at a low percentage.

CHAPTER 6

RESEARCH FINDINGS, ANALYSIS AND INTERPRETATION

6.1 Introduction

This chapter is based the observations related to the site visits (Section A of the questionnaire and interviews) as well as additional findings arising from the work experience of the researcher. In addition, the chapter examines corrective practices taken by various areas to address the water situation or perhaps prepare for worst occurrences. While doing so, it also elaborates on failures by various areas, departments or individuals to deal with the water situation.

A number of people in the Eastern Cape are acknowledging the fact that the government has been working tirelessly, trying to address the water backlog in the province. Talking to local people in the rural areas with no access to water at all, they had strong confidence regarding the supply of water as they see neighbouring villages being supplied with water. None of them were aware of any possible wrongdoing that was contributing to exhaustion of various water sources in the surrounding areas.

In collection of data, various areas in both urban and rural areas were visited. These areas included villages without water, with water and some with infrastructure but with no water. Townships which formed part of urban water supply were visited and a comparison between urban and rural was made with regards to water infrastructure set up.

In this chapter, not only flaws or improvements are identified, but good governance and corrective measures that could contribute towards satisfactory supply of water to end users, and how water conservation could assist water resources to last longer or to at least be sustained.

6.2 Management of water infrastructure and resources

With regards to management of water infrastructure and resources, there is either a good way or a bad way of looking at it. While conducting this research, various water schemes were approached, where signs of good and bad handling were encountered. The bad handling was associated with damage caused by people and non-maintenance and non-rehabilitation of water infrastructure and resources.

Similar to looting of government building such as clinics and libraries when there is unrest in various places, the water sector in some of the areas visited identified theft as being the cause of damage occurring to the water infrastructure.

6.2.1 Mavundeleni village

Mavundleni village is a mountainous area under the local municipality of Mhlontlo and OR Tambo District. The area consists of approximately seven thousand dwellers. The supply of water to the village is from a borehole situated at the lower end of the village.

The infrastructure in the area looked relatively new. According to one of the residents, the infrastructure was constructed in 2013. However, the water only lasted for a period of four months and after that it never came out of taps. The reason reported by residents was that the engine/generator which pumps the water to a local reservoir was stolen soon after it was installed and no further efforts to replace it and re-establish the water supply have been made.

6.2.2 Hewu village

The village of Hewu is a sub-village of Ndabakazi Village in Butterworth under a local and district municipality of Mnquma and Amathole respectively. The village is supplied with water from a borehole that is within the village. It is closely situated to the town of Butterworth, but its water scheme is separate from the town scheme.

Beside consecutive identification and disconnection of illegal connections in the area, there was an issue of stealing of copper taps in order to make money out of them. The removal of these taps resulted in non-stop running of water out of broken taps, exhausting the water resources.

6.2.3 Mgababa village

This village is situated in the Southern part of the Eastern Cape, under a rural town called Peddie. It is under Ngqushwa local municipality which is under Amathole District Municipality.

The water source for this village was changed. Initially they were using water from Nxuba dam which also supplies the rural town of Peddie. The municipality recently cut off the supply from the Nxuba Dam to the village and made use of local borehole pumping to a nearby elevated steel tank. This was due to constantly increasing population in the towns of Peddie and Port

Alfred which are fed from this dam.

Due to this change, the Mgababa village no longer has water. The reservoir was well placed to have enough pressure head, but the borehole was not yielding enough water to the elevated tank to supply Mgababa village.

6.2.4. Town of Butterworth

The town of Butterworth is a semi urban area, which consist of factories that attract a number of rural people who are seeking job opportunities. Butterworth has an estimated population of just below 300 000. It consists of a number of surrounding townships that contribute to the high number of residents. Butterworth is under the local municipality of Mnquma and District Municipality of Amathole. In addition to very long-standing townships in Butterworth, the municipality developed another township between years 2012 – 2013 as a means to relocate informal settlement dwellers from the town.

The entire Butterworth town (including surrounding townships) is dependent on Gcuwa dam as its only source of water supply. The Butterworth Water Treatment Works (BWTW) receives water from Gcuwa dam, whilst Gcuwa dam is on the receiving end of Xilinxa dam and other catchment areas between Gcuwa and Xilinxa dam. Xilinxa dam is regarded as the mother dam in relation to Gcuwa dam, but is situated approximately 25km away from the Gcuwa dam which results in massive water loss between the two particularly due to interruptions of water streams and channels.

Xilinxa dam is often at a low level due to poor catchment area, making the Gcuwa Dam a stand-alone. The catchment areas for Gcuwa Dam are perhaps very good, the only problem is that the Gcuwa Dam is currently heavily silted, making it impossible to hold enough water to sustain the people of Butterworth. A two-day non-stop rain during the period of the study resulted in the dam overflowing heavily due to large volumes of sand deposited at the dam (Figure 13). The volume of water collected in such a rain would only last the town for a period of not more than two months.

Figure 13: Silted Gcuwa dam in Butterworth

Figure 13 shows the silted Gcuwa dam with grass and bushes appearing on the water surface. The above discussed facts perhaps answer the question once asked by former ADM mayor Nomfusi Nxawe, regarding why, despite significant rainfalls in the Butterworth area, the Gcuwa dam was in fact quick to run dry (Dayimani, 2017). Grass and bushes are great water drinkers, hence it would be advantageous if the responsible department does not allow them to grow in the middle of the dam.

Considering the size of Butterworth dam, an additional township would put more strain on the unrehabilitated dam. The district municipality has pointed out the non-collaboration between governmental institutions (Department of Water and Sanitation) which was responsible for providing raw bulk water from dams to treatment plants in order for them to take the responsibility of purifying and supplying the water to the people.

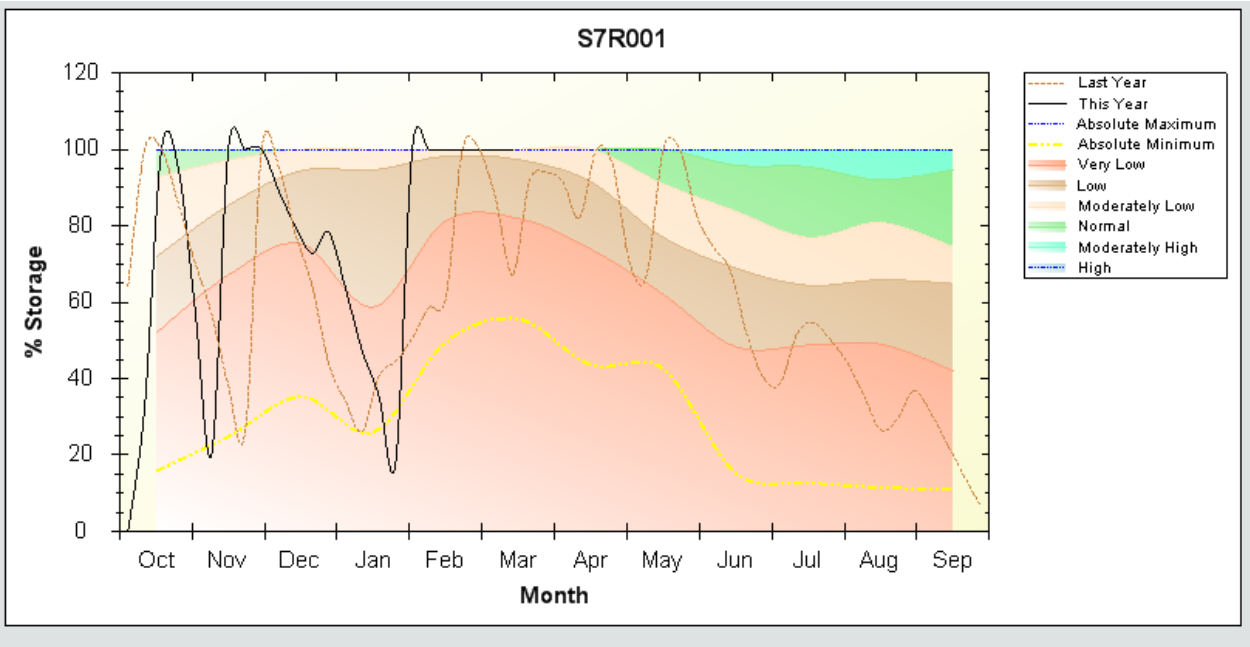

Figure 14: Gcuwa dam indication level 2017-2018
Source: DWS (2017b)

Figure 14 is an illustration of Gcuwa dam level indications between year 2017 and year 2018. According to Figure 14 above, the Gcuwa Dam between October 2017 and February 2018 was fluctuating to a point of over-flowing and suddenly dropped to a point of absolutely no water in the dam, in a space of four weeks and less. This shows how bad the Gcuwa dam capacity is and how urgent rehabilitation is required.

