Analysis of water supply unreliability and saving behaviour in Harare, Zimbabwe: quantitative comparison of high- and low-density residential areas

By

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Submitted in partial fulfilment of the requirements for the degree

MSc Agric (Agricultural Economics)

In the

Department of Agricultural Economics, Extension & Rural Development

Faculty of Natural and Agricultural Sciences

University of Pretoria,

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February 2019

DECLARATION

I hereby declare that this dissertation which I submit for the degree of MSc Agricultural Economics at the University of Pretoria, is my own work and it has not been previously submitted by me for a degree at this or any other higher education institution.

Signature………………….
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Prof. E. D. Mungatana
Date……………………….

DEDICATION

I dedicate this dissertation to my mother, Mrs Spiwe Mushamba, for all her hard work and sacrifices to enable me to accomplish my goals, ensuring a better future. I also dedicate this study to my beloved brothers, Tinoda and Tapiwanashe Mushamba for all their love and support and also to my late father Admire Mushamba, I know he would have been so proud of me. Finally, to my Father in heaven, God almighty for the strength He provided me throughout my studies. I would not have made it without Him.

ACKNOWLEDGEMENTS

I would like to acknowledge the following individuals and institutions. Without their contributions, I could not complete my study. My sincere gratitude to my supervisor, Prof. E. D. Mungatana, for his devotion, guidance and encouragement. He shared his vast expertise that taught me to construct a virtuous dissertation. He also assisted me in preparing me for my future career. His prompt responses when I needed his assistance, is appreciated. I am immensely thankful to my mother, Mrs S. Mushamba for funding my studies and providing me with her full support during my study period.

My profound gratitude also extends to the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria, the acting Head of Department Prof. Charles Machethe and all the departmental staff for the opportunity to enrol. They provided me with proficiency. I was also provided with funding needed for my research. Thank you to all the non-academic staff, including the TUKS residence, for providing me with accommodation.

Special thanks to all my MSc colleagues at the University of Pretoria for their support. Thanks to my friends, Mrs G. Manjate and Miss T.G. Chibvongodze and my mentor Mr. P.Dhlara for their encouragement and emotional support. Not forgetting my pastors, Mr N.N. Chigoma and Mr L.Thoma for their spiritual support and prayers. Thank you to my editor, Ms Liza Marx from Academic and Professional Editing Services (APES), for attending to proofreading, copy-editing and formatting of my dissertation.

Lastly, I would like to thank the most amasing family and extended family that God blessed me with, for their prayers, motivation, encouragement, inspiration, emotional and financial support. To all those who I have not mentioned here who contributed directly and indirectly to the completion of this study - Thank you!

ABSTRACT

ANALYSIS OF WATER SUPPLY UNRELIABILITY AND SAVING BEHAVIOUR IN HARARE, ZIMBABWE: QUANTITATIVE COMPARISON OF HIGH- AND LOW-DENSITY RESIDENTIAL AREAS

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This study employs data from Harare, Zimbabwe, to assess the extent that unreliable domestic water supply challenges differentially affects households in high-density residential areas. Data are relative to those in low-density areas, based on the following household level measures: Water supply status, water related habits, water conservation consciousness, coping with water supply unreliability and managing future water supply unreliability. Harare was purposely selected because of its documented water supply unreliability challenges, causing suffering households. The study sampled 67 randomly selected households from high-density residential areas and 80 households from low-density residential areas, comprising 147 households. Structured questionnaires and face-to-face interviews were employed. Results concerning **water supply status**, indicate that when households access water from primary municipal sources, unreliable supply challenges do not indicate differential impacts. When constrained to obtain households from secondary sources, those in high-density areas are inclined to use community boreholes ($\chi2 = 93.25$, $p = 0.000$) or to purchase water from bulk sellers ($\chi2 = 20.60$, $p = 0.000$). Households in low-density areas are inclined to obtain water from private boreholes ($\chi2 = 13.99$, $p = 0.000$) or private wells ($\chi2 = 12.67$, $p = 0.000$). Households from high-density areas are also inclined to endure inadequate water supply pressure ($\chi2 = 15.6249$, $p = 0.000$), unpredictable water supply intermittency ($\chi2 = 4.1687$, $p = 0.041$) and water quality they perceive ($\chi2 = 3.2165$, $p = 0.073$) and observe ($\chi2 = 6.2953$, $p = 0.012$) appears inadequate. The results regarding **water related habits**, indicate that unreliable supply challenges have differential impacts on low-density households compared with high-density households. Households in low-density areas are inclined to install showers for personal hygiene ($\chi2 = 46.1558$, $p = 0.000$). Households in high-density areas are inclined to waive water intensive practices, such as frequent floor mopping ($\chi2$ =21.3260, p = 0.000) and rinsing of dishes ($\chi2$ =4.2397, p = 0.039), at the cost of their personal and household hygiene. The results concerning **water conservation consciousness**, indicate that unreliable supply challenges have certain differential impacts on low-density households and high-density households. Households in low-density areas are inclined to install water conservation devices ($\chi2$ =21.0262, p = 0.000), water flow regulation devices ($\chi2$ =27.3979, p = 0.000) and accept legislation to encourage water conservation by limiting the quantity of water use supplied by the municipality ($\chi2$ =9.6560, p = 0.002). The results concerning **coping with water supply unreliability**, indicate that unreliable supply challenges have certain differential impacts on low-density households and high-density households. Households in low-density areas are inclined to use enhancement strategies to cope with inadequate water pressure ($\chi2$ = 106.0411, p = 0.000), inadequate water intermittency ($\chi2$ =25.3845, p = 0.000) and inadequate water quality ($\chi2$ = 72.1068, p = 0.000) from their primary water supply sources. Households in high-density areas are inclined to use accommodation strategies to cope with inadequate water pressure ($\chi2$ = 106.0411, p = 0.000), inadequate water intermittency ($\chi2$ =25.3845, p = 0.000) and inadequate water quality ($\chi2$ = 72.1068, p = 0.000) from their primary water supply sources. Finally, concerning managing **future water supply unreliability**, households in low-density areas are inclined to accept an exemption from water interruption at the cost of paying higher water bills ($\chi2$ = 18.5001, p = 0.000). The study concludes that unreliable water supply results in suffering, disproportionately high on households in high-density areas as they bear the significant share of the cost. The study recommends that the Harare Municipality should consider improving the reliability of the water supply to the Harare residents. During water interruption periods, they should consider residents located in high-density areas in addition, as they suffer the most from residents located in low-density areas. The policy-makers should also consider developing policies to address the welfare loss caused by the unreliable water supply challenge in the city of Harare.

Keywords: Unreliable household water supply, welfare losses, coping costs, coping strategies, urban areas, Zimbabwe

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ACRONYMS

APES	Academic and Professional Editing Services
MDG	Millennium Development Goal
SRS	Simple random sampling
WHO	World Health Organisation
Stata	A general-purpose statistical software package

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Water supply unreliability became an important concern in modern urban developing countries (Howard *et al.*, 2003). According to literature concerning water supplies, unreliability indicates various aspects. A unified definition or assessment criteria does not exist (Majuru, 2015). Kudat (1993) emphasises that households do not simply observe water supply as a municipality service delivery, but as a commodity with multiple attributes, such as pressure, intermittency and quality. Water pressure is defined as measuring the force, enabling the water through main pipes into the tap outlets. It is measured in 'bars'; for example, one bar is the force needed to raise water to a height of 10 metres. Intermittent water supply is when piped water supply service supply water to users for less than 24 hours per day. Water quality is defined as the chemical, physical, biological and radiological characteristics of water. It is a measure of the condition of water, relative to requirements of one or more biotic species for any human need. Households demand these attributes and they use them to rate a water source as reliable or unreliable. In this study, an unreliable water supply is defined as lacking all the attributes necessary to satisfy a specific household's water demand.

Despite the existence of a basic water supply infrastructure, water services in several developing countries are characterised by low pressure, intermittent supply and deficient quality because of its increasing population, whilst an infrastructure remains fixed (Vásquez *et al.*, 2009). The unreliable water supply profoundly impacts individuals' health and their livelihood *(*Hunter *et al.*, 2009). Unreliable water supply, instigated consumers to consider alternative supplies to meet daily water requirements in Kathmandu Valley (a city in Nepal, Asia). Fourty-eight per cent of households have a water reservoir tank in their homes; half of the households either boil or use filters for purification; approximately 7% of households travel over 15 minutes to fetch water (Katuwal, 2011). In urban areas of south Asia, piped water is available for only a few hours daily (IBNET, 2011).Data indicate that the status of the water supply in these countries is unreliable and consumers are pursuing alternative ways to cope with the situation.

The World Health Organisation (WHO) estimated that 89% of the global population would have an improved water supply (WHO & UNICEF, 2014). This confirms to meet the Millennium Development Goal (MDG) estimation that half of the global population without access to safe drinking water by 2015. The credibility of this achievement is debatable when confronted with the local reality of unreliable water supplies, indicating ‘dry’ taps for consecutive days to weeks (Majuru *et al.*, 2012).

Attributable to unreliable water supply, households encounter substantial net costs, such as foregone opportunities, out-of-pocket and relocating resources costs, to accommodate water supply unreliability (Kudat, 1993). In such situations, coping strategies appear a logical response to unreliable water supply (Katuwal, 2011). Households incline to develop various coping strategies to satisfy their needs, resulting in coping costs, such as copious funds a consumer encounters for improved services (Abdalla, 1992). In most cases, coping costs are significantly higher for consumers than the water bill from the water supplies authority. Conversely, consumers spend sundry time fetching and storing water, whilst a significant amount of money is spent on treating the water (Katuwal, 2011). The coping strategies can be divided into two major categories: Enhancement strategies and accommodation strategies. Enhancement strategies intend to increase the level and quality of supply services by supplementing the available supply.

Accommodation coping strategies are intended to adjust behaviour to accommodate the unreliable water supply (Kudat, 1993). The variety of coping strategies comprise, purchasing water from vendors or neighbours, collecting water from public taps or boreholes, boiling water before use and investing in wells, tanks and filtration systems (Subhrendu, 2005). Findings from other studies reveal that wealthy households and underprivileged households choose various strategies to cope with water supply unreliability. The level of income and education are the main determinants, identifying adopted strategies (Majuru, 2015). The unreliable water supply is causing welfare loss to urban consumers. The loss is disproportionately the responsibility of a certain group of households (Kudat, 1993).

With specific reference to Zimbabwe, several developing countries also encounter the same challenge of unreliable water supply in urban areas. Urban residents relying on tap water supplied by the municipality, encounter intermittent water supply. In most cases the water quality is inadequate for drinking and cooking purposes. The city council encounters significant maintenance costs to maintain the pumping equipment, ensuring functioning as it outlived the efficiency of its design (Mangizvo & Kapungu, 2010). Attributable to these outdated equipment, the water treatment plant produces less than the demand; on average it produces 12003m3/day instead of at least 18000m3/day (Chaminuka, 2013).

Attributable to this unreliable water supply, residents adopt various strategies, such as digging shallow underground wells, which according to the water act, is illegal in high-density areas of Zimbabwe. These wells are shallow, lacking continuous casting, rendering them subject to contamination from nearby sources. These wells are also unreliable because they dry up during drought periods, when water tables drop below the wells (Hunter *et al.*, 2009). Instead of bringing relief to residents, they cause health hazards. Most wells are unprotected, and the runoffs collect in them (Mangizvo & Kapungu, 2010). Boreholes are also drilled in low-density areas, without permission (Chaminuka, 2013). certain residents must walk long distances and queue for hours to obtain water from surrounding farms and low-density areas (Baietti *et al*., 2006).

The Bulawayo City Council introduced water shedding. The normal daily routines of residents were altered to accommodate the shedding schedule (Mukuhlani & Nyamupingidza, 2014). Certain residents have water and others not; for example, Entambane (a suburb in Bulawayo) had to buy water from Mpopoma (another suburb in Bulawayo), selling for approximately 50 cents per container (Mukuhlani & Nyamupingidza, 2014). The situation is the same in the Harare urban. Residents incur direct and indirect costs, attributable to the unreliable water supply in the city. Residents are forced to use certain accommodation and enhancement coping strategies, resulting in welfare losses in the community. The extent to which unreliable domestic water supply challenges differentially affect households in high-density residential areas relative to those in low-density areas, are assessed.

1.2 PROBLEM STATEMENT

Researchers studied the unreliability of water supply in Zimbabwe (Baietti *et al*., 2006; Hunter *et al*., 2009; Mangizvo & Kapungu, 2010; Chaminuka, 2013). certain studies focussed on the causes of the unreliable water supply (Mangizvo & Kapungu, 2010) and others focussed on the strategies that residents use to cope with the water supply unreliability challenge (Hunter et al, 2009). These studies indicate a challenge of unreliable water supply, needing immediate attention. Inadequate knowledge concerning the unreliability burden is shared amongst households in various areas in the same city (high-density areas vs low-density areas). Studies lack, focussing on establishing if there is any difference on how urban dwellers from various areas of the same city shares the burden of water supply unreliability in Zimbabwe.

Attributable to unreliable water supply, the society encounters welfare losses. Tt is possible though, that certain households bear the most responsibility, alike others. When individuals endeavour to solve the challenge of unreliability, it is important to identify how the burden is shared amongst households. The extent to which unreliable domestic water supply challenges differentially affect households in high-density residential areas relative to those in low-density areas, are assessed. Residential density is the ratio of a population to residential land area. High-density residential areas are zoned for densities greater than one dwelling unit per acre, including both existing and planned development and their associated infrastructure, indicating the ratio of a population to land area is high in those areas. Low-density areas are zoned for densities of <=1 dwelling unit per acre, including existing and planned development and their associated infrastructure, indicating a low ratio of a population to residential land areas.

The extent of the difference between the two groups of residents is crucial; when the policy-makers consider solving the water supply unreliability challenge in Harare, they will know exactly how to create policies that will assist specific households, according to their needs and the extent of holding the responsibility. This will provide policy-makers with adequate information to assist them to produce effective improved policies. This is preferred to solve the challenge blindly with the assumption that the unreliability challenge is equally affecting every household in the city. The information will assist the policy-makers to focus on the most affected areas of the city and produce informed decisions.

Consequently, this study seeks to address the following main question:

Is the water supply unreliability challenge equally affecting households in high-density and low-density areas of the city of Harare?

