



ASSESSING THE EFFECTS OF URBANIZATION ON WATER SUPPLY IN  
SOMALILAND: A CASE STUDY OF HARGEISA CITY

BY

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A MASTER THESIS SUBMITTED TO THE WATER PROGRAM IN PAN AFRICAN  
UNIVERSITY FOR WATER AND ENERGY SCIENCE INCLUDING CLIMATE CHANGE  
FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF  
MASTER OF SCIENCE IN WATER POLICY

MARCH, 2024  
TLEMCEN, ALGERIA

## **Dedication**

I would like to express my thanks to my family, friends, and loved ones for their continuous support by dedicating my thesis to them.

## **Statement of the Author (Declaration)**

I, Mawliid Mustafe Ahmed, I declare hereby that this thesis is my own work. I also pledge that all the data, information, and results from other publications that I've used in this paper have been properly mentioned and referenced in line with academic standards and best practices.

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Signature:



Date: 03/22/2024

## Advisor Approval Sheet

This is to certify that the thesis entitled “Assessing the effects of urbanization on water supply in Somaliland: A case study of Hargeisa City” submitted in partial fulfillment of the requirements for the degree of Master of Science in Water Policy, the Graduate Program of the Pan Africa Institute for Water and Energy Sciences (incl. Climate Change), and has been carried out by **Mawliid Mustafe Ahmed** Id. No **PAUWES/2022/MWP07**, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the Water Program for defense.

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Date: 3/22/2024

## Examiner’s Approval Sheet

The cosignatories verify that they have read and herewith recommend to the Pan African University for Water and Energy Sciences – including Climate Change (PAUWES) to accept and admit the Thesis submitted by Mawliid Mustafe Ahmed entitled “The Effects of Urbanization on Water Supply in Somaliland: A Case of Hargeisa City” in partial fulfillment of the requirements for the of Master’s Degree in Water Policy.

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## **Acknowledgement**

All thanks Allah (SWT). I am grateful to the African Union Commission (AUC) which offered me this respected scholarship and supported me realizing this research and their ingenuity to create Pan University; The Pan African University Institute of Water and Energy Sciences - Including Climate Change (PAUWES), the Director (Prof. Abdellatif Zerga) and the Water Coordinator (Prof. Cherifa Abdelbaki), their team and the guest lecturers. I would like to sincerely appreciate and express my gratitude to my esteemed adviser, Awoke Guadie (PhD). Without his invaluable guidance, patience, and significant contributions, this paper would not have achieved its success. He provided consistent support for the production of this work from the outset and consistently offered suggestions for improvement. Hence, this work is the outcome of a collaboration between two individuals. I would like to express my gratitude to him for his mentorship, which has not only been valuable for this particular paper but also for shaping my future endeavors.

I express my deepest appreciation to my beloved family, consisting of my father; Mustafe Ahmed Hassan, my lovely mother, Fadxa Abdillahi Abshir, as well as my brothers and sisters. I appreciate their patience, tolerance, and unwavering support as they tolerated my absence and seeming lack of proper attention during the process of creating this research paper. I sincerely express my gratitude to you and will always remember your gift for as long as I live. My cordial thanks also go to dear friends for their encouragement and motivation. I wish you all a long life and paradise. I also hope to express special thanks to the Tlemcen people, for hosting me in their privileged country. At the same time, my gratitude goes to Durdur Drilling and Water Supply Company for the internship opportunity. I also extend my special thanks to my friends, and classmates of the 8<sup>th</sup> cohort for their genuine friendship and support during our studies in Tlemcen, Algeria. You have all stood so kind to me.

Finally, I shall thank and keep in mind, forever the respected respondents and interviewees from Hargeisa City, who dedicated and volunteered to contribute the backbone of this thesis – the primary data.