The same situation applies between March and June of 2017, the water level was fluctuating between high water levels to very low water level within the space of weeks.

6.2.5 Idutywa township

Neighbouring on Butterworth is the town of Idutywa. It is approximately 35km away from Butterworth and is under the local and district municipality of Mbhashe and Amathole respectively. Just like the town of Butterworth, Mbhashe local municipality has recently developed a township close by to the town of Idutywa.

Due to the size of the dam supplying the town of Idutywa, the municipality could not supply the newly constructed township from the same dam supplying the town of Idutywa. Each RDP unit was supplied with a 250kl Jojo tank temporarily, while the municipality is busy constructing dam that will boost the supply of potable water for the town of Idutywa and

surrounding townships. The township was developed in 2014 and in 2016 the construction of the dam to supply water was underway. According to the Amathole District Municipality water officials, during the dry season water tankers managed to fill up water tanks of Idutywa Township, while the town managed to go through the drought period with no major water shortages. Though water cuts were implemented, the dam managed to sustain itself and did not get dry up completely.

Even though the strategy implemented in the Idutywa Township might have critics, it proved the fact that proper planning and relevant technical skills can lead to successful supply of potable water at a planned time.

6.3 Operation and maintenance of water schemes

In the Eastern Cape the border between urban and rural areas is significant in relation to water supply. Even though the province is dominated by rural areas, many of these rural areas do not have access to potable water, while urban areas have all been provided with potable water for quite some time. Many rural areas still have a glimpse of old water infrastructure such as communal standpipes, reservoirs and windmills which were put in decades ago but have not been working for the last two decades.

The government has been making plans and strategies to address the backlog of this infrastructure in the rural areas, for instance, the government has introduced Municipal Infrastructure Grants (MIGs), the National Development Plan, and National Infrastructure Plan, all to solely focus on areas which were previously disadvantaged and do not have important services such as clean water. These grants and plans put in place by government also ensure the day to day functioning of existing infrastructure in urban and rural areas is attended to accordingly.

These small towns had infrastructure put in a while ago, but due to ageing the infrastructure has been deteriorating. Big cities like East London, Port Elizabeth and some attractive urban areas such as Port Alfred in the Eastern Cape have the issue of failing infrastructure due to age, and the migration to these big cities create immense strain that contributes to this deterioration.

A comment from the Operational and Maintenance Unit team of Amathole District Municipality was that the allocation of funds for their unit was extremely insufficient considering the problems they encounter. According to the team, the infrastructure they were

fixing on a day to day basis had gone beyond its life span to the extent that it was no longer being manufactured and this compelled them to request special fittings to be made whenever they had a burst or leak to attend to. For example, in the case of the water pipes they attend to, the old infrastructure was made from asbestos and it has been many years since asbestos water pipes were stopped from being used as water conduits. Hence, they were forced to replace them with PVC pipes and have had to request special adapters to combine these two different pipes. Due to such circumstances, attendance to water leaks takes longer than they should, resulting in local businesses, particularly restaurants, closing for days if they cannot make alternative plans for clean water.

6.4 Poor monitoring of works and lack of engineering capacity

The Mavudleni bulk and reticulation network was constructed with no supervision by the client or client's representative and the contractor had to approve his own work according to some participants of the Mavundleni village. Due to that, the locals report that the water came out of the taps for a few months and stopped. The water was only restored again when another contractor came to build a school in the village and needed water to do the construction. They investigated the faults and resolved all the blockages and broken pipes, and water was restored until the engine was stolen.

This scenario is an example of the poor monitoring of construction works taking place in some rural areas. This results in the collapse of infrastructure and failure of service delivery by water service providers. The same applies to the village of Mgababa, where poor engineering decisions were taken which caused a breakdown of access to potable water by local residents.

The lack of engineering skills in the whole of South Africa has badly affected the water supply in the country. That has compelled governmental authorities to turn to other countries to acquire services and skills in order to resolve the problem.

In 2015, Minister of Water and Sanitation, Nomvula Mokanyane announced that she was bringing 35 Cuban engineers to work with South African government to remedy the water situation which was getting worse rather than improving (Watson and Moloi, 2015). The lack of technical skills was corroborated by one of the interviewed engineers from Aurecon SA who mentioned that they were given a project by CoGTA to visit specific local and district municipalities within the Eastern Cape in order to assess the functionality of the Project Management Unit. Their findings were that they visited four district municipalities and eight

local municipalities, and they were all short of technical staff. Evidence was that even the available staff within these visited municipalities were unable to attend interviews they were required to go through in order to have their technical competency evaluated, due to the many projects each individual was looking after.

One of the biggest cities in the Eastern Cape, The Nelson Mandela Bay (Port Elizabeth), comprises about 1.15 million people but reportedly only has one professional civil engineer within the municipality (Kahn, 2017). This is a clear indication of how bad the situation is, hence, there is non-stop infrastructure failure that ultimately contributes to poor supply of services of an acceptable standard.

6.5 Water quality differences between urban and rural areas

In order to evaluate respondents' comments regarding water quality in their respective areas, the researcher randomly chose some water schemes to visit within the three municipalities, to check on the water treatment methods and verify the quality of water they were producing.

The water quality was evaluated in terms of turbidity, biological and chemical parameters in both urban and rural water schemes. Table 14 depicts standard limits as set by SANS 241-1:2015.

Table 14: Water quality parameter and standard limits

SANS 241-1:2015			
Parameters	**Unit**	**Standard Limit**	**Risks**
Biological compliance (Coliforms)	MPN/100ML	10	Operational
Chemical compliance (TDS)	mg/l	1200	Chronic health
Turbidity compliance	NTU	5	Aesthetic

Urban areas

Table 15 depicts quality results from the main water storage facilities that were visited during the survey. These include water treatment plants and main reservoirs supplying water to various communities.

Table 15: Urban area water treatment plants

Water Storage Facilities	Biological Compliance (Coliforms)	Chemical Compliance (TDS)	Turbidity Compliance
Mzonyana Water Treatment Works	0,88	86	0,78
Nahoon Water Treatment Plant	0,78	193	0,29
Butterworth Water Treatment Plant	6	123	1.62
Mthatha Water Treatment Plant	0,90	39,00	2,20
Tsolo Water Treatment Works	0,90	71,00	1,60
Port St Johns Water Treatment Works	0,90	118,00	0,58
Coffee Bay Water Treatment Works	0,90	121,00	1,70
Fortgale Water Storage Reservoir	0,90	39,00	2,40
Lusikisiki Prison Storage Reservoir	9	70	0,80
Garden Court Storage Reservoir	164,00	51,00	1,40

Source: Amatola Water Amanzi (2018, 2019a and 2019b).

Water sources depicted from Table 15 are mainly dams. The water treatment plants in the table supply urban areas, apart from the Butterworth, Tsolo and Port St Johns treatment plants which are supplying relatively small towns that are categorised as semi urban areas in the study.

- In respect of turbidity compliance – urban areas are in compliance except for the Garden Court storage reservoir.
- Chemical compliance (total dissolved solids) – all the results obtained from the areas visited showed compliance in this regard. The areas not only showed compliance, but the volume of chemicals found in the water sources was relatively small amount.
- Biological compliance (total coliforms) – the results obtained showed compliance, with the exception of Mqanduli and Garden Court.

Rural areas

Table 16 depicts the quality results from a number of rural water scheme sources. These water sources are mainly boreholes supplying water to distribution localised reservoirs.

Table 16: Rural water scheme sources

Water Storage Facilities	Biological Compliance (Coliforms)	Chemical Compliance (TDS)	Turbidity Compliance
Centane Phase 4 Water Supply Scheme	84,00	1088,00	1,80
Gcizela Regional Water Scheme	22,00	376,00	2,00
Sidwadweni Water Treatment Works	172,00	36,00	0,52
Misty Mountain Community Standpipes	14,00	75,00	0,58
Mqanduli Water Treatment Works	2420,00	224,00	12,00
Thabo Mbeki Borehole	29,00	235,00	0,65
Baziya/Jojweni Borehole	2420,00	32,00	85,00
Mbekweni Clinic Borehole	816,00	482,00	0,28
Mafusini Community Standpipe - Qumbu	3,00	156,00	0,48
Upper Chulunca Water Scheme -	1	34	0,47

Source: Amatola Water Amanzi, (2018, 2019a and 2019b)

- Turbidity compliance – the areas visited showed compliance except for the Baziya borehole, located at the border of Ngcobo and Mthatha area.
- Chemical compliance (total dissolved solids) – all areas visited showed compliance in respect of chemical parameters. However, the amount of chemicals found in these boreholes was relatively high compared to those of urban areas.
- Biological compliance (total coliforms) – the results obtained showed a relatively high volume of bacteria found in most of the water sources evaluated.