The following specific questions guide this study:

1. Is the status of the water supply in high-density areas the same as in low-density?
2. Is there a difference on the consciousness of water conservation and water related habits, between high-density and low-density households?
3. Do households in the high-density and low-density areas encounter the same costs and coping strategies, attributable to unreliable water supply?

1.3 STUDY OBJECTIVES

The main objective of this study is stated as follows:
To assess the extent to which unreliable domestic water supply challenges differentially affect households in high-density residential areas relative to those in low-density areas.
The following are the sub-objectives guiding this study:

1. To determine if the status of households' water supply in Harare is the same amongst households in high-density and in low-density areas.
2. To determine if there is a difference on the consciousness and water related habits of households on water conservation amongst residents in high-density and residents in low-density areas.
3. To evaluate if the cost of coping strategies encountered by households attributable to the unreliable water supply, is the same between households in high-density areas and households in low-density areas.

1.4 STUDY HYPOTHESIS

The main hypothesis of this study is stated as follows:
Households living in the low-density areas and those living in the high-density areas of the city of Harare face an equal burden of water supply unreliability.

The following are the sub-hypothesis, guiding this study:

1. There exists no difference in the status of water supply in low-density and high-density residential areas.
2. There exists no differences in water conservation consciousness and practices between households in low-density and high-density residential areas.
3. There exists no differences in water supply unreliability coping costs between households in low-density and high-density residential areas.

1.5 IMPORTANCE AND BENEFITS OF THE STUDY

The study contributes to the existing body of knowledge on the economic analysis of water supply and water related behaviour, from an applied perspective. It estimates costs incurred at household level, attributable to unreliable water supply and determine the coping strategies. This study will assist policy-makers to realise how important a reliable water supply is to the Harare community. The welfare loss concept will assist informing them on how this issue affects lives of Harare residents. It will provide information that will cover the disparity of previous policies and inform future policies. The concept of "differential impact on households in different areas" will provide relevant information to policy-makers on supplying reliable water, leading to reliable decision-making concerning supplying Harare residents with trustworthy water. This study will raise awareness of the value of continuous water supply and will promote water conservation consciousness. It will also inform the decision-makers on how to handle future water interruptions and minimise welfare loss.

This study comprises five chapters. Chapter 1 represents the introductory. It comprises the background of the study, problem statement, specific questions, objectives and the study hypothesis. Chapter 2 comprises the theoretical and empirical literature. Chapter 3 comprises the research methodology, indicating the sampling, survey instrument development, facilitation of the instrument, variable description, data analysis and socioeconomic characteristics of households. Chapter 4 presents the results and discussion of the study. Finally, Chapter 5 represents the conclusion, recommendations and limitations of the study.

CHAPTER 2: THEORETICAL AND EMPIRICAL LITERATURE

2.1 INTRODUCTION

The first objective of this chapter is to review the theoretical and empirical literature on urban water supply unreliability, welfare loss concept, unreliable water supplies in developing countries and costs, coping with unreliable water supply. The second objective aims to identify the knowledge disparity and emphasises the contribution of the study. The chapter is organised in the following sections: Section 2.2 reviews theoretical literature under the following subsections: Section 2.2, indicating urban water supply unreliability and 2.2.2, indicating the welfare concept. Section 2.3 reviews empirical literature through comparative studies. Section 2.4 presents the knowledge disparities. Section 2.5 concludes the chapter.

2.2 THEORETICAL LITERATURE

2.2.1 Urban water supply unreliability

Urban areas are defined as developed areas, operating within the jurisdiction of a municipality or town committee. Paved roads, street lights, water and electricity supplied to households by the municipality characterise the areas (UNICEF, 2012). The urban households rely on the municipality to supply them with water at a cost, usually monthly. Definitions of water supply unreliability varies across literature; most literature focus on water as a service delivery function, defining unreliability as an intermittent supply. The word "intermittent" means a water supply unavailable for periods. Accessing water in an intermittent system is unreliable. The situation can instigate severe implications for consumers (Galatsi *et al*., 2016).

Griffin (2000) defines water supply unreliability as a supply system with a chance of future shortfall. CUWA (2012) defines it as a system, unable to meet consistent water demand. Certain literature focusses on water supply as a commodity with multiple attributes (intermittency, pressure and quality) and defines water supply unreliability concerning those attributes, as: The water supply that does not have all the necessary characteristics to satisfy a specific household's water demand (Kudat, 1993).

2.2.1.1 Attributes of unreliable water supply

The first and most popular attribute of an unreliable water supply is unpredictable intermittency. Unpredictable intermittency is characterised by uncertain delivery time and the risk of insufficient quantity. The delivery is inconsistent, and consumers are forced to make choices under uncertainty. This interaction requires behavioural, emotional and physical adjustment to cope with the shortages. Residents may store water, but their reserves may become depleted. The might need to invest in much more expensive supplemental sources from private vendors. The challenge is extreme when discontinuity is frequent and unpredictable (Howard *et al.*, 2003). The inconsistent nature of intermittency causes additional costs for communities. Coping strategies for water rationing are expensive for the consumers (Habi *et al.*, 2015). Unpredictable intermittent water supply systems render water access unreliable. Consumers are left with serious implications (Galatsi *et al.*, 2016).

The second attribute of unreliable water supply is inadequate quality. Water quality is important for health and improvement of the wellbeing of human beings. When the urban municipalities do not provide quality water continuously, consumers regard the supply as unreliable, incurring coping costs. Consumers may choose to buy chemicals to treat water or observe alternative sources that is expensive (in most cases) (Moffat *et al.*, 2011).

The third and final attribute of unreliable water supply is inadequate water pressure. Water can be available continuously but if the pressure is too low consumers regards it as unreliable. Low pressure can provide the same impacts of intermittent supply, for example if it takes 20 or more minutes to fill a 20-litre container the resulting effect will be almost the same as an intermittent supply, which consumers regard as unreliable (Gumbo *et al.*, 2003). Bacteria growth may also be present in the pipes during the periods of low to no pressure. This incidence compromises the quality of the household water supply, mainly used for consumption (Matsinhe *et al.*, 2014). When the water supply is unreliable, consumers suffer welfare loss, incurring costs to individuals, causing economic challenges.

2.2.2 The welfare concept

2.2.2.1 Definition of welfare

The word ‘welfare’ historically relates to happiness and prosperity. The understanding first emerged in the 20th century (Williams, 1976). The concept of welfare in the historical and cultural context where it is embedded, is vital. There is no intention to enter into a long historical analysis of the concept (Greve, 2008). In the economic theory, ‘welfare’ is a synonym to ‘utility’. Alternatively, it is an evaluation assigned by an individual to the contribution of our wellbeing from those goods and services that we can buy (Van Praag & Frijerts, 1999). In economics, welfare is connected to an individual’s perception and utility of using income funds. The economist Pigou, stressed that the only obvious way to measure welfare, concerns money. Money is not the end goal though, but it is used to achieve welfare. Greve, 2008 suggests that welfare be defined as the highest possible access to economic resources, providing citizens an elevated level of wellbeing, including happiness and the ability to ensure a good life.

2.2.2.2 Welfare economics

Welfare economics is the branch of economic sciences attempting to establish how and by what criteria policy-makers ought to make their choices between alternative policies and ‘good’ and ‘bad’ institutions (Arrow *et al.*, 1969). The primary objective of welfare economics is to provide a guide, distinguishing a desirable and undesirable state of economy (Quirk & Saposnik, 1968). Much of the welfare economics distinct the criteria implied in the works of the classical, declaring free trade as ‘good’ and monopoly as ‘bad’. But in succeeding these criteria, several truths of economics were exposed, and the consequent reanalysis placed the science findings on a comprehensive basis (Reder, 1947).

2.2.3 Measuring welfare losses

A supply disruption, followed by shortages, relative to quantity-demanded, have the potential to adversely affect economic outcomes amongst several types of water users (Buck & Nemati, 2017). Figure 2.1 on the next page measures the residential welfare losses as area ABD.

The area between the demand e and supply curve, represents a total surplus. This area is maximised at the market equilibrium: Point B in figure 2.1 above. Consumer surplus is an economic measure of consumer benefit. It is calculated by analysing the difference between consumers' willingness and ability to pay for a reliable or a service relative to its market price, or what they actually spend on goods or services. The areas above the equilibrium price and below the demand curve on the graph above, represent the consumer surplus. Producer surplus differs in how much of a good the producer is willing to supply, versus how much the trade receives. The difference or surplus amount is the benefit the producer receives for selling the good on the market. If the quantity equals two, the total surplus will be smaller. Q represents quantity of goods and P represents price of goods. Mathematically, consumer surplus (CS) + producer surplus (PS) should be maximised.

$$CS + PS = [U(Q) - PQ] + [PQ - \int PQdQ] = U(Q) - \int PQdQ \qquad (1)$$

Eventually supply curve, P(Q) =AC=MC

AC - total cost divided by number of goods produced

MC - the cost added by producing one additional unit of a product or service

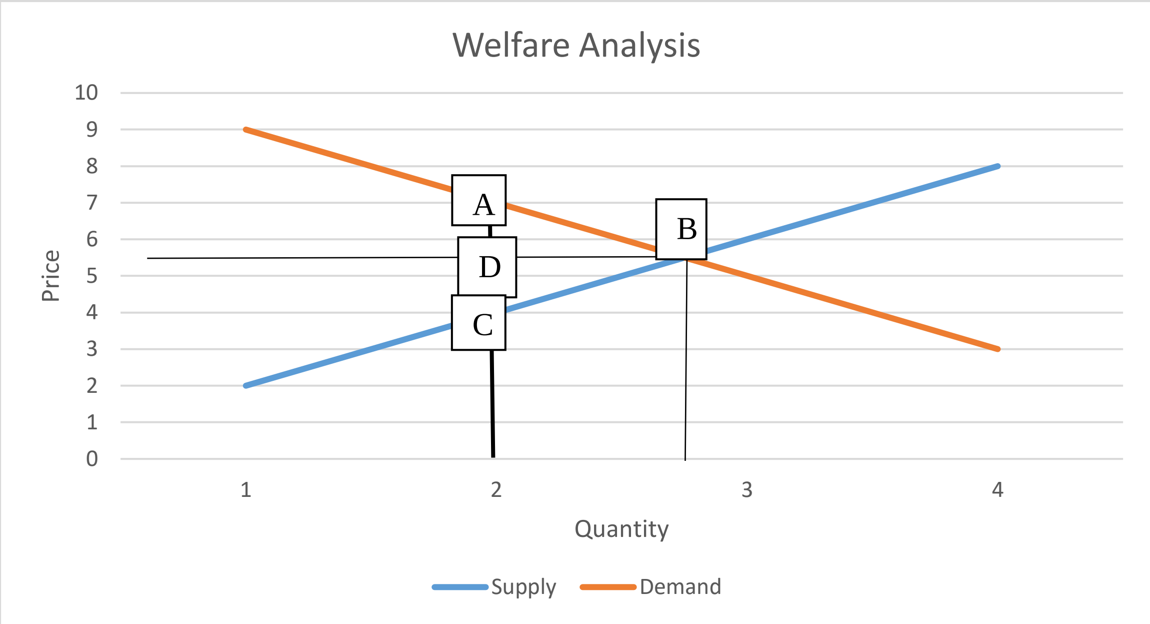

Figure 2.1: The residential welfare losses measured as area ABD

Maximisation occurs where the marginal value of Q to the consumer is equal to market price, such as the market equilibrium. Welfare losses can be calculated, using consumer surplus by restrictions on voluntary transactions, such as Harare, were water supply is restricted and does not meet the demanded quantity. The total welfare loss from restricted output to Q = 2 is the area of a triangle ABC. The producer and consumers share this welfare loss. This study focusses on the consumer’s welfare loss, presented in area ABD of Figure 2.1 above. Attributable to the unreliable water supply in Harare, the consumers are supplied with less water than demanded, which leads to immense welfare loss. The welfare loss costs the individuals and the economy.

2.3 EMPIRICAL LITERATURE

2.3.1 Unreliable water supplies in developing countries

Numerous studies were conducted on the topic of unreliable water supplies in urban areas. These studies indicate that in several developing countries, water supplies are unreliable

(Humplick *et al.*, 1993; Madanat & Humplick,1993; Baisa, 2010; Kudat *et al.*, 1993). It is estimated that at least 300 million individuals globally, are served by water supplies. These supplies are available for less than 12 hours per day and most of them are in Sub-Saharan Africa and South Asia (Kumpel *et al.*, 2016). Growing concern exist concerning the impact of these unreliable water supplies (Hunter, 2009). Even though the topic remains understudied, unreliability has significant influences on households' health and welfare (Kumpel *et al.*, 2013; Kumpel *et al.*, 2016; Hunter, 2009; Majuru, 2011; Baisa, 2010). Majuru (2011) suggests that with the assumption that unreliable water supplies will continue to be a challenge in developing countries, effective coping strategies should be identified to ensure reduced health risks in households, obtaining safe and adequate quantities of water at an affordable price.

2.3.2 The importance of water supply attributes to consumers

Literature indicates that water consumers are mostly concerned about the attributes of water as a commodity. Galaitsi *et al* (2016) suggest that predictable intermittency will benefit households in situations where water supply is intermittent but follows a provided schedule. Welfare gains from the predictable intermittent water supply (Baisa *et al.,* 2010). This factor implies that although the water supply is intermittent, households are content if they are aware of the water supply schedule.

Supply systems of drinking water are unreliable. The systems do not meet the requirements of households. Households place value on water services and quality (Haq *et al.,* 2007). Perceived water quality is imperative. The differences in water quality perceptions can result in various priorities, affecting the community's decision-making regarding water concerns (Hu, 2011). Certain studies established that individuals' attitude towards paying for the water is influenced by their perception of the water quality (Dogaru *et al.*, 2009).

Majuru *et al.* (2016) established that water pressure is essential when supplying water to the consumer. Pressure fluctuations may result in limited or a lack of supply. Studies established that households engage in various enhancement coping strategies to manage low water pressure from their supply. Strategies include: Installing storage tanks and electric pumps and installing motors directly to municipal water connections to boost the water pressure (Choe *et al*.,1996; Zérah, 2000).

Lebabo (2016) establishes that it necessary to regard water pressure as a specific aspect regarding water supply as vital to consumers. Various attributes of water hold diverse values, regarding the identifiable use of water. For residential consumption in urban households, quality and pressure are important for drinking, food preparation, health, hygiene, housekeeping, home-based production and leisure activities (Kudat, 1993).