6.6 Improper expenditure

Improper expenditure of funds allocated for water infrastructure by water service providers and national government is a major issue which contributes to insufficiency in supply of water to people. According to Peyper (2017) CoGTA was fingered for underspending by R3.2 billion which was budgeted for infrastructure development. According to CoGTA, the municipalities were the main cause of such under expenditure, as they were supposed to request grant such as MIG whenever they require funds to do developments.

The government authorities responsible for various infrastructure projects are taking time to act on challenges these projects face. Hence these projects take long to complete. Corruption together with political interference are playing a major role in service delivery within government institution.

An interview with ADM operation and maintenance unit revealed that the allocation of funds

to run the unit was extremely limited and does not even cover a quarter of the financial year. According to the unit, the financial assistance given does not take into consideration the growth of water schemes as some projects gets completed and handed over to them. As a result, in Butterworth and surroundings, they have been depending on savings on local projects being handled by ADM in order to perform operational services and maintenance of existing schemes for over a year now, as the funds for such were completely depleted.

6.7 Recommendations

Water supply is a systematic scenario, not only in terms of networking the infrastructure that supplies water but in reference to structured stakeholders that are responsible for its supply. Hence, if one of the structures fails to play its required role, the whole system of supplying water is put at risk. Therefore, the follow recommendations are made:

i. Rivers and dams which are the sole means of capture of surface water when there are rains are governed by the Department of Water and Sanitation. The Department will have to play its responsible part, particularly in obvious situations such as the Gcuwa Dam, and clean up dams and maintain and rehabilitate catchment areas.
ii. Improved management in all aspects i.e. financially, infrastructure and other resources need to be prioritised. This requires all governmental spheres which sponsor or handle finances, infrastructure and personnel to play their part in the supply of water infrastructure.
iii. A proper screening of appointments made within government, and all service providers to government be they are consulting engineers or contractors, need to be frequently audited. Political involvement must be a supporting factor to service delivery rather than an interference in it.
iv. Lastly, a sense of responsibility amongst water users, particularly in rural areas, needs to be created. This will minimise vandalism and illegal connections to water infrastructure
v. Measures to set up proper water treatment plants in rural areas, similarly to those of urban areas need to be executed, as a means to improve water quality.

6.8 Conclusions

It is very clear that the collapse of infrastructure is becoming a greater problem. This is a situation where infrastructure does not necessarily last its life span, but due to poor design,

poor construction and vandalism, it crumbles before its life span is reached. The negative effect of this cannot be emphasized enough because it causes funds to be circulated in one place rather than being escalated to more people in need of service delivery. This is due to infrastructure being installed at high cost, but then in the space of no time it requires maintenance and thereafter followed by replacement.

Extensive collaboration between the Department of Water and Sanitation, water boards, water service providers and water users is the one solution that will produce positive results starting from water preservation, water distribution/supply and water usage. The important issue is that everyone needs to understand the declining water levels of various water sources.

After analysing the rural water quality results, it is evident that some rural water users are at risk due to high levels biological and chemical components that were detected at their storage facilities.

CHAPTER 7

MAJOR KEY PLAYERS TO RESCUE THE WATER SITUATION

7.1 Introduction

Looking at the major role players that could possibly change the water situation, one needs to first consider the major contributors to the water crisis. Water leaks contribute a great deal to the water crisis. With water pipes being buried underground it is difficult to identify leaks as soon as they occur. A study by Hay *et al.* (2012) on five areas within the Eastern Cape established that only 48% of water reaches the end users, which confirms that water lost through leaks is much greater than anticipated.

Some of the major contributors are natural causes and there is very little one could do to prevent these from occurring, for example drought, climate change, and evaporation. However, there are possible interventions one could practise to reduce the severity of their occurrence.

Water mismanagement forms a major, but controllable, negative effect. Water mismanagement occurs not only by water users, but by water suppliers as well. In South Africa, water resources such as rivers and dams are owned by Department of Water and Sanitation (DWS). The water resources are not there, only to provide water for human beings, but also to serve animals.

Various local municipalities working together with DWS are taking it upon themselves to ensure that they not only provide drinking water for people, but they rehabilitate dams for the sake of animals as well.

It is a common situation that rural dwellers are hugely dependent on livestock for food and money. They sell and eat as a result of their livestock.

Figure 15 is an example of where the government has taken the responsibility of regularly rehabilitating this dam for the sake of livestock in the area.

Figure 15: Typical well-rehabilitated dam in Sidwadweni in Tsolo

Figure 16 is an example of a non-rehabilitated dam in Mngomazi village in Butterworth. The silting of dam results in mud and the rapid evaporation of water. The two different areas represented in Figures 15 and 16 are relatively close to each other and will thus be receiving similar precipitation. However due to the non-rehabilitation evident in Figure 16 there is hardly water for animals, resulting in the death of livestock.

Figure 16: Typical non-rehabilitated dam in Mngomazi in Butterworth

This chapter looks in depth at various ambiguities associated with different role players involved or affected by water, be they water users, water service providers or water boards. It discusses these ambiguities with the purpose of bringing alternative approaches to solving them.

7.2 Key players in the water situation

Generally speaking, everybody has a responsibility and a role to play in ensuring water is preserved, supplied and used efficiently.

7.2.1 Water users

The term ‘water user’ refers to water consumers, i.e. households, agricultural firms, any production companies or entities that utilise water in any way. The difference is that urban area dwellers pay rates for their usage of water, while rural dwellers do not pay rates for their usage of water. That alone creates a different attitude between these users. A free resource will never be kindly treated while people paying for water will utilise it with a clear mind-set that their usage is attached to a rate which they will have to pay.

It is therefore up to government to pose suitable rates for rural dwellers as well in order to promote responsible water usage, particularly for those who require house connections. Some rural dwellers are dependent on grants and do not have any decent jobs, therefore, to compel them to use water sparingly and responsibly, government is required to monitor closely their water consumption, and have water promotion workshops focused on saving water. In doing this, the municipalities will be required to install water meters for those who request house connections.

Agricultural entities and all other water dependent businesses will have higher water standard rates than usual, but penalties need to be posed in a situation where damages are the result of an individual or certain business sector. In designing of water reservoirs and water tanks, an estimate of required water per day, per month and ultimately per year is calculated. This means an approximation of water required by each agricultural firm or company per month could be calculated and agreed upon, but the company would not be allowed to exceed that agreed approximation by certain percentage, failing which, penalties would need to be imposed.

7.2.2 Water service providers/water service authorities

The district and metropolitan municipalities in South African have taken over the responsibility of being water service providers. Among the responsibilities they have is to ensure the treatment of water to achieve the required minimum quality, proper supply to water users and maintenance and operation of the existing water infrastructure. Further to that, the service providers take responsibility of appointing consultants and contractors to design and install water infrastructure.

The problem with the supply of water, particularly in the rural areas comes with incompetent contractors of water infrastructure. This results in frequent maintenance of infrastructure before it reaches its predesigned life span, which becomes costly to the service providers. In urban areas competency of contractors is not really an issue as work is done under close supervision of the client, however failure of infrastructure still occurs due to old infrastructure deteriorating. In as much as WHO is quite satisfied with the quality of South Africa drinking water generally, it is still less so compared to various countries around the globe (Rademeyer, 2013). The quality assessment of water done by water service providers does not include water supplied to rural areas when checking the quality of water, as there are no water treatment plants in rural water schemes.

A combination of political interference and incompetent officials within the water service provider (district and metropolitan municipalities) contribute to poor management of water schemes (supply of water and maintenance of infrastructure). Funds limit the extent of the operation and maintenance which is important in repairing deteriorating infrastructure. Lack of speedy response to reported water related issues is another problem that contributes to depletion of water resources.

Figure 17: Leaking water meter strapped in with a plastic bag

Figure 17 is a photo taken in the business development centre of Butterworth, where a water meter has not been properly repaired. It is an indication of poor work by operational and maintenance units of the district municipality. In such situations, large volumes of water disappear underground. Butterworth is one of the most drought-stricken areas, with dam levels as low as 6% (DWS, 2017b), therefore such situations should be avoided at all costs.

7.2.3 Water boards

In the Eastern Cape water sources belong to Department of Water and Sanitation, therefore all activities to interfere with or involving rivers and dams have to be approved by the Department first. The Department makes provision for raw water to the service providers, who then purify it and supply it to the end users.