2.3.3 Strategies adapted to cope with unreliable water supply

Studies indicate that households adapt various strategies to cope with unreliable water supply services. The reported enhancement coping strategies frequently used to access or enhance water quality, are: Digging shallow wells or drilling boreholes; storing; and purchasing water (Moffat *et al.,* 2011). Eleven studies report that drilling wells or drilling boreholes as enhancing coping strategy for water quantity, (Humplick, 1993; Kudat, 1993; Kudat, 1997; Zérah, 2000; Pattanayak *et al*.,2005; Cook, 2016; Chaminuka, 2013; Nganyanyuka, 2014; Widiyati, 2011; Jamal, 2012; Altaf, 1994). Households also store water in smaller containers, such as buckets and pots. The pressure from the supply is often too low.

The processes involved to store water, is often a prolonged process. Households are forced to awaken early in the mornings or stay up late in the evenings to fill the containers, whilst the supply is still available (Smiley, 2016; Nganyanyuka, 2014; Caprara, 2009). In circumstances with unpredictable intermittent supply, the feasibility of such storage is limited (Baisa, 2010) and (Smiley, 2016). Households purchase water from vendors, neighbours, kiosks and pay for container or tanker deliveries for refilling (Choe, 1996;Nganyanyuka, 2014; Caprara, 2009; Pattanayak, 2005; Gulyani, 2005; Widiyati, 2011).

The literature identified four accommodative strategies to cope with unreliable water supply:

- Reducing water use.
- Recycling water.
- Rescheduling domestic activities.
- Collecting water from alternative sources.

Households reduce water use by reduced frequency of bathing and laundry, including less rinsing of fruits and vegetables and reduce flushing toilets to only once daily, where possible (Chaminuka, 2013). A study conducted in Botswana, established that reduced water use was challenging, especially for individuals caring for family members with HIV/ AIDS and other conditions or diseases (Ngwenya *et al.*, 2006). Households reduced daily cooked meals, and reduced baths or washing of their frail or ill family members. They retained laundry until more water would be available. Certain households recycle their water by flashing toilets, watering gardens and mopping floors, using greywater (waste water) (Kudat, 1993; Zérah, 2000; Nganyanyuka, 2014).

Numerous studies indicate that domestic activities requiring sundry water, such as laundry, bathing, dishwashers and car washing, amongst others, are rescheduled to days when water is available (Mycoo, 1996; Zérah, 2000; Nganyanyuka, 2014; Olsson, 2010; Smiley, 2016; Gerlach *et al*., 2009; Ngwenya *et al.*, 2006). Collecting water from alternative sources is the most popular strategy, reported in several studies. Alternative sources comprise, communal wells, boreholes and taps, burst water pipes and trenches and surface water or springs (Zérah, 2000; Pattanayak *et al.*, 2005; Nganyanyuka, 2014; Chaminuka *et al.*, 2013; Smiley, 2016). Households spend a minimum of 30 minutes to a maximum of three hours collecting water from these alternative sources, which is time consuming (Cook *et al.*, 2016; Smiley, 2016).

Unreliable water supply negatively influences household health and welfare (Hunter *et al.*, 2009; Majuru *et al.*, 2011; Baisa *et al.*, 2010). Certain strategies that households use to cope with unreliable water supply are harmful. A good example indicates the case in Zimbabwe where households dug shallow wells because of water supply interruptions. They became contaminated with cholera and caused a 2008 to 2009 cholera outbreak in the country (Chambers, 2009) and (Mangizvo *et al.*, 2010).

Several studies reported that households treat water through disinfection, boiling and filtration; boiling and filtration are the most commonly used strategies (Dutta *et al.*, 2005; Pattanayak *et al.*, 2005; Katuwal *et al.*, 2011). Studies indicate that certain households choose to purchase bottled or sachet water (Cook *et al.*, 2016; Nganyanyuka, 2014; Vásquez *et al.*, 2009; Vásquez *et al.*, 2016). The average weekly consumption of bottled water for households in urban Jordan is 32L and 51L in urban Mexico (Vásquez *et al.*, 2009; Gerlach *et al.*, 2009). Perceptions of water quality influence water treatment behaviour. Individuals treat the water according to their perceiving of its quality, regardless of their perceptions presenting reality (Zérah, 2000; Cook *et al.*, 2016; Katuwal, 2011).

2.3.4 Cost of unreliable water supply

Literature indicate that households encountered with unreliable water supply become responsible for supplying their own water. They adopt coping strategies. The adoption of coping strategies involves costs. Certain costs are direct monetary expenses and others are indirect costs (Moffat *et al.*, 2011). Four studies reported costs associated with treating water for household consumption (Dutta *et al.*, 2005; Zérah, 1998; Pattanayak *et al.*, 2005; Cook *et al.*, 2016) and three studies reported costs associated with water related illness (Dutta *et al*, 2005; Zérah, 1998; Cook *et al.*, 2016). Although studies indicate that collecting water from alternative sources is the most common strategy, most of them report on time consuming collection of water (opportunity cost) and three studies (Choe *et al.*, 1996; Pattanayak *et al.*, 2005; Cook *et al.*, 2016) estimated the value of time spent on travelling. In the study conducted in Nepal (Pattanayak *et al.*, 2005) the average time consumed on collecting water from alternative sources, comprised 45% coping costs. In Kenya, the average time related costs for households without piped water, comprised 6% of their monthly income. Although low-income households incur lower direct coping costs compared to high-income households, these costs still take a higher proportion of their income. According to Zérah (1998) (a study conducted in India), coping costs comprised 15% of the income for low-income households; whereas for high-income households it was only 1%.

Studies established that in addition to their coping costs, households with piped connections may still be charged with water utility bills. In a study concerning Zimbabwe households, they did not have water for over a month. They were expected to still pay their fixed monthly bills as they had piped connections (Chaminuka, 2013). Several studies established that minimum coping costs were equivalent to monthly bills but could be even double or six times as much (Choe *et al.*, 1996; Pattanayak *et al.*, 2005; Zérah, 1998). Some studies also use coping costs to review households’ willingness to pay, as a useful lower bound estimate (Pattanayak *et al.*, 2005).

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter presents the methodology employed in the study in nine detailed sections. Section 3.2 presents a discussion on the study area, whilst Section 3.3 discusses sampling. The survey development instrument is discussed in Section 3.4, and survey facilitation in Section 3.5. Section 3.6 presents data analyses and Section 3.7 presents the variable distribution. Household characteristics of the sample are discussed in Section 3.8, whilst Section 3.9 presents empirical study methods. Finally, Section 3.10 presents the concluding summary.

3.2 STUDY AREA

The study was conducted in Harare urban area, focussing on the high- and low-density areas of the city. Harare is situated in the North-East of Zimbabwe, with an estimated population of 1485231 (2012). Harare is Zimbabwe's commercial capital city. It covers an area of 371 square miles; 961 square kilometres. Harare urban area comprises the following suburbs: Kuwadzana, Budiriro and Dziarasekwa in high-density areas. Hatfield, Borrowdale and Mount Pleasant are located in low-density areas. According to data collected during the study, 94% of residents from high-density areas hold a post primary education level; 96% of residents in low-density areas have the same level of education. It can be concluded that inhabitants in these areas are educated. Harare urban is under the jurisdiction of the Harare Municipal Council, providing all public services, such as piped water and electricity. The municipality supplies high- and low-density areas. Both areas comprise well-structured public roads, clinics and electricity. Households from high- and low-density areas have access to water resources. All houses in the city are connected to municipal water supply, with access to tap water in less than or equal to five metres.

The study chose this area as the urban areas of Zimbabwe encountered challenges concerning unreliable water supply for a decade. Choosing Harare for the study, is conspicuous, since it is the capital city of Zimbabwe and the largest city of the country. The city is ideal for the study as its suburbs are divided into low-density and high-density areas. The same municipality supply these areas with water.

3.3 SAMPLING

The study employed purposive and simple random sampling methods to collect survey data from the Harare urban area. Harare was purposively selected for this study. The city forms the centre of Zimbabwe, indicating the leading financial, commercial and communications centre of Zimbabwe. It is also the largest urban area of Zimbabwe, encountering unreliable water supply. Harare urban areas comprise 1485231 individuals, including 534 106 households. A sample of 147 respondents were randomly selected from the sampling frame, using a simple random sampling (SRS) method. One-hundred and forty-seven sample respondents participated, considering the type of survey. A questionnaire has to be administered properly; considering the time frame and the resources of this study, a significant sample size could have resulted in a deficiently administered survey, failing to produce high quality results. This area has a homogenous population; a sample of 147 respondents is a good representation of the population. SRS was used because of the homogenous characteristics of the Harare urban area. Each unit of the population has the same selection probability. Respondents from Kuwadzana, Budiriro, Dziarasekwa, Hatfield, Borrowdale and Mount Pleasant suburbs were interviewed. The sample was divided into 67 respondents from high-density areas; 80 respondents were from low-density areas. The interviewed respondents represented the individual households.

To achieve the objective of the study, the household survey was carefully designed, facilitating to collect information on households' water supply status, their water related habits, consciousness of households on water conservation and costs and coping strategies encountered, attributable to unreliable water supply. During the collections of households' information, only heads of houses were interviewed. Where the head of the household was unavailable, the spouse or the eldest person could provide reliable information on behalf of the head. For this study "households head" refers to the proprietors since Harare urban comprises proprietors and tenants. Tenants were not interviewed. They often do not stay in the same place for extended periods, therefore their information might not be reliable.

3.4 DEVELOPING THE SURVEY INSTRUMENT

The survey instrument represents a structured questionnaire, comprising seven sections. The questionnaire is designed to capture all the relevant information, addressing the research problem. Section A focusses on introducing the purpose of the survey and universal information of the respondent. Section B collects information relating to demographic statistics of the respondent. Section C concentrates on the status of the household water supply. Section D captures information on households' water related habits and Section E focusses on establishing households' water conservation consciousness. Section F captures the cost of water supply unreliability and lastly Section G captures managing future water supply unreliability.

After designing the questionnaire, pre-tests were conducted. In the pre-tests, the questionnaire was tested in a real survey, within a close establishment. Ten respondents were selected for one-on-one interviews, lasting 20 to 30 minutes. Data collected from the pre-tests were analysed; the questionnaire was carefully revised. Three well-trained research assistants aided with data collection.

3.5 SURVEY FACILITATION

Face-to-face interviews were conducted in Harare urban area. Three enumerators conducted interviews. Interviews continued for a period of 20 to 30 minutes. Respondents were assured of confidentiality of their responses before answering the questions. Before any question were directed to them, they were provided with clear information and objectives of the study. They could choose to participate in the survey by providing their consent. Enumerators were trained and supervised before and during the interviews. The enumerators were instructed to interview only heads of households (proprietors not tenants), but in cases were the head was unavailable, they were allowed to interview the spouse or the eldest person in the household who would provide reliable information.

Follow-up questions were indicated in certain sections, ensuring an improved understanding of the responses. The debriefing section at the conclusion of the questionnaire assisted to test the internal consistency, determining if respondents understood the question and if they provided reliable responses. Respondents seemed to understand the questions and answered them truthfully, provided the way the questionnaire was structured. The results indicated that respondents clearly understood the questions and their response were reliable.

3.6 DATA ANALYSIS

A Microsoft Excel™ spreadsheet was used for entering data, where it was coded and labelled before imported to Stata. Data were imported to Stata Version 12 where they were prepared, using summary statistics to identify and correct possible mistakes during data entries that could possibly affect the results. The main aim of the analysis was to test whether the location where individuals reside, had a significant impact on influencing the participants' response, especially if the location affects the magnitude of costs that the respondent encounters. The objectives of the study were analysed with summary statistics, Chi-square tests and p-values.

3.7 VARIABLE DESCRIPTION

The main variables used in the analysis are discussed in this section. The descriptive statistics described the variables as frequencies and percentages. Certain variables captured the various objectives of the study. The socioeconomic variables used, indicated gender, age, participation of respondents in the household, basic need affordability and their financial circumstances. The following variables were used to capture the household's water supply status:

- The main source was where respondent had to state their main water source supply.
- Secondary source where the respondent had to state the alternative source providing water when water is unavailable at the main source.
- Water pressure from the main source.
- Water pressure from the secondary source.
- Water intermittency from the main source.
- Water intermittency from the secondary source.

Perceived water quality from the main source and water quality from the secondary source, represents water quality from both sources. The study used additional variables, such as personal hygiene, household and yard cleaning, and vegetable gardening to capture the respondents' water related habits. The analysis was used to understand if households practice daily water conservation. The following variables were used to establish households costs sustained, attributable to unreliable water supply:

- Water pressure.
- water intermittency.
- observed quality perceived.

Respondents were questioned to provide coping strategies concerning unreliable water attributes. The analysis was used to indicate costs that water supply unreliability causes households. Finally, to capture respondents' opinions for improved services, they were questioned on the maximum number of days that is acceptable deprived of water and if they will experience inconvenience, the number of days' notice for water interruption and the medium of communication to be used.

3.8 EMPIRICAL STUDY MODELS

3.8.1 Chi-square test model

The study used the one-way Chi-square model to verify the potential association of location with the respondents' status of water supply, water related habits, water conservation consciousness, cost of water supply unreliability and future managing of water supply unreliability. Stata Version 12 run the model.

3.8.1.1 *Model specification for Chi-square model*

Letting χ^2 be the Chi-square statistic, the Chi-square model was specified and estimated as:

$$\chi 2 = \frac{(Observed - Expected)^2}{\text{Expected}} \tag{3}$$

The Chi-square tests determined whether two categorical variables are independent (no relationship). The null hypothesis of the test states that there is no relationship between the two variables. Alternative hypothesis identifies a relationship between the two variables. Under the null hypothesis, this statistic has a t-distribution with (n -1) degrees of freedom; where n is the number of classes. The equation above is used to calculate the $\text{Chi} - \text{Square statistic}$, then the value is compared to the critical value from the standard critical value table. As conducted in this study Stata can calculate the p-value (probability value) to conclude if it is statistically significant. If $p \leq 0.05$ the test is statistically significant. The null hypothesis of independence is rejection indicating that there is a significant relationship between the two variables; of p > 0.05 the test is not statistically significant, and the null hypothesis is not rejected.

CHAPTER: 4 RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter presents the results and discussion of the study. The chapter comprises eight sections. Section 4.1 presents the introduction. Section 4.2 presents the household characteristics of the sample. Section 4.3 presents results and discussion on the status of households' water supply. Section 4.4 presents results and discussion on household water related habits. Section 4.5 presents results and discussion on households' water conservation consciousness. Section 4.6 presents results and discussion on coping strategies for unreliable water supply. Section 4.7 presents results and a discussion on managing water supply unreliability. In conclusion, Section 4.8 summarises the results and discussion.

4.2 HOUSEHOLD CHARACTERISTICS OF THE SAMPLE

The sample size for this study comprises 147 respondents, derived from two-split samples: 80 households (54%) were obtained from the low-density areas of Hatfield and 67 households (46%) were obtained from the high-density areas of Kuwadzana. Table 4.1 presents the socio-demographic and socioeconomic characteristics of respondents.

Table 4.1 Socio-demographic and socio-economic characteristics of respondents

Variable	Description	Low Density	High Density	Overall
	Gender of respondent			
Gender	*Dummy: 0=Male*	31(39%)	27 (40%)	58 (31%)
	1=Female	49 (61%)	40 (60%)	89 (61)
	Age of respondent:			
Age	15-25	17(21%)	10(15%)	27(36%)
	26-64	63(79%)	57(85%)	120(64%)
	64>	0	0	0
Role in Household	The role in the household of the respondent			
	1=Head of household	54(68%)	43 (64%)	97(66%)
	2= Spouse of the household	15(19%)	16 (24%)	31(21%)
	3=Child of the household	10(13%)	8 (12%)	18(12%)
	4=Parent of the household	1(1%)	0	1(0.7%)
Educational Level	Level of education of the respondent			
	1= No formal Education	2(3%)	1(1%)	3(2%)
	2=Adult Education	0	2(3%)	2(1%
	3=Primary Education	1(1%)	1(1%)	2(1%)
	4=Post Primary	77(96%)	63(94%)	140(95%)
Afford Basic needs	Does your household afford basic needs like food and water?			
	1=Yes Always	28(35%)	21(31%)	49(33%)
	2=Sometimes difficult	50(62%)	45(67%)	95(65%)
	3=No	2(3%)	1(2%)	3(2%)
Financial Situation	Which statement best describes your family's financial situation			
	1= We do not have enough money	5(6%)	3(5%)	8(5%)
	2= We have money for food but cannot afford	7(9%)	11(16%)	18(12%)
	public utilities	42(53%)	34(51%)	76(52%)
	3=We can afford food and public utilities but it's difficult to pay for school fees	6(8%)	11(16%)	17(12%)
	4= Can afford public utilities, pay fees but can't afford durables	20(25%)	8(12%)	28(19%)
	5=We have enough money to pay for all our needs and can afford to buy durable goods			

The sample had a significant representation of females (64%) relative to males (36%); generally consistent with the demographics are observed in Zimbabwe where females outnumber males (Zimstat, 2016). All the interviewed individuals were at least aged 15 years. The majority of those interviewed, were household heads (66 %) or spouses (21%), indicating that the survey comprised answers from responsible persons. Ninety-five per cent of interviewees held a post primary level of education; 1% had primary school qualifications and 1% had adult education school qualifications. The survey comprised answers from literate individuals. To further understand whether socioeconomic and demographic descriptors can be used to discriminate amongst households residing in low-density areas from those residing in high-density areas, questions were directed related to households' affordability of basic needs and financial situation. Table 4.2 indicates the results of the basic needs analysis.

Table 4.2: Ability of a household's basic monthly needs

Statement	Population density of where household is located		
	Low	High	Total
Household can always afford basic needs	28(35%)	21(31%)	49(33%)
Household sometimes finds it difficult to afford basic needs	50(62%)	45(67%)	95(65%)
Household cannot afford basic need	2(3%)	1(2%)	3(2%)

Source: Author's elaboration.

Note: Figures in the table shows the number of people who indicated yes and figures in brackets represents their percentage.

Thirty-three per cent of households reported that they can always afford basic needs, such as food and water; 65% reported that they find it difficult to afford basic needs at times, such as food and water. To further investigate the robustness of the results, Chi-square ($\chi 2$) tests were applied to verify the association of the basic need affordability with the suburb, such as whether the respondent can afford basic needs affects the suburb where the respondent resides.

Contrary to expectations, the results ($\chi2 = 0.2194$, $p = 0.639$) indicate that location is not a concern, since the Chi-square statistic is not statistically significant**.** This result is inconsistent with the expected, indicating the ability of a person to afford basic needs to influence whether they stay in high- or low-density areas. In this instance it is not established. A possible reason is that Harare citizens grow their own maize for maize meal needs in Harare or in their nearby rural areas. They are not involved in vegetable gardening for daily use. The following statements are designed to measure how households best describe their family financial situation, presented to households:

- The family lacks adequate funds.
- The family has adequate funds for food but cannot afford public utilities.
- The family can afford food and public utilities but cannot afford school fees.
- The family can afford food, public utilities and school fees but cannot afford durables.
- The family can afford food, public utilities, school fees and durables. Table 4.3 presents results from this analysis.

Table 4.3: Financial situation of the household

Statement	**Population density of where household is located**		
	Low	**High**	**Total**
The family does not have adequate money to cover for basic needs through the month	5(6%)	3(5%)	8(5%)
The family has adequate money for food but cannot afford public utilities	7(9%)	11(16%)	18(12%)
The family can afford food and public utilities but cannot afford school fees	42(53%)	34(51%)	76(52%)
The family can afford food, public utilities and school fees but cannot afford durables	6(8%)	11(16%)	17(12%)
The family can afford food, public utilities, school fees and durables	20(25%)	8(12%)	28(19%)

Source: Author's elaboration.

Note: Figures in the table shows the number of people who indicated yes and figures in brackets represents their percentage.

Five per cent of the sample population reported, lacks adequate funds; 19% can afford basic needs and durables; 52% of the sample population can afford food and public utilities but cannot afford school fees. To further investigate the robustness of the results, Chi-square ($\chi 2$) tests was applied to verify the association of the household's financial situation with the suburb, such as whether the household's financial situation affects the suburb where the respondent resides (high-density or low-density). The variable financial situation is statistically significant at 10% as the results of the $\chi 2$ tests failed to reject the null hypothesis of equal variation of households' suburb. The Chi-square ($\chi 2$) was used because the variables are categorical. Table 4.4 below displays the results of the $\chi 2$ tests and the p-values in brackets.

Table 4.4: Association of households' financial situation within a suburb

Statement	Suburb
The family does not have adequate money to cover for basic needs through the month	0.2226(0.637)
The family has adequate money for food but cannot afford public utilities	1.9951(0.158)*
The family can afford food and public utilities but cannot afford school fees	0.0449(0.832)
The family can afford food, public utilities and school fees but cannot afford durables	2.8354(0.092)*
The family can afford food, public utilities, school fees and durables	4.0331(0.045)**

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 % and 1 %, respectively

The results from Table 4.4 indicate (2) the family has adequate funds for food but cannot afford public utilities, (4) the family can afford food, public utilities and school fees but cannot afford durables and (5) the family can afford food, public utilities and school fees; durables are statistically important in influencing households' place of residence. This is indicated by Chi-square and their p-value indicated in brackets. The results (2) ($\chi 2$ = 1.9951, p = 0.158), (4) ($\chi 2$ = 2.2354, p = 0.092) and (5) ($\chi 2$ = 4.0331, p = 0.045) indicate that location matters, since the Chi-square statistic is statistically significant. The relationship is significant at 10%, 10% and

5% respectively. This result is consistent with the expectancy. It is expected that a household's financial situation should be considered in determining the area of residence.

4.3 STATUS OF HOUSEHOLD WATER SUPPLY IN HIGH-DENSITY VERSUS LOW-DENSITY AREAS

Three measures were used to understand and explain the status of household water supply: Primary and secondary sources of water, water quantity from primary and secondary sources and water quality from primary and secondary sources. Section 4.3.1 analyses the water sources. Section 4.3.2 analyses the water quantity from primary and secondary sources. Section 4.3.3 analyses the water quality from primary and secondary sources.

4.3.1 Water sources

Households' sources of water were distinguished between primary source (where the household draws water regularly) and secondary source (household water sources when water is unavailable from the main source).

4.3.1.1 Primary water sources

Table 4.5 presents the results of primary water sources to households.

Table 4.5: Households' primary sources of water

Water source	Population density of where household is located		
	Low-density	High-density	Inclusive
Tap water	80(100%)	65(97%)	145(98%)
Community borehole	0(0%)	1(1%)	1(0.7%)
Private borehole	0(0%)	1(1%)	1(0.7%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The results indicate that, from the total sampled households, the vast majority (98%) use municipal tap water as their primary source and only 2% use alternative sources. Most households in Harare are therefore connected to the municipal tap water source where they obtain water for daily use. To further investigate the robustness of these results, Chi-square ($\chi2$) tests verified the association of location with the primary sources of water. The results ($\chi2 = 2.4210$, $p = 0.298$) failed to reject the null hypothesis of independency of the location and primary water sources, implying that location is not a concern in determining the primary water source a household inclines to use. The results suggest that households regard tap water as their primary source, regardless of the location. The reason for this intention might be that the majority of households are connected to the municipality tap water. It is convenient for them to use it as a primary source as they do not have to travel long distances to fetch water elsewhere since it will be easily accessible as close as their kitchens and bathrooms.

4.3.1.2 Secondary water sources

Households indicated five options as secondary water sources. Table 4.6 indicates the various water sources.

Table 4.6: Households' secondary water source options

Water source	Population density of where household is located		
	Low-density	High-density	Inclusive
Community boreholes	0(0%)	51(76%)	51(34%)
Private wells	35(44%)	11(16%)	46(31%)
Buy water from bulk sellers	26(33%)	2(3%)	28(19%)
Private boreholes	15(19%)	0(0%)	15(10%)
Neighbours' well	4(5%)	3(4%)	7(5%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The results indicate that most (34%) households use community boreholes as their secondary water source; only 10% use own private boreholes. The results also indicate that a few (5%)

rely on their neighbour's well as their secondary source. About 31% use private wells and less than 20% buy water from bulk water vendors.

Chi-square ($\chi 2$) tests verified the association of location with the secondary sources of water to further investigate the robustness of these results. Table 4.7 reports the results of the $\chi 2$ in conjunction with the p-values.

Table 4.7: Association of households' location concerning secondary water sources

Water source	Location
Community boreholes	93.2463 (0.000)***
Buy water from bulk sellers	20.5997 (0.000)***
Private boreholes	13.9901 (0.000)***
Private wells	12.6692 (0.000)***
Neighbour's well	0.0219 (0.882)

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively

The results reject the null hypothesis of independency of location and secondary sources of water, implying that location matters in determining the secondary sources and the relationship is significant at (1%) level. The results ($\chi 2 = 93.2463$, $p = 0.000$) suggest that residents from high-density areas are inclined to use community boreholes as a secondary source. Residents from low-density areas are inclined to use private boreholes and private wells as secondary sources. Residents from low-density areas are therefore inclined to privately invest in their secondary sources of water compared to residents from high-density areas. Since most households in low-density areas have privately invested in boreholes and wells, it can be concluded that their secondary sources of water are convenient. They do not need to walk long distances and wait in queues to obtain water alike high-density households. The aspiration is that the water is more hygienic with less pressure since it is for a single household unlike the community boreholes, shared amongst a community of 20 to 30 households.

Conversely, households from high-density areas rely on community boreholes. The conclusion is that the supply is inconvenient since they need to walk long distances and remain in queues to obtain water. According to the data collected, residents from high-density areas spend 27 minutes on average, waking to and from sources, collecting water and 26 minutes on average waiting in queues to collect water. These factors imply high opportunity costs; instead of being productive, they spend time walking long distances and queueing to collect water. According to (Chaminuka 2013), the situation is sometimes worse than in most high-density areas. Women wake up at 4:00 to fetch water from boreholes. The results are consistent with findings, suggesting that low-income household have fewer resources available, hence fewer choices to cope with inadequate water supply (Kudat et al. 1993).

4.3.2 Water quantity

Water is viewed as a commodity with multiple attributes, such as of them is **quantity** (pressure and intermittency), for the purpose of this study. Water **quantity** is the property/amount of water, determined by measurement; the measurement in this instance, is pressure and intermittency. Water pressure is defined as the measure of the force moving the water through main pipes into the taps. It is measured in 'bars', such as one bar is the force needed to raise water to a height of 10 metres. Water pressure is **adequate** where all normal uses can occur without noticeable inconvenience, **inadequate** where certain uses are not possible or involve significant inconvenience; **none** indicates no usable amount of water available at any point accessible to households.

4.3.2.1 Water pressure of primary sources

Table 4.8 presents the results of water pressure of primary sources.

Table 4.8: Water pressure of primary sources

Statement	Population density of where household is located		
	Low-density	High-density	Inclusive
Inadequate	78(98%)	61(91%)	139(95%)
Adequate	2(3%)	6(9%)	8(5%)
None	0(0%)	0(0%)	0(0%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

Based on the results most population (95%) indicated that the water pressure from their primary source is inadequate. This implies that certain water uses are not possible or involve significant inconvenience. To further investigate the robustness of these results, Chi-square ($\chi 2$) tests were used to verify the association of location with water pressure of primary source. The results ($\chi 2 = 2.9526$, $P = 0.860$) failed to reject the null hypothesis of independency of location and water pressure of primary sources implying that location is not a concern in determining the pressure of the primary sources which households uses. The results suggest that the primary source water pressure is equally inadequate across the city. The results are unexpected, as one would expect the water pressure in low-density areas to be at least adequate or better than water pressure in high-density areas because of low population density. The reason might be that the water from the municipality has averagely low pressure, therefore; regardless of where it is distributed, the pressure is relatively low.

4.3.2.2 Water pressure of secondary sources

Table 4.9 presents the results of households' water pressure of secondary sources.

Table 4.9: Water pressure of secondary sources

Statement	Population density of where household is located		
	Low-density	High-density	Inclusive
Adequate	72(90%)	41(61%)	113(77%)
Inadequate	8(10%)	25(37%)	33(22%)
None	0(0%)	1(1%)	1(0.7%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The results indicate that water pressure from most secondary sources is adequate since the majority (77%) indicated adequacy and only 22% respondents indicated inadequacy. All normal water uses can occur without noticeable inconvenience. To further investigate the robustness of these results, Chi-square ($\chi 2$) tests verified the association of location with water pressure of secondary sources. Table 4.10 reports the results of $\chi 2$ along with the p.