The water boards come into the equation of water supply as water service providers, who appoint engineers and contractors to design and construct bulk water supplies. The problems which impact the water boards are associated with less rain which is directly linked to various natural causes such as global warming and drought. Additionally, there are other issues which are human-made. For example, illegal sand mining which widens the river-banks and mismanagement of water by users and service providers. All these natural and human-made factors contribute to exhaustions of dams and rivers which are the main source of drinking water.

7.3 Recommendations

The fact that Eastern Cape does not boast any big dams of their own which could sustain the province even when there are no rains for a long time, means that corrective practises with regards to water management are required to keep water available for the next day. It is therefore in everyone's interest to manage and use water sparingly.

After all, the pivotal role players in sustainability and management of water usage are the water service providers (District and Metropolitan Municipalities). However, without the collaboration, cooperation and assistance from the water users, engineers, contractors and water boards their attempts to rescue the water situation will never succeed.

These governmental institutions that receive grants to improve the water supply in various areas, particularly in disadvantaged areas, which never had access to potable water, need to practise the following to rescue the situation:

i. Ensure their own team is made up of professional members whose interest is to make change and provide services to the dwellers of the province. Ensure that the decisions they take on the appointment of engineers and contractors is not in any way influenced or politically motivated. That will involve thorough screening of engineers and contractors in order to make sure they are competent and experienced in the field of water.
ii. The water service providers need to take it into their own hands to address the situation of insufficient water and the decrease of water resources. This includes sourcing their own water (rain harvesting) and adequately preserving it in order not to be fully dependent only on municipal supplied water. Water service providers need to spend more money in promoting proper water usage through radio and television as they reach to the majority of residents of the province. However, Eastern Cape is mountainous, and some rural people do not have good radio or television reception therefore the service providers also need to have a drive around programme which visits, promotes and educates residents in those areas about using water sparingly.
iii. As illustrated by Figure 13, service providers will not succeed in providing water if the dams do not have water. Therefore, the Department of Water and Sanitation needs to take it upon themselves to ensure they rehabilitate and maintain their own dams and rivers.
iv. Illegal miners of sand that destroy catchment areas in dams and riverbanks must be

prosecuted and receive hefty penalties to control the situation. Hence the responsible governmental institutions need to improve their watch of these water resources and implement the constitution as stated.

v. It is the duty of the Water Service Boards, Water Service Providers and Department of Water and Sanitation to ensure that they impose penalties for any wrongdoing regarding their water resources i.e. pollution from surrounding factories, agricultural firms and various large companies.

vi. Water service providers are the coordinating commanders in making a difference to the water situation. Therefore, they need to invest in and improve on campaigns targeting schools and community gatherings.

The most challenging factor for water service providers is running out of funds/budgets allocated for various activities within their scope. Without a budget most of the suggestions cannot be implemented. Hence, the involvement of National Treasury is of great importance to ensure that funds are being spent accordingly and to monitor shortfalls timeously.

7.4 Conclusion

As indicated above, water management should be everyone's concern, as its unavailability severely affects everyone. Water users, service providers and water boards are required to be equally aware of their roles to partake in bringing the water situation to normality.

Some rural areas still do not have access to potable water, and with water crises occurring from time to time, that means they sometimes share river and dam water with animals, if they do not make their own means to harvest rain water. Therefore, the focus on not wasting the already available water needs to be taken with great seriousness. This involves keeping the water resources in good condition for them to sustain themselves and be able to retain greater volumes of water.

Development of more water retaining resources needs attention by the Department of Water and Sanitation and they must be pro-active rather than reactive in order to rectify existing problems. Water service providers need to have an organised systematic way of monitoring the lifespan of existing infrastructure and to do regular infrastructure assessment that will be used a baseline to take care of deteriorating infrastructure before it collapses.

The policies within the service provider departments and water boards need to be implemented

in order to achieve desired outcomes, otherwise individuals will disregard the legislation and laws put in place.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

This chapter reflects on all the chapters making up the study and provides a thorough summary of the findings and recommendation suggested in each chapter and draws conclusions from the study as a whole. This chapter further summarises the comparison of the researcher's findings with the findings of the literature review.

8.2 Summary of findings

Regarding the literature gathered, it can be concluded that the situation of water in South Africa at large is deteriorating, with some parts worse than others. According to the findings, the area of study (Eastern Cape) is not entirely in a dire state yet, but the situation is deteriorating and a number of people who used to have water no longer have water and the infrastructure turning into white elephants as it is abandoned.

The general awareness of the people about the water situation was very limited, and water was taken for granted. According to the findings, urban areas enjoy greater privileges when it comes to service delivery such as water. The reason for this is that urban areas are mainly the focus point when it came to economic transformation and development, therefore they are considered first in the infrastructure development projects compared to rural areas. This ultimately contributes to rapid urbanisation and urban infrastructure takes more strain and collapses more frequently.

The study reveals that a high percentage of urban dwellers are very satisfied with the manner in which their water was being supplied including the quality of the water, whereas the same cannot be said for rural dwellers. The fact that some people still use river and dam water reveals the level of inequality between urban and rural areas. Even with those who were being supplied with water, they still had to find the means to collect water from distanced standpipes. This shows that the strategy of integration the government was implementing was somehow still not at the same standard and hence not entirely satisfying to everybody and has resulted in negative consequences such as urbanisation and maybe illegal connections by dwellers in rural areas.

With urbanisation, development and industrialisation being central in many cities and towns of

the Eastern Cape, environmental pollution and ultimately water pollution is of great importance. The intense water purification in bigger cities such as East London is far better compared to other smaller urban areas such as Tsolo, and obviously much better compared to rural areas which do not have treatment plants at all. The release of untreated industrial effluents into sewage channels results in the underground water quality deteriorating, posing health risks. Environmental pollution is a great risk where toxic and hazardous substances are carelessly disposed of, having the potential of polluting the underground water. This kind of pollution poses a risk to both urban and rural areas but considering the fact that rural areas do not have proper examination of water before it is discharged to end users, particularly borehole water, rural dwellers are at greater risk.

To address the integration, the government needs to take into consideration the standard of service they deliver in both urban and rural areas. According to the ADMs Operation and Maintenance Unit, illegal connections are growing in the rural areas, therefore the government needs a way to address that problem. Illegal connections result in water leaks, as these connections are being done by unprofessional artisans, something that contributes to depletion of water resources in the province.

In as much as the findings suggest that the water service providers (municipalities) are central to the supply and ensuring sustainability of water resources, such a task is impossible without the help and cooperation of water boards, national government (Department of Water and Sanitation), service providers (consulting and contractors) and water users.

Water service providers seem to lack expertise or willpower in management of the allocation of funds and delivery of infrastructure projects of acceptable quality till operation and maintenance level. The appointment of consulting engineers and contractors that execute municipal infrastructure projects is approved by municipal officials, therefore the standard of work they deliver should be satisfactory at the municipal level. Through this study, it was revealed that municipalities had insufficient technical personnel (engineers, technicians and technologists) to look after all the water infrastructure programmes during construction and for operational maintenance later on. The few technical staff available were overloaded with many projects.

One of the findings of this study is that the reliability of urban water is at a high level, with water service providers being very involved to ensure that there is water at all times in urban

areas, particularly in big cities like East London and Mthatha and King Williams Town. The response to water related issues in rural areas was discovered to be taking many more days before being attended to. In both urban and rural areas, respondents showed that they were doing their best to preserve water. However, the fact that rural dwellers had to travel hundreds of metres to fetch water was a major disadvantage, as it was conveyed by some rural dwellers that they had to pay money for people to fetch water from the common collection tap because they were disabled and at times too old to walk the distance with a bucket full of water.

8.3 Summary of conclusions

As indicated in the literature review, the importance of water for life, development and economic stability is crucial. It is a fundamental requirement for life on planet earth. The agricultural sector is a large consumer of water which some countries are solely dependent on, hence water availability is associated with economic stability. The construction sector which creates a number of job opportunities that raises the economy of countries also is dependent upon water.

However, the situation of water in the entire world is changing for the worse, with major dams and rivers which are the main source of water around the globe deteriorating significantly. The cause of such deterioration is due to both human-made activities and natural causes. Factors such as climate change, drought, poor management, surface runoffs, infrastructure failure, population increase, water pollution and economic development have significant negative impacts on water resources. South Africa as a country is also not doing well in terms of having enough water for its citizen; it has for decades been trying to address the backlog, but water sources seem to be drying up as a result of the above-mentioned factors.

The Eastern Cape is dominated by rural areas which are under-developed and lag behind in infrastructure. There are various governmental interventions seeking to integrate urban and rural areas, so the Eastern Cape is regarded as a developing province. But these developments have the potential of displacing the underground water, while at the same time times causing underground and surface pollution during the construction stage.