Table 4.10: Association of household's location with households' water pressure of secondary sources

Statement	Location
Adequate water Pressure	17.0173 (0.000) ***
Inadequate water Pressure	15.6249 (0.000) ***

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively

The results ($\chi2 = 17.2472$, $p = 0.000$), ($\chi2 = 15.6249$, $p = 0.000$) rejected the null hypothesis of independency of location and water pressure of secondary sources, implying location matters in determining the water pressure of secondary sources. This relationship is significant at a 1% level. The results suggest that residents from low-density areas are inclined to experience adequate water pressure from their secondary sources; residents from high-density areas are likely to experience inadequate water pressure from secondary sources. The results can assist the conclusion that residents from high-density areas suffer more; they bear the significant proportion of the welfare costs. Low water pressure means that it will be time to fill their containers when collecting water. It was established that residents in high-density areas wait in long queues in the early hours of the day, spending 30 minutes to fill a 20 litre container with water (Chaminuka 2013). The high-density households encounter high opportunity costs attributable to this unreliable water supply. They have to forego certain beneficial activities, spending time collecting water. These results are expected as residents from low-density areas should have enhanced water pressure since most of them have privately invested in their secondary sources, therefore there is less competition on demand.

4.3.2.3 Intermittency of primary sources

Intermittent water supply is when piped water supply service delivers water to users for less than 24 hours per day. Intermittency is **continuous** where certain level of supply is available most of the time; **predictable** where certain level of supply is available certain of the time and users can form expectations regarding time, duration and frequency and **unpredictable** where certain level of supply is available certain times, but users cannot form expectations regarding time, duration and frequency. Table 4.11 presents the intermittency of households' primary source.

Table 4.11: Intermittency of primary sources

Statement	Population density of where household is located		
	Low-density	**High-density**	**Inclusive**
Unpredictable	80(100%)	64(96%)	144(97%)
Predictable	0(0%)	2(3%)	2(1%)
Continuous	0(0%)	1(1%)	1(0.7%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The majority (97%) of the sample population indicate that the intermittency of water from their primary source is unpredictable. This implies that certain level of supply is available certain of the times but users cannot form expectations regarding time, duration and frequency.

To further investigate the robustness of these results, Chi-square ($\chi 2$) tests verified the association of location with primary source intermittency. The results of the $\chi 2$ along with the p-values are reported in Table 4.12 below.

Table 4.12: Association of household's location concerning intermittency of secondary sources

Statement	Location
Continuous	6.5674 (0.234)
Predictable	15.5643 (0.153)
Unpredictable	3.5657 (0.164)

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively

The results failed to reject the null hypothesis of independency of location and intermittency of the primary sources, implying that location is not a concern in determining the intermittency of the primary sources. The results suggest that the intermittency of water of the primary sources is equally unpredictable across the city, implying that regardless of where individuals reside, they still encounter unpredictable intermittency. The results were consistent with study expectations. Since residents from high-density and low-density areas receive water from the same primary source, the water interruption patterns is expected to be the same across the city.

4.3.2.4 Intermittency of secondary sources

Table 4.13 presents the intermittency of households' secondary sources.

Table 4.13: Intermittency of secondary sources

Statement	Population density of where household is located		
	Low-density	**High-density**	**Inclusive**
Predictable	50(63%)	55(82%)	105(71%)
Continuous	26(33%)	2(3%)	28(19%)
Unpredictable	4(5%)	10(15%)	14(10%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The above results indicate that the majority (71%) of the respondents' secondary source intermittency is predictable and only 19% believed it is continuous. This implies that if a certain level of supply is available, users can form expectations regarding time, duration and frequency. The study established that 19% of respondents indicating that their supply is continuous, correspond with those who buy water from the bulk sellers. They indicated that it is always available when needed.

To further investigate the robustness of these results, Chi-square ($\chi 2$) tests were used to verify associating location with water intermittency of secondary sources. The results of the $\chi 2$ along with the p-values, are reported in Table 4.14 below.

Table 4.14: Association of household's location concerning intermittency of secondary sources

Statement	Location
Continuous	20.5997 (0.000)***
Predictable	6.8563 (0.009)***
Unpredictable	4.1687 (0.041)**

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively

Based on the results above, the location has an association with the intermittency of the secondary sources. The results ($\chi2$ = 6.8563, p = 0.000) rejected the null hypothesis of independency of location and water intermittency of secondary sources, implying that location matters in determining the water intermittency of secondary sources. The results suggest that households from low-density areas are inclined to predictable water intermittency. Households from high-density areas are inclined to unpredictable water intermittency from their secondary sources. The relationship is expected positive sign and it is significant at (1%) level. With the results above, it can be concluded that welfare costs are borne disproportionately and households from the high-density are responsible for a share of the cost. High-density households cannot predict water availability on their secondary sources.

During water interruption from their main sources, they might not be able to obtain water from their secondary sources as expected and would be without water. This will cost them even more as they will have to travel even further to find water from alternative sources. According to (Kudat *et al*. 1993), these households are more often forced to reduce their water usage. Since water is crucial for survival, they are forced to use a sizeable portion of income to secure their water supply when possible. The results were consistent with the study expectations that residents from low-density areas with improved secondary sources, have advanced intermittency, compared to residents from high-density areas with limited resources.

4.3.3 Water quality

This section analyses water quality, defined as chemical, physical, biological and radiological characteristics of water. It is a measure of the condition of water, relative to the requirements of certain biotic species or to any human need. The questionnaire distinct clearly between observed and perceived quality, ensuring that the respondent understands the process. The **perceived quality** is an individual's beliefs concerning chemical and microbiological safety of the water. **Observed quality** is actually observed and experienced, such as visible colour, visible solids, odour and the taste of the water.

Regardless observations that the water is clean, if the perception is negative, it will affect individuals' behaviour towards water. Research established that respondents did not use water for drinking, cooking or bathing because they believe that it is not safe to use (City & Africa 2000). An individual's perception is limited by existing beliefs, attitudes and experience. An individual's perception may be substantially different from reality (Pickens 2005). The differences in water quality perceptions can result in various priorities, affecting the community's decision-making regarding water concerns (Hu 2011). Studies established that peoples attitude towards paying for water is influenced by their perception of water quality; the actual observed quality of the water is not correlated to the perceived quality (Orgill *et al.* n.d.) and (Dogaru et al. 2009). It is possible that people observe the water to be clean, but they sense that it is not safe to use. Individuals' perceptions on water quality (perceived quality) and distinguish it from what they actually observe (observed quality) should be established to understand their behaviour towards water concerns.

4.3.3.1 Perceived quality of primary sources

The perceived quality can be **adequate** where all normal uses occur without concern, **inadequate** where certain uses are foregone or curtailed, attributable to quality and **absent** where quality problems result in the termination of all uses. Table 4.15 below presents the perceived quality of households' primary source.

Table 4.15: Perceived quality of primary sources

Statement	Population density of where household is located		
	Low-density	**High-density**	**Inclusive**
Inadequate	80(100%)	65(97%)	145(98%)
Adequate	0(0%)	2(3%)	2(1%)
Absent	0(0%)	0(0%)	0(0%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The results indicate that the vast majority (98%) of the respondents' perceived water quality from primary source is inadequate. This implies that the majority of households believe that water from their primary source is unsafe to drink. These results are supported by the vast majority (79%) of respondents from the high-density households, stating that they use the water for alternative purposes, but they do not use it for drinking (consumption). Residents are at risk of water borne diseases if they use this water to drink or in preparing food. Therefore, to avoid the risk, they might have to observe alternative sources of water to drink or in preparing food. This might encounter further costs, money, time and energy.

To further investigate the robustness of these results, Chi-square ($\chi 2$) tests verified the location association of perceived water quality from primary sources. Based on the results ($\chi 2$ =2.4210, p =0.120) the study can conclude that location is not a concern in determining the perceived quality of water from the secondary sources. Since the results failed to reject the null hypothesis of independency of location and perceived water quality from primary sources. The results suggest that the perceived quality of the water from primary sources is inadequate across the city. The results are as expected since most respondents obtain water from the same supplier of their primary source (tap water).

4.3.3.2 Perceived quality of secondary sources

Table 4.16 presents the **perceived** quality of households' secondary sources.

Table 4.16: The perceived quality of secondary sources

Statement	Population density of where household is located		
	Low-density	**High-density**	**Inclusive**
Adequate	76(95%)	58(87%)	134(91%)
Inadequate	4(5%)	9(13%)	13(9%)
None	0(0%)	0(0%)	0(0%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

Based on the results above, the majority (91%) secondary source perceived that quality as adequate. This perception implies that respondents believe that the water is safe to use, therefore all normal uses, such as drinking, food preparation and washing occur without concern. To further investigate the robustness of these results, Chi-square ($\chi2$) tests were used to verify the association of location with secondary source's perceived quality. The results of the $\chi2$ along with the p-values are reported in Table 4.17 below.

Table 4.17: The association of households' suburb with their perceived quality of secondary sources

Statement	Location
Adequate water pressure	3.2165 (0.073)*
Inadequate water pressure	3.2165 (0.073)*

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively

The results ($\chi2$ =3.2165, p = 0.073) results rejected the null hypothesis of independency of location and perceived the quality of water from the secondary sources, implying that location matters in determining the perceived quality of water from the secondary sources. The results are significant at a 10% level. They suggest residents from low-density areas are inclined to adequate perceived water quality from their secondary source, indicating that they believe that it is safe to use for drinking and cooking. The results are as concluded. Residents (from low-density) with improved resources have access to better secondary source water quality than those who have fewer resources (from high-density). Based on the results above, the conclusion is that welfare costs are incurred; they are borne disproportionately on households. Households from the high-densities bear a significant share of costs. If their perception is that the water is unsafe to use, they use it reluctantly and with the fear of becoming ill. This in turn, would increase their welfare costs. They might also incur expenses buying chemicals and will need to boil it to make it safe for use.

4.3.3.3 Observed quality of primary sources

The observed quality is: **adequate** where all normal uses occur without concern, **inadequate** where certain uses are foregone or curtailed, attributable to quality and **absent** where quality problem results in termination of all uses. Table 4.18 presents the **observed** quality of households' primary sources.

Table 4.18: Observed quality of primary sources

Statement	Population density of where household is located		
	Low-density	High-density	Inclusive
Inadequate	78(98%)	65(97%)	143(97%)
Adequate	0(0%)	2(3%)	2(1%)
Absent	2(3%)	0(0%)	2(1%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The results indicate that the majority (97%) of respondents' observed quality of water from their primary source as inadequate. This indicates that most respondents forego or curtail certain water uses, attributable to substandard quality.

To further investigate the robustness of these results, Chi-square ($\chi2$) tests verified the association of location with the observed quality of water from the primary sources. The results of the $\chi2$ along with the p-values are reported in Table 4.19 below.

Table 4.19: Association of households' location with their observed quality of primary sources

Statement	Location
Inadequate	2.4210 (0.120)
Adequate	4.2355 (0.293)
Present	4.1467 (0.4101)

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively

The results ($\chi2$ =2.4210, p =0.120) failed to reject the null hypothesis of independency of location and observed the quality of water from primary sources, implying that location is not a concern in determining the observed quality of water from the primary sources. The results suggest that the observed quality of water from the primary source is equally inadequate across the city. The majority (98%) of the sample population obtain water from the same primary source, which is tap water from the municipality; the quality is expected to be the same.

4.3.3.4 Observed quality of secondary sources

Table 4.20 presents the **observed** quality of households' secondary sources.

Table 4.20: Observed quality of secondary sources

Statement	Population density of where household is located		
	Low-density	High-density	Inclusive
Adequate	77(95%)	58(87%)	134(91%)
Inadequate	2(3%)	9(13%)	11(7%)
None	2(3%)	0(0%)	2(1%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

Based on the above results, the majority (91%) of the total sampled households indicated that the observed quality of the water from their secondary source is adequate. This implies that all normal uses of water occur without concern.

To further investigate the robustness of these results, Chi-square ($\chi2$) tests verified the association of location with the observed water quality of secondary sources. The results of the $\chi2$ along with the p-values are reported in Table 4.21 below.

Table 4.21: Association of households' suburb with the observed quality of secondary sources

Statement	Location
Inadequate water pressure	6.2953 (0.012)***
Adequate water pressure	3.2165 (0.073)**
Absent	1.6981 (0.193)

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively

The results rejected the null hypothesis of independency of location and observed quality of water from the secondary sources, implying that location matters in determining the observed quality of the water from the secondary source. The results suggest residents from low-density areas are inclined to have adequate water quality from their secondary sources. Results are as expected as residents who have better resources (from low-density areas), ensuring better observed quality of water from the secondary source than those who have fewer resources (from high-density areas).

4.4 HOUSEHOLD WATER RELATED HABITS IN HIGH-DENSITY VERSUS LOW-DENSITY AREAS

The purpose of this section is to understand the water conservation practices that households experience daily. From the first objective above, based on the results, the study established that there is a challenge of unreliable water supply. The study has the basis for establishing if respondents conserve the water available to them. Households' water practices were divided into the following activities: Showering, kitchen, house and yard cleaning and vegetable gardening. Respondents were asked if they follow certain water conservation practices with each activity. Results of this analysis are presented in Table 4.22.

Table 4.22: Multiple response analysis of households' water related habits

Statement	Low-density	High-density	Inclusive
Do you use grey (*previously used*) water from washing machines for cleaning yards or flushing toilets?	78(98%)	67(100%)	145(99%)
Do you avoid the unnecessary rinsing of dishes, wiping dishes with duster cloth or using a wet cloth to minimise rinsing?	72(90%)	52(78%)	124(84%)
Do you clean floors with a broom rather than floor mopping?	57(71%)	47(70%)	104(71%)
Do you avoid frequent floor mopping?	66(83%)	31(46%)	97(66%)
Do you take short showers?	48(60%)	43(64%)	91(62%)
Have you Installed a water saving showerhead?	68(85%)	20(30%)	88(60%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

Based on the results, the study established that respondents practice water conservation. Results are consistent with the expectations, since over 90% of the sample population stated that the intermittency of water from their main source is unpredictable, therefore rational consumers are expected to rather conserve as much water possible when it is available.

To further investigate the robustness of the results, Chi-square ($\chi 2$) tests were applied to verify the association of location with respondents' water related habits. Table 4.23 displays the results of the $\chi 2$ tests along with the p-values in brackets.