The supply of water between urban and rural areas of Eastern Cape is not equal, according to the findings of the study. Through analysis of data obtained in the course of this study, it can be concluded that the RDP standard of water supply which is still being applied by government will surely be out of fashion in the next 10years, as it is full of problems at this moment resulting

in people doing their own illegal connections. This practice hinders the government, as water sources suffer the most due to leaks that occur in the process of doing these illegal connections. This study suggests an accommodative process of migrating the RDP standard and allowing those who want yard and house connections on the basis of them accepting to pay rates.

The purification system being used in urban and rural areas needs to accommodate the sources in which each area get water from, not that one area has purification system, and another does not. Urban areas are enjoying better privileges compared to rural areas in relation to water supply, even so, there is improvement required in urban water supply, hence the satisfaction of respondents in the findings did not rate the supply at 100%.

Therefore, one way for the government to approach the integration of urban (townships inclusive) and rural areas, is to address the imbalance of water supply between urban and rural areas. This will help reduce urbanisation and allow the economy of the cities and ultimately the country to be controllable. In the literature gathered for the study, it is evident that imposing tariffs on water supply promotes responsible usage of government supplied water. Hence, it is recommended as part of the solution to impose same tariffs on rural areas who are willing to have water in their yards, because, letting them have illegal connections is more costly.

In this way, problems relating to illegal connections will surely be reduced. With such an accommodation, those who get caught connecting to the municipal mainlines illegally will be justifiably charged in a court of law and be penalised for such. Most importantly the idea of accommodating those who want house connections would be an indication that the government realises that there is a change in lifestyle in the rural dwellers as well, as they will be buying equipment such as washing machines and dish washers, things that makes life much easier in the urban areas.

Even though most urban dwellers were satisfied with the supply of water of decent quality, there were still complaints regarding high water tariffs. The questionnaire was not only prepared to find out answers from participants, but to also create awareness. The questionnaire managed to create a sense consciousness in the participants, particularly when they had to answer questions about the corrective ways of using water, such as if the participants were closing taps when brushing their teeth; methods they undertook to save water and more. Similarly, through the interviews which were undertaken with for water service providers and engineers, the strategy of creating responsibility for them regarding water provision and taking

care of it was adequately achieved. With respondents of both Section A and B interviews were able to mention what their roles and responsibilities were supposed to be in order to create a smooth supply of water to people.

The main aim of the study was to achieve the integration of urban and rural areas, through addressing the imbalance of water supply between these two areas. It sought to make the water service providers aware of the change in lifestyle for rural communities in order to pave the way for rightful services to be delivered to them as well. While doing so, the study brought awareness to water users about the situation of Eastern Cape water sources and further educated them regarding measures for using water sparingly and conserving it. The study brought a sense of ownership to water users of the infrastructure in their areas, for them to take responsibility for it and to avoid unnecessary damage caused by their children.

To achieve these desired outcomes of the study and to be able to supply water to both rural and urban communities of the Eastern Cape to the satisfaction of its citizen, the following aspects need to be improved:

- Design and construction of good quality water infrastructure.
- Proper management from the water boards and water service providers in order to facilitate infrastructure projects efficiently.
- Responsible manner of using water, taking into consideration the strain the water sources are under.
- Pro-activeness by the operational and maintenance units with regard to deteriorating infrastructure rather than acting only when the infrastructure has collapsed.
- Governmental institutions to invest in technical aspects (engineers, technicians, and technologists) to improve the supply of water and to bring more ideas.

8.4 Summary of recommendations

It is often the case that a very large team becomes very difficult to control and gain compliance, but in this case of the water supply chain there are responsible institutions which are being run by managers and subordinates therefore need to act as required. This includes water users, who are completely dependent on water service providers to have potable water.

Based on the study, the following are recommendations suggested for consideration to improve the supply of water in urban and rural areas:

- Beginning with the Department of Water and Sanitation which governs the water sources, it is recommended that policies and regulations that are stipulated by the Department be adhered to, failing which severe penalties need to be imposed on the culprits who illegally disturb water sources such as dams and rivers through sand mining practises.
- The Department is responsible for these dams, rivers and catchment areas but is failing to rehabilitate and maintain them. Hence, water supply is affected in various areas where rain has been adequate, but there is insufficient storage. Therefore, the Department needs to maintain and even expand existing dams if possible, in order to create enough storage, taking into consideration the population growth and increasing demand of water due to lifestyle changes of people in various areas. More dams need to be developed by the Department to assist with meeting water demand.
- Water service providers need to ensure that there is enough communication between the Department and themselves to make sure that dams which are the source of water are being looked after.
- The water service providers need to employ competent people in the management role to be able to facilitate the supply of water. This process begins with the application for funds to the level of responsible expenditure in the infrastructure projects, in order to avoid returning of funds allocated for infrastructure grants whilst there are still some rural areas with no water infrastructure at all.
- The above point also implies the possibility of insufficient technical teams to look after many projects running concurrently, hence funds are at times returned to treasury. With that being said, it brings a recommendation of increasing municipal technical teams as it was indicated in the study that some of the Eastern Cape's municipalities are lacking in terms of technical staff to run projects they have.
- It is often the case that the government becomes responsive rather than proactive i.e. government only promote responsible usage of water and conservation after severe droughts. However, it is suggested that government makes a routine of visiting rural areas, urban areas, schools and do more programmes and workshops to promote usage of water sparingly even when water seems to be enough.
- Improvement regarding management of infrastructure does not only apply once infrastructure is complete, but during the construction phase as well. The quality of work at the construction stage needs to be achieved through approved design and

specification provided by the consulting team so that the infrastructure can last as long as intended. Therefore, proper supervision of works to ensure that the quality of work is being consistently achieved during construction stage is essential.

- The management of infrastructure also requires consistent operational oversight and maintenance of completed infrastructure. A standardised method of monitoring existing infrastructure with the aim of either repairing or replacing a particular infrastructure needs to be adopted by the water service providers. In such situations the infrastructure will be assessed regularly to determine the condition of it and there will be a time frame for attendance to upkeep and maintenance (Asset Register).
- Improved technical skills by engineers, technicians and technologists to improve their designs will improve the water supply. This includes coming up with interventions that are suitable for both rural and urban areas considering their topographical differences.
- As part of improving the supply of water in both urban and rural areas, particularly when it comes to responding to calls for repairs or even water supply interferences, the responsible water service providers need to have call centres where water related issues can be reported and attended to as soon as possible. In doing so, the water service provider will be able to track records for reported matters and monitor the performance of the operational and maintenance units.

As indicated already that, the standard of water supply in urban areas is of a high standard even though it also has its own flaws. It has aspects that are much better than the system provided in rural areas. Due to that rural dwellers have resorted to illegal connections because their lifestyle has started to change, and they can afford water using appliances found such as washing machines and dish washers.

Below are the recommendation offered to improve the standard of water supplied in rural areas and urban areas in order to create a balance in water supply in the Eastern Cape province:

- The water infrastructure placed in urban areas has long been installed and is gradually deteriorating, therefore the municipalities need to do routine assessment and replacement where necessary which will reduce leaks in the urban infrastructure water networks.
- Water service providers need to not only operate and maintain existing infrastructure, but they need to be able to extend the infrastructure in accordance with the growth and development of rural areas in order to avoid long distances that normally inconvenience

rural dwellers when they build houses further away from the already constructed standpipes.

- With regards to quality of urban water, it is a work in progress. Basically, water treatment plants are in place and the Department of Water and Sanitation is monitoring the quality of water through the blue-drop system which is effective in monitoring the progress towards achieving targets of required water quality. However, it is recommended that more focus be given to small towns in order to achieve the same percentages that are being achieved by metropolitan municipalities. That would require an appointment of more knowledgeable people to run and manage the treatment plants, and most importantly improve the standard of the treatment plants in such towns to be of the same standard as in metropolitan municipalities.
- The same applies to rural areas; in order to achieve the required quality of water, the water service providers need to start constructing rural water treatment plants, so as to minimise health risks in rural areas. The study has shown that biological and chemical parameters in rural water are outside of the normal and acceptable range. Water sources in rural areas are mainly borehole water, in comparison to that of urban water, which is predominantly dam water.
- Once such things are settled in urban areas, more work will need to be done in rural areas to balance the provision of water to that of urban areas. This will include:
    - Water service providers to make provision for those who want yard or house connections and are willing to pay rates. Considering the poor living conditions of rural dwellers, a recommended tariff of between R5.5/kl and R7.50/kl is recommended. Paying of tariffs will not only make money for the water service providers but will promote efficient water usage.
    - The operation and maintenance units will need to take into consideration the expansion of villages for them to extend the reticulation networks. As indicated in the findings, once villages are extended, the 200m maximum distance walk starts to become longer and the operation and maintenance teams never go beyond taking care of such developments.
    - Improved monitoring when it comes to construction of infrastructure in the rural areas in order to eliminate poor quality work done by contractors in those remote and rural areas due to poor supervision by clients or clients' representatives. If work is being done as per specifications, is approved by the client and proper

monitoring is done afterwards, this will increase the life span of the infrastructure.