Table 4.23: Association of households' suburb with their water related habits

Statement	Location
Have you installed a water saving showerhead?	46.1558 (0.000)***
Do you avoid frequent floor mopping?	21.3260 (0.000)***
Do you avoid the unnecessary rinsing of dishes, wiping dishes with duster cloth or using a wet cloth to minimise rinsing?	4.2397 (0.039)**
Do you use grey (*previously used*) water from washing machines for cleaning yards or flushing toilets?	1.6981 (0.1937)
Do you clean floors with a broom rather than floor mopping?	0.8527 (0.653)

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively.

The results from the above table indicate that the suburb is statistically important in influencing certain households' water related habits. The results rejected the null hypothesis of independency of location and water related habits, implying that location is relevant in determining the respondents' water related habits. The results ($\chi2$ =46.1558, p = 0.000) suggest that households in low-density areas are inclined to install showerheads rather than households in high-density. The relationship is significant at a 1% level. The results ($\chi2$ =21.3260, p = 0.000) also indicates a relationship between suburb and "if they avoid frequent floor mopping". The relationship is significant at a 1% level, suggesting that households from high-density areas are inclined to forego mopping frequently to conserve water above households from low-density.

Location appears to be associated with households' "wipe dishes with cloth or use a wet cloth to minimize rinsing". The relationship is significant at a 1% level. The results suggest that households from high-density areas are inclined to compromise their kitchen hygiene to conserve water. The study observes that residents from high-density areas are inclined to forego practices requiring the use of more water, such as frequently mopping the floor and unnecessarily rinsing dishes but rather wipe them with a cloth. Households from high-density areas bear a significant share of the welfare costs, because they are sacrificing to forego practices that will cost them on hygiene of their houses in order for them to save water. They end up living with dirty surfaces and dirty toilets, which is not good for their health. These results are as expected since in times of municipal water interruptions, residents from high-density areas, are those who have to travel long distance to fetch water. They should minimise the least necessary water usage when possible.

4.5 HOUSEHOLDS' WATER CONSERVATION CONSCIOUSNESS IN HIGH-DENSITY VERSUS LOW-DENSITY AREAS

The purpose of this section is to establish if respondents are conscious about conserving water. To achieve this purpose, respondents were required to answer the questions using a six-point likert scale to indicate the respondent degree of agreement or disagreement with the statement regarding water conservation consciousness. With one indicating "strong agreement" and six indicating "not applicable". The results of this analysis are presented in Table 4.24.

Table 4.24: Association of households' suburbs with their water conservation consciousness

Statement regarding water conservation consciousness	Strongly agree (1)		Agree (2)		Neutral (3)		Disagree (4)		Strongly disagree (5)	
	Low-density	High-density	Low-Density	High-density	Low-density	High-density	Low-density	High-density	Low-density	High-density
Our society experiences water shortages	55 (69%)	39 (58%)	25 (31%)	27 (40%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
It is important to always save water to avoid water shortages	7 (9%)	5 (7%)	73 (91%)	62 (93%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
People should use no more water in the home than is necessary	6 (8%)	3 (3%)	73 (93%)	64 (96%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
If each household reduces the amount of water it uses by just a little, it will make a substantial difference for the community	6 (8%)	3 (4%)	74 (93%)	62 (93%)	0 (0%)	1 (1%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)
Trying to save water is an indication of good upbringing and culture	5 (6%)	4 (6%)	70 (88%)	52 (78%)	5 (6%)	8 (12%)	0 0%)	3 (4%)	0 (0%)	0 (0%)
I sense a moral obligation to use water carefully	3 (4%)	7 (10%)	73 (92%)	57 (85%)	4 (5%)	3 (4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
My neighbours and friends always practice water saving	1 (1%)	1 (1%)	53 (67%)	39 (58%)	16 (20%)	12 (18%)	10 (13%)	15 (22%)	0 (0%)	0 (0%)
I regularly check my water bill	1 (1%)	1 (1%)	28 (35%)	25 (37%)	2 (3%)	2 (3%)	48 (60%)	38 (57%)	1 (1%)	1 (1%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

Based on the sample results, the study confidently concludes that respondents are water conservation conscious. The results were as expected since the results indicate that residents are aware that they encounter water shortages, one would expect them to conserve water and use it as wise as possible. The location did not seem to have any association of these results since it failed to reject the null hypothesis of independency of location and households' water conservation consciousness. Across the sample, households are equally water conservation conscious regardless their location.

Further questions were directed to understand households' water conservation consciousness. Respondents were asked if they sensed that it is a good idea to install a water conservation device that will manage the daily volume of water usage to save water. The majority (73%) of respondents answered 'yes' to the question. The results were consistent with what was expected, since over 90% of respondents indicated they believe that people should not use more than necessary water in their homes. It was expected that they would agree to install a device that will assist them to save water. From the sample, population (76%) indicated that they would like a water flow regulation device to be installed in their homes. Over 90% of respondents indicated that they sense that facilitating educational programmes for water conservation will be an innovative idea. This indicates that majority of the people sense that conserving water is crucial, and people should be taught to assist communities. Results are as expected since over 90% indicate that they deem it important to always save water to avoid water shortages. The results indicate that 57% of respondents would accept a policy, facilitated to encourage water conservation.

To further investigate the robustness of the results, Chi-square ($\chi2$) tests verified the potential association of location with households' water conservation consciousness. Table 4.25 reports the results of the Chi-square.

Table 4.25: Association of households' suburbs concerning water conservation consciousness

Statement	Location
Do you think it is a good idea to install a water conservation device that will manage the amount of water you use per day to save water?	21.0262 (0.000)***
Are you willing to have a water flow regulation device installed in your house?	27.3979 (0.000)***
Would you accept a policy that will be facilitated to encourage water conservation in a way that there is a limited quantity of water every household should not exceed?	9.6560 (0.002)***
Do you think it is a good idea to facilitate educational programmes for water conservation?	1.1215 (0.290)

Source: Author's elaboration.

Note: *, ** and ***show the statistical levels of significance, at 10 %, 5 %, and 1 %, respectively.

The results reject the null hypothesis of independency of location and the above respondents' water conservation consciousness, implying that location matters in determining the respondents' water conservation consciousness. The results ($\chi 2 = 27.3979$, $p = 0.000$) are statistically significant at a 1% level, suggesting that residents from low-density are more inclined to agree to installing the water conservation device than residents from high-density. The reason is that most households from the high-density fear to be limited when they need more water and they also reason that it will be expensive for them to install those devices and they will not be able to afford them.

The location has an association with the respondents' willingness to have a water flow regulation device installed in their houses. This variable has an expected sign and it is statistically significant at a 1% level. The results suggest that residence in low-density areas are more inclined to accept installing this device than residence from high-density areas. The reason for this is also that households from high-density areas fear incurring costs that they will not be able to afford; they prefer to rather monitor their water use manually.

Results of water conservation consciousness indicate that location has an association with respondents' willingness to accept a policy "that will be implemented to encourage water conservation in a way that there is a limited quantity of water every household should not exceed”. The results suggest that households in low-density areas are inclined to have positive attitudes towards such a policy. This relationship is statistically significant at a 5% level.

4.6 COPING STRATEGIES FOR UNRELIABLE WATER SUPPLY IN HIGH-DENSITY AREAS VERSUS LOW-DENSITY AREAS

The objective of this section is to capture costs that respondents encounter attributable to an unreliable water supply. To address this objective, respondents were asked what actions they take to cope with the challenge of undesirable water pressure, intermittency and quality of their primary sources. According to (Kudat *et al*. 1993), when individuals encounter unreliable water supply, they pursue various coping strategies. Several factors can influence the coping strategy. Coping strategies can be divided into two major categories: **Enhancement** strategies (strategies that intend to increase the level and quality of water supply services by supplementing the available supply) and **accommodation** strategies (strategies that intent to adjust behaviour, accommodating the unreliable water supply). Low-income households have fewer available resources. They are more inclined to accommodate than to enhance an unreliable water supply. The welfare loss is disproportionately their responsibility (Kudat *et al.* 1993). Respondents were provided various options to indicate coping strategies to cope with unreliable water supply.

4.6.1 Enhancement coping strategies

4.6.1.1 Water pressure

Respondents were asked if they use the enhancement coping strategies (stated below) to cope with inadequate water pressure. Table 4.26 presents the results.

Table 4.26: Multiple response analysis of enhancement coping strategies

Statement	Location		
	Low-density	High-density	Inclusive
Installed a tank	79(95%)	7(10%)	83(56%)
Installed a pump	56(70%)	1(1%)	57(39%)
Installed a pressure booster	13(16%)	0(0%)	13(9%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

NB: Respondents were able to choose more than one Strategy

The results above indicate that most (56%) respondents installed a water tank; (39%) installed pumps and others (13%) installed a pressure booster to cope with undesirable water pressure. To further investigate the robustness of these results, Chi-square ($\chi 2$) tests verified the association of location with the coping strategies used. The results ($\chi 2$ = 106.0411, p = 0.000), ($\chi 2$ = 24.8800, p = 0.000) rejected the null hypothesis of independency of location and enhancement coping strategies, implying that location matters in determining which coping strategies a household is likely to use.

The results suggest that households from low-density areas are inclined to use enhancement coping strategies. The results are significant at (1%) level. These results are in accordance with the study expectations that households in low-density areas have more resources, enabling them to cope with unreliable water supply. They are more likely to enhance than accommodate resources.

4.6.1.2 Water intermittency

Respondents were asked if they use the enhancement coping strategies stated below to cope with unpredictable water intermittency. Table 4.27 presents respondents results.

Table 4.27: Multiple response analysis of enhancement coping strategies

Statement	Location		
	Low-density	**High-density**	**Inclusive**
Installed a tank	75(94%)	6(9%)	81(55%)
Buy water from bulky water vendors	77(96%)	2(3%)	79(54%)
Installed a well	34(43%)	4(6%)	38(26%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

NB: Respondents were able to choose more than one Strategy

The results indicate that over half of respondents installed tanks or buy water from bulk sellers to cope with unreliable water intermittency; few individuals (26%) store water in buckets.

To further investigate the robustness of these results, Chi-square ($\chi 2$) tests verified the association of location with water intermittency coping strategies. Based on results, the study established that location is significant in determining coping strategies that a household is likely to use with undesirable intermittency. The results ($\chi 2$ =25.3845, p = 0.000), ($\chi 2$ = 21.9493, p = 0.000) rejected the null hypothesis of independency of location and enhancement coping strategies, implying that location matters in determining coping strategies that a household is likely to use. The results suggest that households from low-density areas are inclined to use enhancement coping strategies. The results are statistically significant at a 1% level. These results are in accordance with the study expectations that households in low-density areas have more resources to cope with unreliable water supply. They are more likely to enhance than to accommodate sources.

4.6.1.3 Water quality

Respondents were asked if they use the enhancement coping strategies stated below to cope with inadequate water quality. Table 4.28 presents the results.

Table 4.28: Multiple response analysis of enhancement coping strategies

Statement	Location		
	Low-density	High-density	Inclusive
Treat with chemicals	62(78%)	5(7%)	67(46%)
Clean with water filters	47(59%)	1(1%)	48(33%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

NB: Respondents were able to choose more than one Strategy

Based on the results above, less than 50% of respondents treat water with chemicals or purify it with filters to cope with inadequate water quality from their primary sources.

To further investigate the robustness of these results, Chi-square ($\chi 2$) tests verified the association of location with water quality coping strategies. The results ($\chi 2 = 72.1068$, $p = 0.000$), ($\chi 2 = 77.0603$, $p = 0.000$) indicates that location is significant in determining coping strategies for households. The results suggest that households from low-density areas are inclined to use enhancement coping strategies when dealing with undesirable water quality. The results are statistically significant at a 1% level. These results are coherent with the study expectations that households in low-density areas have more resources to cope with unreliable water supply, likely to enhance than to accommodate.

4.6.2 Accommodation coping strategies

4.6.2.1 Water pressure

Respondents were asked if they use the accommodation coping strategies below to cope with inadequate water pressure. Table 4.29 presents the results.

Table 4.29: Multiple response analysis of accommodation coping strategies

Statement	Location		
	Low-density	High-density	Inclusive
Alter schedule	45(56%)	60(89%)	105(71%)
Use one tap at a time	41(51%)	60(90%)	101(69%)
Fill buckets	4(5%)	57(85%)	61(42%)

Source: Author's elaboration

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

NB: Respondents were able to choose more than one Strategy

The results above indicate that over 60% of respondents alter their schedule or use one tap at a time to cope with undesirable water pressure. Less than 50% fill containers to cope with the situation.

To further investigate the robustness of these results, Chi-square ($\chi 2$) tests verified the association of location with water pressure coping strategies. The results ($\chi 2$ = 106.0411, p = 0.000), ($\chi 2$ = 24.8800, p = 0.000) rejected the null hypothesis of independency of location and accommodation coping strategies, implying that location matters in determining coping strategies for a household. The results suggest that households from high-density areas are inclined to use accommodation coping strategies. The Chi-square results are significant at a 1% level. These results are consistent with the study expectations that households in high-density areas have fewer resources to cope with unreliable water supply and they are more likely to accommodate than enhance.

4.6.2.2 Water intermittency

Respondents were asked if they use the enhancement coping strategies stated below to cope with unpredictable water intermittency. Table 4.30 presents the results.

Table 4.30: Multiple response analysis of accommodation coping strategies

Statement	Location		
	Low-density	**High-density**	**Inclusive**
Recycle water	45(56%)	61(91%)	106(72%)
Store water in buckets	6(8%)	59(88%)	65(44%)
Collect water from other sources	4(5%)	58(86%)	62(42%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

NB: Respondents were able to choose more than one Strategy

The results indicate that over 70% of households recycle water to cope with the undesirable intermittency of the water from their primary source and just above (40%) sore water in containers or collect from alternative sources to cope with the situation. To further investigate the robustness of these results, Chi-square ($\chi 2$) tests were used to verify the association of location with intermittency coping strategies. Based on the results the study established that location does matter in determining which coping strategies a household is likely to use to cope with undesirable intermittency since the results rejected the null hypothesis of independency of location and accommodation coping strategies.

The results ($\chi 2$ =25.3845, p = 0.000), ($\chi 2$ = 21.9493, p = 0.000) suggests that households from high-density areas are inclined to use enhancement coping strategies. The results are statistically significant at (1%) level. These results are consistent with the study expectations that households in high-density areas have fewer resources to cope with unreliable water supply and they are more likely to accommodate than enhance.