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APPENDICES

Appendix 1: Questionnaire cover letter

SAMPLE QUESTIONNAIRE LETTER

RESEARCH ON WATER SUPPLY CHALLENGES IN URBAN AND RURAL AREAS OF EASTERN CAPE

Dear Participant

I would like to take this opportunity and thank you for taking part in this survey.

The aim of this research is to look at the challenges surrounding the supply of water in urban and rural areas of the Eastern Cape and bring in Civil Engineering attributes as a means to improve them where necessary. The research seek to alter the thinking of people in general towards their behaviours towards usage of water, secondly it will reveal the importance of civil engineering career in relation to water study and the input it can contribute to bring about acceptable standards of water in relation to the quality and infrastructure. It also intends on bridging the gap between the standard of water supply between the rural areas and urban areas.

A participant will be required to answer the questionnaire which is drafted with the intention to stimulate positive attitude towards water usage and civil engineering input towards water improvement. Even though the study will be focusing in the Eastern Cape, the findings will be applicable to the other provinces as well.

Participants should feel free in answering questions and be advised that the identity will be kept confidential and will solely be used for academic purposes without associating any feedback to the participants or their organisation. It is anticipated that the questionnaire will take between 8 – 15 minutes to complete.

Thank you for your utmost co-operation and contribution towards my research for the Master's Degree at DUT

Yours Sincerely
Mpumelelo Dolo (Mr) – 083 522 7463
Email:mpumelelo.dolo@aurecongroup.com

Appendix 2: Observation and questionnaire sections

SECTION A: OBSERVATIONS

1. Municipality: .....

2. Locality:

    a) Urban Area ☐
    b) Rural Area ☐

3. Estimated size of the area: .....

4. Does the area have access to drinking water?

    a) ☐Always
    b) ☐Seldom
    c) ☐Never

5. How does the condition of visible water infrastructure look:

    a) ☐Good
    b) ☐Satisfactory
    c) ☐Poor
    d) ☐Not Applicable

6. Is there visible water infrastructure in the area Yes☐ No☐

7. If Yes in 6, where are the taps situated?
    a) ☐In the Yard
    b) ☐Outside the Yard

QUESTIONAIRE SECTION

SECTION B: URBAN AND RURAL AREAS HOUSEHOLD

1. Residential Address:
2. Gender: ☐Male ☐Female
3. Race Class: African☐ White☐ Indian ☐ Coloured☐ Other☐
4. If other above, please specify: .....
5. Age: Below 20yrs ☐ (21 – 30yrs) ☐ (31 – 40yrs) ☐ (41 – 50) ☐

   (51 – 60yrs) ☐ Above 60yrs☐
6. Educational Level: None☐ Primary School☐ Sec School ☐ Tertiary ☐
7. For How long have you been residing in this area:

   a) Less than 5yrs ☐ b) (6-15yrs) ☐ c) (15-30yrs) ☐ d) over 30yrs ☐
8. Marital Status: Single☐ Married☐ Divorced☐ Widowed☐
9. What is your Monthly Income:

   Less than R3000☐ (R3000 – R8000) ☐ R8000 – R15000☐

   R15000 - 25000☐ R25000 - 35000☐ Over R35000☐
10. Do you have access to drinking water: Yes ☐ No ☐
11. How long have you had drinking water? Less than 5yrs☐ 5-15yrs☐ over 20yrs☐
12. Do you pay for water? Yes☐ No☐
13. If Yes in 12, How much do you spend on water tariffs

    a) R0 – R250 ☐ b) (R255 – R450) ☐ c) Over R455 ☐
14. If Yes in 10, do you experience water shortages?

    a) Never ☐

    b) Once in a Week ☐

c) 2 -3 times in a Week ☐

d) Over a Week ☐

15. If No in 10, where do you get water? a) Dam☐ b) River☐ c) Tank☐ d) Other☐

16. If other in 15, specify the source here? .....

17. What is the condition of your water infrastructure? Good☐ Fair☐ Bad☐

18. Does the water infrastructure in your area get maintained?

a) Regularly☐

b) Seldom ☐

c) Never ☐

19. How far is your tap from the house you residing in?

a) In the House ☐

b) In the Yard ☐

c) 0 – 200m ☐

d) Over 200m ☐

20. Who is responsible for your water infrastructure?

a) Municipality☐ b) Landlord/Private company☐ c) Myself☐

21. How quickly does your maintenance problems get attended to?

a) Within a day ☐ b) (1 – 3 days) ☐ c) Takes a week ☐ d) Over a week ☐

22. What is your satisfactory rating in relation to the quality of water in your area?

a) Very Good ☐

b) Satisfactory ☐

c) We Use water Filter☐

d) Bad ☐

23. Have you ever had any illnesses due to drinking of water? Yes ☐ No ☐

24. Which water do you prefer for drinking?

a) Tap water ☐

b) Store bottled water ☐

c) Both of the above ☐

25. Which form of washing the body in your home is used?

a) Take a bath ☐

b) Take a Shower ☐

c) Other ☐

26. If other in 25, Specify here .....

27. How much water do you use a day in your home?

a) 20 litres ☐ b) (25-50 litres) ☐ c) over 50 litres ☐

28. Do you usually leave the water running while brushing your teeth?

a) Yes ☐

b) No ☐

29. What measures do you take to save water? .....

.....

.....

30. Does your municipality/private service provider do enough to attend to your water related problems?

a) Yes☐

b) No ☐

Thank you for your participation

Appendix 3: Letter requesting access to Amathole District Municipality water schemes

Mpumelelo Dolo
Ngcolokeni A/A
P O Box 94
Qumbu
5180
16 January 2016

The Director of Engineering Services
Amathole District Municipality
P O Box 320
East London
5200
Attention: Mr M Shezi

Dear Sir

PERMISSION TO CONDUCT RESEARCH IN THE AREA AMATHOLE DISTRICT MUNICIPALITY

My name is Mpumelelo Dolo and I'm currently studying towards a Master's Degree in Civil Engineering at Durban University of Technology. I'm undertaking a research in the area of water resource management. The research will mainly focus in the Urban and Rural areas covered by Amathole District Municipality. In conducting this research I'll be required to do a survey in a form of interviews and questionnaires within the Water Infrastructure department and communities under the municipality. This ultimately includes officials of the municipality as well. My research topic is as follows: **"Water Supply Challenges in Urban and Rural areas of Eastern Cape"**

Considering the strain, the province is under with water shortages that are resulting in water cuts, this research will seek to find possible means that will reduce or eliminate these water cuts. It is the intention of this research to explore all measures that will possibly improve the water situation in the province from sourcing of water till the rightful usage of it. While finding these ideas and inputs from the participants, the research will be educating those taking part.

The process will purely be voluntary, and each participant will be clearly advised prior to the commencement of the survey process. No participant will be harassed in taking part in the research. There will be no penalty for objecting taking part in the research. It should be noted that this research is by no means to discredit or undermine the efforts of the municipality, rather it is an effort to bring about new ideas and educate people about water. The time to complete the interview or the questionnaire is relatively short and shall be arranged at the participant's convenience.

All findings gathered in the research will be kept confidential. In publicising the results of the findings, the identity of the participants will be kept confidential with no mention of names. The research gathered will only be used for academic purposes.

The findings of the study in your respective area will be made available to your organization upon your request.

Your assistance in this regard is highly appreciated

Yours Faithfully

_____

Mr Mpumelelo Dolo
Cell: 083 522 7463
Tel: 043 721 0900
Email: mpumelelo.dolo@aurecongroup.com

Appendix 4: Response from Amathole District Municipality

AMATHOLE
DISTRICT MUNICIPALITY

Amathole District Municipality
All correspondence to be addressed to:

Municipal Manager
Waverly Office Park, 3 - 33 Phillip Frame, Chiselhurst, 5247
P.O Box 320 * East London * South Africa * 5200
Telephone: 043 701 4000 * Facsimile: 043 721 2874
Email: info@amathole.gov.za * Web Address: www.amathole.gov.za

19 January 2017

Mpumelelo Dolo
Ngcolokeni AJA
PO Box 94
Qumbu
5180

Dear Mr M Dolo

Re: Permission to conduct research in the area of Amathole District Municipality

The above subject matter refers.

Kindly note that your request to conduct research in the area of Amathole District Municipality has been approved.

Yours Faithfully

[redacted]

Mr C Magwangqana
Municipal Manager

19-01-2017
Date

Appendix 5: Letter requesting permission to conduct a research in BCMM

Mpumelelo Dolo
Ngcolokeni A/A
Qumbu
5180
17 January 2018

THE CITY MANAGER
BUFFALO CITY METROPOLITAN MUNICIPALITY
PO BOX 134
EAST LONDON
5200

Dear Sir,

RE: REQUEST FOR PERMISSION BY STUDENTS TO CONDUCT RESEARCH STUDY AT BCMM

I am a student at Durban Univeristy of technology, studying towards Master of Engineering (Meng) Degree. I trust that you are aware that any post graduate study involves completion of a Treatise or Dissertation or Thesis. It is for this reason that I request your personal and professional permission to partake in my research in directorates and departments within BCMM.

The title of my research Treatise or Dissertation or Thesis is "**WATER SUPPLY CHALLENGES IN URBAN AND RURAL AREAS OF EASTERN CAPE**", and is being undertaken under the Supervision/s or Promotion/s of Professor Dhiren Allopi.

The objectives and aims of this study are to find possible means that will contribute to elimination water cuts, that are due poor water management, water use, and unnecessary pollution of water resources. It is the intention of the study to explore all measures that will possibly improve the water situation in the province at large, from sourcing of water till the corrective usage of it by end users. While finding these ideas and inputs from the participants, the study will be educating those taking part. The research study shall make use of interviews/completion of questionnaries with key selected potential participants or respondents, chosen through a randomisation method within the engineering water sector of the municipality, community and city's businesses.The process will purely be voluntery and no participant will be harrased or compelled to take part in the survey. The study will benefit BCMM through giving knowledge to water users about the state of the Metropolitan Water situation. The

outcomes of the research will form part of knwoledge source/references the municiplaity can go back to in trying to resolve the wtaer supply challenges within it's juristiction, and that will positively contribute towards the city's appeal of practiseing corrective usage of water by the community.

The ethical research principles will be strictly adhered to thoughout the research process so as to maintain a high standard of work and a high quality of the research study. The infomation obtained will be used only for purposes of this study, and will ensure anonymity and confidentiality of potential research participants or respondents. A copy of the full research report, once approved by the University will be handed to BCMM.

I thus request granting of permission to collect the necessary data/information from relevant officials (and Councillors) at BCMM for the purposes of completion of my Research Treatise or Dissertation or Thesis

Your kind assistance in granting me permission will be highy appreciated and thank you for taking the time in allowing your staff to be part of this research study as I am sure it will not only be of benefit to me but to them as well..

Yours faithfully,

Mpumelelo Dolo
E-mail address: mpumelelo.dolo@aurecongroup.com
Cellphone: 083 522 7463

CITY MANAGER

Approved	~~**Not Approved**~~

Appendix 6: Letter granting permission to conduct a study in the area of BCMM

BUFFALO CITY METROPOLITAN MUNICIPALITY

MEMORANDUM

Date: **01 FEBRUARY 2018**

From: **HEAD:INFORMATION KNOWLEDGE MANAGEMENT, RESEARCH AND POLICY**

To: **Mpumelelo Dolo**

Our ref:	Please ask for	Your ref:
	MR J.FINE	
	(043) 705 9742	

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN BCMM: MR. MPUMELELO DOLO

It is hereby acknowledged that **Mpumelelo Dolo,** a student at **Durban University of Technology,** completing the **Master of Engineering Degree,** has met the prerequisites for conducting research at Buffalo City Metropolitan Municipality (BCMM) for partial fulfillment of his degree. He has provided us with all the necessary documentation as per the BCMM Policy on External Students conducting research at the institution. With reference to the letter to the City Manager received on the 30 January 2018, permission was requested to conduct research at BCMM for his Research Report, entitled **"Water supply challenges in urban and rural areas of Eastern Cape"** This request was acknowledged by the Office of the City Manager, and forwarded to the Information & Knowledge Management, Research & Policy Unit for further assistance. **Mr. Dolo** was asked to provide the Unit with the necessary documentation, which he subsequently did.

The relevant Officials to assist in the research were identified and duly informed about the research, and the fact that **Mr. Dolo** has met all the prerequisites. Their contact details have also been provided to **Mr. Dolo** and he was informed to contact them directly for assistance.

We wish you good luck in your studies.

[redacted]

DR T F NORUSHE

HEAD: INFORMATION, KNOWLEDGE MANAGEMENT, RESEARCH AND POLICY

Appendix 7: Response letter from OR Tambo District Municipality

O. R. TAMBO DISTRICT MUNICIPALITY

OFFICE ADDRESS:
O.R. Tambo District
Municipality House
Nelson Mandela Drive

POSTAL ADDRESS:
Private Bag X 6043
UMTATA
5100

O.R. TAMBO
DISTRICT MUNICIPALITY

TEL:(047) 501 6400
FAX: (047) 532 6518
E-mail:ortambodm@ortambodm.gov.

Enquires A. Velem 047 501 6427/26

02 February 2018

Dear Mr M Dolo

SUBJECT : PERMISSION TO CONDUCT A RESEARCH IN ORTDM

The Gatekeeper's permission is hereby granted for Mpumelelo Dolo, a student at Durban University of Technology, who is completing his studies in Master of Engineering Degree. A letter of consent detailing the information about the nature of research has been received by office. We acknowledge the tittle of your research project "Water Supply challenges in Urban and Rural Areas of the Eastern Cape".
We are pleased to inform you that your request to conduct the study in the area and offices of ORTDM is hereby accepted. We give permission to Mr Dolo to conduct interviews with the staff members of ORTDM within the Civil Engineering sector which will be of assistance towards the completion of his
Please be advised that the data collected must be treated with due confidentiality and anonymity.
In completion of thesis you (Mr Dolo) are to provide my office with a copy of your final thesis to be kept in our office for information purposes.

We wish you success in completion of your studies

Yours Sincerely

[redacted]

A VELEM

DIRECTOR WATER AND SANITATION SERVICES

100 YEARS HONOURING OUR HERO

Appendix 8: Interview Section A

INTERVIEW SECTION

SECTION A: GOVERNMENT ENTITIES AND PRIVATE SERVICE PROVIDERS

1. What is your feeling about water being supplied to your municipal areas and its surroundings (quality and reliability wise)? .....

.....

.....

.....

2. What is the source of water that is supplied to the people in the work area? .....

.....

3. How would you rate the quality of water supplied to the people, using the scale of 1 – 10 with 1 being extremely bad and 10 being excellent?.....
4. How is it made sure that, the water infrastructure for your respective area is maintained timely and is in good condition to run/supply water (i.e. liaising with water end users)? ...

.....

.....

.....

5. Is there qualified engineers/technician looking after the supply and maintenance of water infrastructure for the water schemes of the municipality?.....
6. If not in 5, who looks after the water infrastructure?.....

.....

.....

7. What do you think is the reason for poor water infrastructure around Eastern Cape? How would you advise on improving it?.....

.....

.....

8. What is the condition of water infrastructure in the area you responsible for?.....

.....

.....

9. How would you improve the supply of water in your responsible area of work?.....

.....

.....

.....

.....

10. Do you receive random complaints related to water supply? Name few of those (min of 2 if there are any and their causes) and explain how you attend to them. .....

.....

.....

.....

.....

.....

Thanks very much for your participation

Appendix 9: Letter requesting permission to conduct a research at Aurecon SA, EL

Mpumelelo Dolo
Ngcolokeni A/A
P O Box 94
Qumbu
5180
28 January 2016

Aurecon SA
No 1 Pearce Street
Berea
East London
5241
Attention: Office Manager

Dear Sir

PERMISSION TO CONDUCT A RESEARCH TO AT AURECON SA

My name is Mpumelelo Dolo and I'm currently studying towards a master's Degree in Civil Engineering at Durban University of Technology. I'm undertaking a research in the area of water resource management. The research will focus in the Urban and Rural areas of the Eastern Cape. In conducting this research I'll be required to do a survey in a form of an interviews and questionnaires in order gather inputs and ideas of engineers, technicians and technologists in the civil engineering field (water engineering). My research topic is as follows: **"Water Supply Challenges in Urban and Rural areas of Eastern Cape"**

Considering the strain, the province is under with water shortages that are resulting to water cuts, this research will seek to find possible means that will reduce or eliminate these water cuts. It is the intention of this research to explore all measures that will possibly improve the water situation in the province from sourcing of water till the rightful usage of it. While finding these ideas and inputs from the participants, the research will be educating those taking part.