4.6.2.3 Water quality

Respondents were asked if they use the accommodation coping strategies stated below to cope with inadequate water quality and the results are presented in Table 4.31.

Table 4.31: Multiple response analysis of accommodation coping strategies

Statement	Location		
	Low-density	High-density	Inclusive
Just use water as is	12(15%)	59(88%)	71(49%)
Do not use the water for drinking at all	65(81%)	52(78%)	67(46%)
Boil the water before drink	41(51%)	18(27%)	59(40%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

NB: Respondents were able to choose more than one Strategy

Based on the results above less than (50%) of respondents use these accommodation coping strategies. To further investigate the robustness of these results, Chi-square ($\chi 2$) tests were used to verify the association of location with water quality coping strategies used. The results ($\chi 2 = 72.1068$, $p = 0.000$), ($\chi 2 = 77.0603$, $p = 0.000$) rejected the null hypothesis of independency of location and accommodation coping strategies, implying that location matters in determining coping strategies a household is likely to use. The results suggest that households from high-density areas incline to use accommodation coping strategies. The results are statistically significant at a 1% level, consistent with the study's expectations.

4.6.3 Additional questions

Additional questions were directed to understand costs of unreliable water supply. Table 4.32 presents the results.

Table 4.32: Multiple response analysis of cost of water supply unreliability

Statement	Description	Low-density	High-density	Inclusive
Water interruptions		80(100%)	67(100%)	147(100%)
Cost of Interruption	More Expensive	80(100%)	59(88%)	139(95%)
	About The same	0(0%)	2(3%)	2(1%)
Mode of Transport	Walking	31(39%)	35(52%)	6(45%)
	Wheelbarrow	22(28%)	18(26%)	40(27%)
	Delivery	27(20%)	2(3%)	29(18%)
	Car	0(0%)	12(17%)	12(8%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

Respondents were asked how often they encountered water supply interruptions from their primary source and what measures they take to cope in such times. The results indicate that 100% of the sample population encounters water supply interruptions; over 70% indicated that the interruptions were as recent as a week ago. The results indicate that water interruptions lasted for three days on average. Over 90% of respondents indicated that even though they do not have to treat water from their secondary source, it is more expensive for them to obtain water from their secondary sources, concerning time and the hustle to bring water home; 46% go on foot to obtain water from their secondary source; 27% use wheelbarrows and 18% obtain water delivered through water vendors.

To further investigate the robustness of these results, Chi-square ($\chi2$) tests verified the association of location with these results. The results ($\chi2 = 2.6741$, $p = 0.263$) failed to reject the null hypothesis of independency of location and costs; regardless of individuals living in low or high-density, all households encounter the same challenge of water interruptions. The results ($\chi2 = 28.9676$, $p = 0.000$) suggested that the mode of transport used to collect water is influenced by the household location. The results suggest that households from high-density areas are likely to walk and use wheelbarrows to collect water, whereas households from low-density areas obtain water delivered to their homes by water vendors.

4.7 MANAGING FUTURE WATER SUPPLY UNRELIABILITY IN HIGH-DENSITY AREAS VERSUS LOW-DENSITY AREAS

When encountering climate change, declining water resources and increased costs to provide adequate water supply to all households in Harare, households should expect water supply interruptions to be acceptable. The objective of this section is to obtain knowledge on the respondents' preferences for managing future water supply interruptions. Respondents were asked various questions to understand their preferences.

Table 4.33: Multiple response analysis of coping with unreliable water supply

Statement	Low-density	High-density	Inclusive
Do you think it is the responsibility of the government to manage water supply reliability challenge	78(98%)	64(96%)	142(97%)
Do you think that households participate in managing or providing solutions to the water supply reliability challenge	68(85%)	57(85%)	125(85%)
Will you accept one day without water with a lower water bill	59(74%)	42(63%)	101(69%)
Will you accept one-day exemption of water interruption with a higher water bill	57(71%)	24(36%)	81(55%)
Are you willing to pay more on water bill to be exempted from future outdoor water use restrictions	37(46%)	21(31%)	58(39%)
Will you accept 2 days exemption of water interruption with a higher water bill	29(36%)	10(15%)	39(26%)
Will you accept 2days without water with a lower water bill	16(20%)	17(25%)	33(22%)
Will accept 3 days exemption of water interruption with a higher water bill	16(20%)	9(13%)	25(17%)
Will you accept 3 days without water with a lower water bill	4(5%)	5(7%)	9(6%)

Source: Author's elaboration.

Note: the figures in the tables indicate the number of respondents who indicated yes and in the brackets are their percentages.

The majority (69%) of respondents indicated they would accept one day per week without water and a lower water bill; 55% of respondents indicated they would accept one-day exemption of water interruption with a higher water bill and over 60% indicated that they would accept a maximum of one-day water interruption without being inconvenienced. This indicates that Harare residents value water as a basic need and endeavour having it available as often as possible. Most respondents prefer a four days' notice through media advertisements before any water interruption.

Sixty-one per cent of respondents indicated that they do not want to pay an exemption to water restriction; this might be because most residents regard water as their rightful basic need and do not have to be restricted. Most households chose the time slot from 10:00 pm to 5:00 am to as suitable if a prohibition of water should occur. Over 90% of respondents believes it is the responsibility of the government to manage the water supply reliability challenge; (85%) perceive that households also participate in managing or providing solutions to the water supply reliability challenge.

To further investigate the robustness of the results, Chi-square ($\chi 2$) tests verified the potential association of location with households' preferences on managing future water supply interruptions. The results (($\chi 2$ = 18.5001, p = 0.000) indicate that location signifies in influencing if households want to be exempted from water interruption with a higher water bill. Households from low-density areas are more inclined to accept this exemption than households from high-density areas. This suggests that although households from high-density areas would such as to have water at all times, they cannot afford a higher water bill; in instances where the water supply has to be interrupted, they will suffer more.

4.8 CONCLUDING SUMMARY

There are five conclusions that can be derived from this section. First, there is sufficient evidence suggesting that water supply in Harare is unreliable. Households connected to the municipal water, are forced to observe alternative water supply because of the unreliability of their main sources of water. Location seems to influence the secondary source that a household is likely to use. The conclusion that can be drawn from these findings is that households from low-density areas have better alternative sources to obtain water from than households from high-density areas. Secondly, the study observes that residents from low-density areas have adequate water quality from their secondary sources, whereas residents from high-density areas have inadequate water quality.

This indicates that in cases of water interruptions when residents have to use alternative sources of water, residents from low-density areas will have better water quality than residents from high-density areas. Residents from high-density areas suffer more than residents from low-density areas. The study concludes that welfare costs are incurred; they are borne disproportionately and households from the high-densities bear the significant share of costs. Should they observe certain dirt in the water, this will make the water unfit for some purposes, such as drinking and washing. This would incur costs to households; they now have to observe alternative sources of water for cooking or they use it, indicating the fear of becoming sick. In certain cases, they might obtain sick and self-treatment that will involve further costs.

Thirdly, households from high and low-density areas are aware of the water challenge in the city and they are water conservation conscious. Residents from high-density areas are more reluctant to agree to actions, requiring them additional costs or policies that might restrict their water usage. The high-density residents have more costs to cope with the unreliable water supply, considering that they do not have adequate resources. Therefore, they would not agree to anything that will increase their costs or that might restrict their water use, even though it might be worthy.

Fourthly, the study concludes that, on the three attributes that were used to measure water supply unreliability (pressure, intermittency and quality), households from low-density areas incline to use enhancement copying strategies, whilst households from high-density incline to use accommodation coping strategies. This indicates that the low-density households can develop alternative supplies of water, install pumps and pressure boosters, buy water from vendors, filter and chemically treat water for drinking.

The high-density households must adjust their behaviour to cope with the situation, such as to alter their schedule for bathing or doing laundry, recycle their water and consume less water. Households from low-density areas have more resources to cope with unreliable water supply; households from high-density areas are more often unable to invest in capital facilities to conduit their deficient water demands or to incur recurring expenditure. Compared to low-density households, high-density households more often reduce water use in response to supply deficiencies. This indicates that high-density households bear a disproportionately significant share of the burden of unreliable water supply. Lastly, the results demonstrate the need for developing policies to address this unreliable water supply challenge in the city of Harare.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This study uses data from Harare, Zimbabwe, assessing the extent that unreliable domestic water supply challenges differentially affect households in high-density residential areas, relative to those in low-density areas, based on the following household level measures: Water supply status, water related habits, water conservation consciousness, coping with water supply unreliability and managing future unreliable water supply. Harare was purposely selected because of its documented water supply unreliability challenges. These challenges cause suffering to households. The study sampled 67 randomly selected households from high-density residential areas and 80 households from low-density residential areas, comprising 147 households. Structured questionnaires and face-to-face interviews were employed.

5.2 STUDY CONCLUSIONS

Concerning the water supply status, the study concludes that when households access water from primary municipal sources, unreliable supply challenges do not indicate differential impacts. When households in high-density areas are constrained to obtain water from secondary sources, they incline to use community boreholes or to purchase water from bulk sellers. Households in low-density areas are inclined to obtain water from access to private boreholes or private wells. Compared to residents from the high-density, those from low-density areas have reliable resources to cope with the situation; they receive adequate water quantity and quality from their secondary sources. Households from high-density areas are also inclined to endure inadequate water supply pressure, unpredictable water supply intermittency and water quality. These conditions are perceived and observed as inadequate.

Concerning water related habits, the study concludes that households in Harare practice water conservation in their homes daily. Unreliable supply challenges have certain differential impacts on low- and high-density households. Households in low-density areas are inclined to install showerheads whilst those in high-density areas are inclined to forego water intensive practices including frequent floor mopping and rinsing of dishes at the cost of their personal and household hygiene. Because of this, high-density households become more susceptible to diseases like diarrhoea or cholera and there are direct and indirect economic costs associated with these waters borne diseases.

Concerning water conservation consciousness, it was concluded that residents from both locations are water conservation conscious. Unreliable supply challenges have certain differential impacts on low-density households and high-density households. Households in the low-density areas are inclined to install water conservation devices, water regulation flow devices and accept legislation to encourage water conservation. They incline to limit the quantity of municipality supplied water. The motive might be that households from high-density areas are cautious that they cannot afford such installations, or that they will not survive the quantity limitations, as the household has several residents.

Concerning coping with water supply unreliability, the study also concluded that the challenges have certain differential impacts on low-and high-density households distinctly. Households in low-density areas are inclined to use enhancement strategies to cope with inadequate water pressure, inadequate intermittency and inadequate water quality from their primary water supply sources. Households in high-density areas are inclined to use accommodation strategies to cope with inadequate water pressure, inadequate water intermittency and inadequate water quality from their primary sources. This indicates that households in low-density areas have enhanced resources to cope with the challenges. Households from high-density areas have little to no choice and have to compromise on the quantity, intermittency and quality of their water.

Finally, regarding the future managing water supply unreliability, the study established that households in low-density areas are inclined to accept an exemption from water interruption by paying higher water bills. The study concludes that unreliable water supply results in suffering that falls disproportionately high on households in high-density areas (they bear the significant share of the cost).

5.3 RECOMMENDATIONS AND POLICY IMPLICATIONS

The study recommends that the Harare Municipality should consider improving the reliability of the water supply to Harare residents. During water interruptions, the municipality should consider residents located in high-density areas; they suffer the most, relative to residents in the low-density areas. The policy-makers should also consider developing policies to address the welfare loss caused by the unreliable water supply challenge in the city of Harare. It is a requisite to establish suitable water resource management institutions, focussing specifically on water supply at household level. A requirement to develop institutions, capturing the welfare losses attributable to unreliable water supply across the city is required. Residents with higher welfare costs should be compensated. The study also recommends that the government should invest or allow private investors to establish alternative sources of reliable water for households to connect to and use as their primary water source. There should be a variety of options that households can choose from. They should not be forced to rely solely on municipality water as their primary source.

First, the study suggests that policy-makers should observe investing in well-built and reliable boreholes in high-density areas, providing affordable bulk water sellers. Where households need a secondary water source, they could obtain reliable sources. They should not have to endure days deprived of water, risking their lives, contracting diseases or even encounter death.

Secondly, when facilitating the policies for water conservation, policy-makers should consider that households in low-density areas are more cooperative to install water conservation devices and daily limit legislations, and it will be an inspiration to commence with those households since they are open to the idea without strain. The research proposes that when there are water shortages households should be made aware on time policies should be put in place to make sure that in situations where water supply is to be cut for over a day there is temporary water supplies to the city which will be adequate for every household.

5.4 STUDY LIMITATIONS AND AREAS FOR FURTHER RESEARCH

This study was limited, comparing the welfare loss, attributable to unreliable water supply amongst two separate locations in urban areas of Harare. It is also advised to expand the study and observe other urban areas in the country, holding various water supply sources. It should be established if the Harare Municipality influenced the study result. Further studies can also observe peri-urban and rural areas in Zimbabwe, establishing if the water concern is influenced only by the area where this study was conducted. The study observed mainly the opportunity costs incurred by residents. It did not put costs into monetary value to establish the estimated costs that residents actually incur apart from their monthly bill, to cope with unreliable water supply. A need exists for further studies to observe the monetary costs incurred for an improved explanation of the problem to the policy-makers. It is easier to comprehend figures than unquantified welfare loss.

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APPENDIX A: LETTER OF CONSENT

Informed consent for participation in an academic study Department of Agricultural Economics, Extension and Rural Development

ANALYSIS OF WATER SUPPLY UNRELIABILITY AND SAVING BEHAVIOUR IN HARARE, ZIMBABWE: QUANTITATIVE COMPARISON OF HIGH- AND LOW-DENSITY RESIDENTIAL AREAS

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Dear respondent,

You are invited to participate in an academic study conducted by Munashe Mushamba, a Masters student from the Department of Agricultural Economics, Extension and Rural Development at the University of Pretoria. The purpose of the study is to estimate the demand for household reliable water supply in Harare Zimbabwe. The study will determine the following:

1. To determine if the status of households' water supply in Harare is the same amongst households in high-density and in low-density areas.
2. To determine if there is a difference on the consciousness and water related habits of households on water conservation amongst residents in high-density and residents in low-density areas.
3. To evaluate if the cost of coping strategies encountered by households attributable to the unreliable water supply, is the same between households in high-density areas and households in low-density areas.
4. Obtain information that will assist in managing water supply unreliability.