The process will purely be voluntary, and each participant will be clearly advised prior to the commencement of the survey process. No participant will be harassed in taking part in the research. There will be no penalty for objecting taking part in the research. It should be noted that this research is by no means to discredit or undermine the efforts of the company, rather it is an effort to bring about new ideas and educate people about water. The time to complete the interview or the questionnaire is relatively short and shall be arranged at the participant's convenience.

All findings gathered in the research will be kept confidential. In publicizing the results of the findings, the identity of the participants will be kept confidential with no mention of names. The research gathered will only be used for academic purposes.

Your assistance in this regard is highly appreciated

Yours Faithfully

_____

Mr Mpumelelo Dolo

Cell: 083 522 7463

Tel: 043 721 0900

Email: mpumelelo.dolo@aurecongroup.com

Appendix 10: Letter from Aurecon Engineers giving permission to conduct a research

East London
No 1 Pearce Street
[illegible]
East London 5241

PO Box 19553
[illegible] 5214
South Africa

T +27 43 721 0500
F +27 43 721 0502
E [illegible]
W aurecongroup.com

aurecon

[illegible] February 2018

Dear Mr M Dolo

<u>**RE: PERMISSION TO CONDUCT A RESEARCH AT AURECON**</u>

Gatekeeper's permission is hereby granted for you to conduct a research within the Aurecon premises, towards you postgraduate studies. provided Ethical clearance has been obtained.

We acknowledge the tittle of your research project:

"**Water Supply challenges in Urban and Rural Areas of the Eastern Cape**"

As an Office Manager of Aurecon (East London office), I give my permission to the researcher to conduct interviews with the staff members of Aurecon that are working within the Civil Engineering (Water Eng) field, which will be of assistance towards the fulfilment of the research

Please be advised that the data collected must be treated with due confidentiality and anonymity

I will also appreciate to be given a copy of the final thesis for our archiving and knowledge management of our institution

On behalf of the Aurecon family, I would like to wish you all the best in your research

Yours Sincerely

[redacted]............

Mr M Ntsebeza

Aurecon Unit Manager

Appendix 11: Interview Section B

SECTION B: CIVIL ENGINEERS, TECHNICIANS AND TECHNOLOGISTS

1. What is your take on the situation of the Eastern Cape water supply in relation to its supply to the urban, rural, and townships? .....

.....

2. How would you improve it, if there are any problems you see in it, if not, what would you point out as being positive results? .....

.....

.....

3. What are the challenges facing civil engineers (water engineers) in the Eastern Cape? .....

.....

.....

.....

4. How does these challenges affect the supply of water to the people in Urban and Rural areas? .....

.....

.....

.....

5. Who, according to your thinking should play a major role in water supply and how? .....

.....

.....

.....

6. What do you think is the reason for water infrastructure failure in the Eastern Cape Province? .....

.....

.....

7. What is the input civil engineer, technician and technologist towards the water supply? ...

.....

.....

.....

8. With regard to quality of water in the Eastern Cape, what's your view and what do you think could be done to improve it, if necessary? .....

.....

.....

.....

9. Looking at the current situation where water has never been delivered to various areas of Eastern Cape particularly rural areas, what do you think is the main cause to that?.....

.....

.....

.....

10. How would you change or improve the situation in relation to point 9 above?.....

.....

.....

.....

.....

Thank you for your participation

Appendix 12: Findings during the data collection of the research

Figure 18: Cegcuwana community in a river (Butterworth)

With reference made to the findings reflected in chapter 3 of the study, Figure 18 above is an illustration of typical condition some people still go under to date in order to wash their clothes. A purely dirty river water, which is also pond for animals to drink, serves as a place to wash clothes for the locals of Cengucwana in Butterworth.

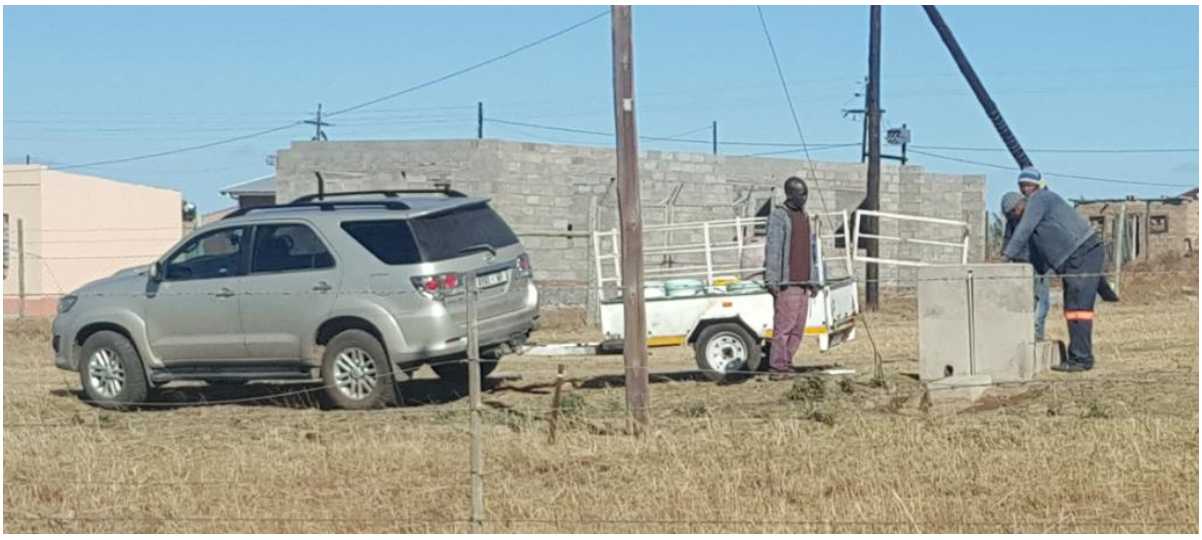

Figure 19: A local fetching water using a vehicle

Figure 19 is an illustration of one of the locals with number of empty containers to fetch water

in a village of Mahlubini in Ngqamakhwe. This is a supporting evidence that some rural dwellers have means to buy themselves pipe connections and connect for themselves, the mere fact that they are able to buy luxury vehicles proves that they also could afford paying rates to avoid the inconvenience they are going through in order to access clean water. Secondly it is portraying how difficult it is for them to access water from far communal standpipes.

Figure 20: A young boy fetching water from river using donkeys

As indicated on the study that, it is not always the case that each village has a dam, and according to Figure 20, in Mngomazi they travel kilometres to the nearest river for them to get water, and therefore they using donkeys fetch water.

Figure 21: Unmonitored overflowing tank in Ibika

Figure 21 is an illustration of poor management by Water Service Providers. The Jojo tank was meant to be a supporting tank during the drought Crisis that was blazing in parts of the Eastern Cape. Instead the tank was left for several hours overflowing, losing large volumes of water.

Figure 22: HDPE water pipe exposed to the ground

Figure 22 above is an illustration of some of poor designs that were done in rural areas. This is an indication of how service providers (consultants and contractors) get away with poor quality of work under the client's eye. An HDPE pipe was not supposed to be hanging on air as children would possibly walk on top of it and cause it to bend. Secondly according to Human Settlement Design guidelines which are widely being used by most municipalities in the Eastern Cape, the water pipes need to at a minimum depth of 800mm from the ground surface and as shown on Figure 21, the cover is between 200 and 300mm from the ground surface.

Figure 23: Township of Idutywa

As talked about in point 6.2.5 of the study, Figure 23 above is an illustration of the township of Idutywa, the only one categorised as urban area in the study but has not networked infrastructure, instead the houses were provided with Jojo tanks. The municipalities have the duty to fill up the Jojo tanks from time to time meanwhile the construction of an extra dam to boost an existing one is underway. This was perhaps one of the great strategies implemented by the ADM municipality, where the issue of housing was attended to successfully and the water issue was thoroughly planned for before the handing over of the houses.

Figure 24: Underground water in a local guest house in Ndabakazi village

Figure 24 above is an illustration of an underground homemade tank which also connected to roof rain collection. It is more dependent on the underground water, which is after pumped out and used for irrigation laundry and all other non-consumption activities. It is one method that shows water conservation, but the owner was having trust issues with regards to quality of this water and preferred it not to be consumed.

Appendix 13: List of journal publications and conference presentation

Publications

Dolo, M. and Allopi, D. 2017. The general situation of water supply in the Eastern Cape. *International Journal of Advanced Research in engineering & Management*, 3(5): 7-11.

Dolo, M. and Allopi, D. 2017. Water, the backbone of life and Economic Stability. *International Journal of Latest Research in Engineering and Technology*. 3(10): 12-17.