<u>Please note the following:</u>

- ✓ This study involves an **anonymous** survey. Your name will not appear on the questionnaire and the answers you provide will be treated as strictly **Confidential**. You cannot be identified in person based on the answers you provide.

- ✓ Your participation in this study is important to us. You may choose not to participate and you may stop participating at any time without any negative consequences.
- ✓ Please answer the question in the attached questionnaire as completely and **honestly** as possible. This should not take over 30 minutes of your time.
- ✓ The result of the study will be used for policy formulation, academic purposes only and may publish in an academic journal. We will provide you with a summary of our findings on request.
- ✓ Please contact my supervisor, Prof. E.D. Mungatana at eric.mungantana@up.ac.za if you have any questions or comments regarding the study. Please sign the form to indicate that:
- ✓ You have read and understand the information provided above.
- ✓ You provide your consent to participate in the study on a voluntary basis.

Respondent signature ………………………..

Date………………………

APPENDIX B: SURVEY INSTRUMENT

A. GENERAL INFORMATION

1. Suburb: ________________________________

2. Name of interviewer ________________________________

3. Date of interview ________________________________

4. Questionnaire ID Number ________________________________

B. RESPONDENT INFORMATION

Please enter the details of household head in the table below, circle only the code or fill where appropriate.

5. Gender	**6. Age**	**7. Role in Household**	**8. Educational Level**
Male [0] Female [1]	________________	Head of household [1] Spouse of the head [2] Child of the head [3] Parent of the head [4] Other (*specify)* [5]	No formal Education [1] Adult Education [2] Primary [3] Post Primary [4] Other (*Specify)* [5]

HOUSEHOLD HEAD INFORMATION

Instructions to interviewee: If respondent is the household head, skip this section

9.Gender	**10.Age**	**11.Education Level**
Male [0] Female [1]	____________________	No formal Education [1] Adult Education [2] Primary [3] Post Primary [4] Other (*Specify)* [5]

12. In your assessment, does your household afford **basic needs,** such as food and water? (a) YES, ALWAYS (b) IT IS SOMETIMES DIFFICULT (c) NO

13. Which of the following statements would best describe your family's **financial situation**?

a) We have not adequate even money
b) We have money for food but cannot pay for public utilities, such as water, electricity…
c) We can afford food and public utilities, but it is difficult to pay for school fees
d) We can afford food, public utilities and pay for school fees but cannot afford to buy durable goods, such as TV, fridge…
e) We have adequate money to pay for our needs and can also afford to buy durable goods.

C. STATUS OF WATER SUPPLY TO THE HOUSEHOLD

Instruction to interviewee: This question distinguishes between your household's **main water source supply** (*where your household draws water regularly*) and **secondary water source supply** (*where your household draws water when unavailable from the main source*).

14. Please state your **main water source** supply: ___________________________________

15. Please state your **secondary water source** supply: _______________________________

Instruction to interviewee: I would like you to assess the **WATER PRESSURE** from your main and secondary sources. Water pressure is: **adequate** where all normal uses can occur without noticeable inconvenience, **inadequate** where certain uses are not possible or involve significant inconvenience and **none** where no usable amount of water is available at any point accessible to households.

16. How would you **rate** the **water pressure** from your main source? (a) Adequate (b) Inadequate (c) None

17. How would you **rate** the **water pressure** from your secondary source when you occasionally used it? (a) Adequate (b) Inadequate (c) None

<u>Instruction to interviewee</u>: I would now like you to assess **WATER INTERMITTENCY** from your main and secondary sources. Water intermittency is: **continuous** where certain level of supply is available nearly all the time, **predictable** where certain level is available certain of the time but users can form expectations regarding time, duration and frequency and **unpredictable** where certain level of supply is available certain of the times but users cannot form expectations regarding time, duration and frequency.

18. How would you **rate** the level of **intermittency** from your <u>main source</u>? (a) Continuous (b) Predictable (c) Unpredictable

19. How will you **rate** the level of **intermittency** from your <u>secondary source</u>? (a) Continuous (b) Predictable (c) Unpredictable

<u>Instruction to interviewee</u>: I would now like you to assess the **OBSERVED QUALITY** of water you receive from your main and secondary sources i.e. (the taste, odour, visible colour and visible solids).The observed quality is: **adequate** where all normal uses occur without concern, **inadequate** where certain uses are foregone or curtailed attributable to quality and **absent** where quality problem results in termination of all uses.

20. How would you **rate** the **observed quality** of your <u>main source</u>? (a) Adequate (b) Inadequate (c) Absent

21. How would you **rate** the **observed quality** of your <u>secondary source</u>? (a) Adequate (b) Inadequate (c) Absent

<u>Instruction to interviewee</u>: I would now like you to assess the **PERCEIVED QUALITY** of the water you receive from your main and secondary sources. The perceived quality refers to: your **beliefs** concerning chemical and microbiological safety. The perceived quality can be **adequate** where all normal uses occur without concern, **inadequate** where certain uses are foregone or curtailed attributable to quality and **absent** where quality problem results in termination of all uses.

22. How will you **rate** the level of **perceived quality** of the water from your <u>main source</u>? (a) Adequate (b) Inadequate (c) Absent

23. How will you **rate** the level of **perceived quality** of the water from your <u>secondary source</u>? (a) Adequate (b) Inadequate (c) Absent

D. HOUSEHOLDS WATER RELATED HABITS

Instruction to interviewee: This section endeavours to understand the **water conservation practices** that you practice (*as an individual*) or encourage your household members to practice. Please put a tick (√) or a cross (×) as appropriate.

Activity	**Definition of water use conservation practice**	**√ or ×**
24.Personal hygiene	a. Turning off the tap **whilst** brushing teeth.	
25. Showering	a. Avoiding running water in the shower whilst shampooing hair and soaping body.	
	b. Taking short showers.	
	c. Installed a water saving showerhead.	
26. Laundry	a. Laundering full loads whenever possible.	
	b. Hand washing several items at the same time and using the rinse water from one group of items as the wash water for the next.	
27.Kitchen	a. Avoiding the use of running water when washing fruits and vegetables i.e. washing them in a basin to save water.	
	b. Washing all the dishes together in a basin.	

	c. Avoiding the unnecessary rinsing of dishes, wiping dishes with duster cloth or using a wet cloth to minimise rinsing.	
28.House and yard cleaning	a. Cleaning yards with a broom or mopping instead of using a hose pipe.	
	b. Cleaning floors with a broom rather than floor mopping.	
	c. Avoiding frequent floor mopping.	
	d. Using grey (*previously used*) water from washing machines for cleaning yards or flushing toilets.	
29. Vegetable gardening	a. Watering vegetable garden only in the evening or morning.	
	b. Watering vegetable garden less frequently.	

Others (*please specify*):____

E. HOUSEHOLD WATER CONSERVATION CONSIOUSNESS

Instruction to interviewee: This section is about your household's water conservation consciousness. **Rate** on a scale of 1 (**strongly agree**) to 5(**strongly disagree**) the extent to which you agree with the following statements regarding water conservation consciousness. If a question does not apply to your household please choose "not applicable".

Statement regarding water conservation consciousness	**strongly agree (1)**	**Agree (2)**	**Neutral (3)**	**Disagree (4)**	**Strongly disagree (5)**	**Not applicable**
30. Our society experiences water shortages						
31. It is important to always save water to avoid water shortages						
32. People should use no more water in the home than is necessary						
33. If each household reduces the amount of water it uses by just a little, it will make a big difference for the community						
34. Making an effort to save water is an indication of good upbringing and culture						
35. I sense a moral obligation to use water carefully						
36. My neighbours and friends always practice water saving						
37. I always regularly check my water bill						

38. In your view, do you think installing **a water conservation device** that will manage the amount of water you use per day to save water in each household will be good idea? (a) YES (b) NO

39. If NO to Q38, please state why:

____

40. Are you willing to have a water flow regulation device installed in your house? (a) YES (b) NO

41. If NO to Q40, please state why:

____

______

42. In your view, do you think **facilitating educational programmes** for water conservation will be a good idea? (a) YES (b) NO

43. If NO to Q42, please state why:

____

______

44. Suppose a policy is facilitated to encourage water conservation in a way that there is a limited quantity of water every household should not exceed. **Would such a policy be acceptable to you**? (a) YES (b) NO

45. If NO to Q44, please state why:

____

______

F. COSTS OF WATER SUPPLY UNRELIABILITY

46. Do you consider the **water pressure** to your household as **undesirable**? (a) YES (b) NO

47. If YES to Q46, please circle the option(s) that you use at your household to carter for the undesirable level of water pressure:

(a) Installed a water pressure booster (d) Altered schedule to use water off peak hour

(b) Installed a water pump (e) Fill in the containers way before we want to use it

(c) Installed a water tank (f) Make use of only one tap at a time at home

48. Do you consider the **water intermittency** to your household as **not continuous**? (a) YES (b) NO

49. If YES to Q48, please circle the option(s) that you use at your household to prepare for those hours that water is unavailable when you need to use it

(a) Installed a water tank (d) Store water in buckets

(b) Installed underground well (e) Recycle water / reschedule activities

(c) Buy water from bulky water vendors (f) Collect water from alternative sources other than their homes

50. Do you consider the **observed water quality** to your household as **inadequate?** (a) YES (b) NO

51. If YES to Q52, please circle option(s)/ measures that your household use to improve the water quality.

(a) Use Chemicals to treat the water (d) Boil the water before use it

(b) Use water filters to clean the water (e) Just use the water as is

(c) Do not use the water for drinking at all (f)

52. Do you **perceive the water quality** to your household as **unsafe**? (a) YES (b) NO

53. If YES to Q56, please circle option(s)/ measures that your household use to prepare the water to be useful:

(a) Use Chemicals to treat the water (d) Boil the water before use

(b) Use water filters to clean the water (e) Just use water as is

(c) Do not use the water for drinking at all (f)

54. Have you **ever encountered a water supply interruptions** from your primary source in 2016? (a) YES (b) NO (c) SOMETIMES

55. When did you **most recently encounter** a water supply interruption from your primary source in 2016?

(a) a week ago or less, (b) two weeks ago or less, (c) a month ago or less, (d) over a month ago.

Instruction to interviewee: The questions to follow only refer to the most recent water supply interruption if applicable

56. **For how long** did the most recent water supply interruption last? ……………… (Record in units of time provided by respondent)

57. **Did you have to pay** to obtain water from the secondary source during water supply interruptions? (a) YES (b) NO

58. In your view, does the water from the secondary source cost (a) about the same, (b) more expensive, (c) less expensive than the water from the primary source (d) you do not know?

59. Did you have to **treat** the water from the secondary source before use? (a) NO (b) ALWAYS (c) SOMETIMES

60. How did you treat the water? (a) Boil (b) Chemicals (c) Filter (d) Other (*Specify)* ______________

61. Approximately, **how much does it cost you per month** to treat the water from the secondary source before use? (a) US$______ (b) I do not know

62. What **mode of transport** did you use to collect water from the secondary water source?

(a) Walking (b) Bicycle (c) Wheelbarrows (d) car (e) Other *(specify)* ___________

63. On average, **how long did it take you to collect water** from the secondary source (round trip travel time)? (a)____ minutes per trip. (b) I do not know

64. On average, **how several trips** did you undertake per day to collect water from the secondary source? (a) ____ Trips. (b) I do not know

65. On average, **how long did you spend waiting** in a queue or filling your container each time you go collect water? ____ minutes per trip

66. Have you made any **investments** to cope with unreliable water supply? (a) YES (b) NO

67. If YES to Q72, please list the kind of investments you have made in the space provided below

____

____

68. In your assessment, how much did these investments cost? US$_________

G. MANAGING WATER SUPPLY UNRELIABILITY

Instruction to interviewee: In the encounter of climate change, declining water resources and increased costs to provide adequate water supply to all households in Harare at all times, households should expect water supply interruptions to be acceptable events going forward. In this section, we would like to know your preferences on managing future water supply interruptions. (**Please Circle your answer**)

69. Would you accept 1 day per week **without water** with a lower water bill (a) YES (b) NO

70. Would you accept 2 days per week **without water** with an even lower water bill? (a) YES (b) NO

71. Would you accept 3 days per week **without water** with a much lower water bill? (a) YES (b) NO

72. What is the **maximum** number of days of **water supply interruptions** you would accept without feeling inconvenienced? …… Days

73. Would you accept to be **exempted** 1 day of water interruptions with a higher water bill? (a) YES (b) NO

74. Would you accept to be **exempted** 2 days of water interruptions with an even higher water bill? (a) YES (b) NO

75. Would you accept to be **exempted** 3 days of water interruptions with a much higher water bill? (a) YES (b) NO

76. How several days' **notice** to you think is acceptable before any water interruption? _____days

77. What form of communication do you prefer for the notice? (a) SMS (b) Email (c) TV Add (d) Radio Add (e) Other (specify)_____________

78. Given that available water is physically limited and water users must incur the shortfall. The municipality then regulates that outdoor water use is restricted. Are you willing to pay more to your usual water bill per month **to be exempt** from the outdoor water use restrictions? (a) YES (b) NO

79. If No choose an outdoor water restriction that you will be willing to comply with

(a) No Hose pipe watering on gardens or lawns, (b) No Over filling of pools, (c) Use of containers only on car washing

80. If **prohibition of water use** between certain hours is put in place, which time slot will be suitable for you?

(a) 10:00 pm to 5:00 am (b) 5:00am to 10:00 am (c)1:00 pm to 5pm

81. In your view, is it entirely the responsibility of **government/City Council** to manage the water supply reliability challenge? a) YES b) NO

82. In your view, do **households** participate in managing / providing solutions to the water supply reliability challenge? a) YES b) NO

H. DEBRIEFING

Instruction to interviewer: This section will assist to identify particular challenges in the questionnaire as well confirm whether the questionnaire successfully accomplished its purpose.

83. In your opinion, did the respondent understand all the questions? Please rank the answers based on the level of understanding in the following table.

Level of understanding	**Rank**
Very well understood	
Clearly understood	
Understood	
Not understood	
Not clearly understood	
Not understood at all	

84. Where there any questions that the respondent found hard to answer because the options provided did not include his/her response? (a) YES (b) NO

If yes please describe them____

85. How would you rate the reliability of the responses provided by the respondent? Please rank the reliability in the following table.

Level of reliability	**Rank**
Very reliable	
Quite reliable	
Reliable	
Not quite reliable	
Not reliable	
Unreliable at all	

Thank you much for your time and your participation in this survey!!!!!