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## **Acronym**

HUWSUP	Hargeisa Urban Water Supply Upgrading Project
MWRD	Ministry of Water Resources Development
NWA	The National Water Act
SNWP	Somaliland National Water Policy
FSWS	Somaliland Food and Water Security Strategy
WRMIP	Water Resource Management and Investment Plan
IDPs	Internally Displaced People
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
SDGs	Sustainable Development Goals
WHO	World Health Organization
HWA	Hargeisa Water Agency
AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
FAO	Food and Agriculture Organization
OECD	Organization for Economic Co-operation and Development
ECA	Economic Commission for Africa
SPSS	Statistical Package for Social Sciences
PPP	Public-Private-Partnership
WASH	Water, Sanitation and Hygiene
UN	United Nations
UNICEF	United Nations Children's Fund
WWAP	World Water Assessment Programme
PAUWES	Pan African University Institute for Water and Energy Science
PAU	Pan African University
UKDFID	United Kingdom Department for International Development
LPCD	Liters Per Capita Per Day

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## Abstract

The rapid urbanization is taking place across many developing countries, including Somaliland, which creates major difficulties in terms of ensuring sufficient water supplies to meet the parallel increasing demand. Thus, the study was conducted to evaluate the effects of urbanization on the supply and availability of water in Somaliland, with a special focus on Hargeisa City. The research emphasizes how important it is to recognize the value of water and take into account its economic, social, ecological, and cultural factors. In Somaliland, the number of people living in cities has been consistently rising, and Hargeisa City is experiencing rapid growth and high population density. The existing urban water infrastructure in the city is insufficient to respond to the demands of its growing population. Consequently, almost 65% of the population of Hargeisa depends on water that is transported by tankers and donkey cars from poorly maintained and unreliable sources. Data was collected using primary and secondary techniques. Primary data was collected through questionnaires, interviews, and observations. From among the nine districts comprising the city of Hargeisa, two primary districts were selected for the purpose of assessing the water supply system and its associated factors. A total of 198 questionnaires containing 49 questions were prepared and distributed to targeted community members (households), in Hargeisa City. As well as, a total of 24 questions were prepared aiming for interviews to the government and private water vendors officials. The collected data was analyzed using the Statistical Package for Social Sciences (SPSS) to visualize the result in various expression forms (frequencies, percentages, correlations, and significant values). The study discovered that a significant proportion (41% = 78 individuals) of households utilizing pipeline tap water supplied by Hargeisa Water Agency spend monthly expenses below \$20. In contrast, the majority of households (43% = 84 individuals) that utilize private water tankers pay between \$35 and \$50 per month, which is substantially more than the first group. Moreover, the correlation analysis showed that a significant negative correlation ( $R^2=-0.246$ ,  $p = 0.001$ ) between household income and reliance on the main water source, and a significant positive correlation ( $R^2=0.14$ ,  $p = 0.018$ ) between the utilization of private water vendors and their associated average monthly cost. The majority of households (90%) stated climate change impacts on water supply, in terms of changes in water availability and decreased rainfall. Overall, this study concludes the challenges faced by Hargeisa city in meeting the water demand of its growing urban population, including inadequate infrastructure, reliance on a single water source, and with economic, environmental and social factors influencing water supply. The study recommends to implement income-based tariff structures, explore alternative water sources, conduct public awareness campaigns, monitor the water supply system and promote effective water management through inclusive collaboration.

**Keywords:** Urbanization, Hargeisa city, Water infrastructure, Water resources, Awareness

# CHAPTER ONE: INTRODUCTION

## 1.1. Background of the Study

“Valuing water entails acknowledging and taking into consideration the many advantages and hazards associated with water, covering its economic, social, ecological, and security aspects, as well as its complex cultural and religious significance. It promotes effectiveness and encourages improved methods by revealing the short and long-term costs associated with pollution, waste, and misallocation. Efficient allocation systems may incentivize the redirection of water to more valuable use in times of water scarcity” (UN-Water, 2019). The United Nations predicts that the world’s population is projected to reach around 9.6 billion by the middle of 2050 (UN Department of Economic and Social Affairs, 2019).

The process of urbanization is occurring at different rates in both developed and developing countries, with varying factors driving this trend. Industrialization has primarily facilitated urbanization in developed countries, as economic growth and job opportunities attract people to urban centres. Meanwhile, in developing countries, particularly those in Sub-Saharan Africa (SSA), urbanization is characterized by rapid population growth without sufficient socioeconomic, technical and environmental infrastructure to support urban expansion. The United Nations estimates that as of 2018, the most urbanized region is North America with 82% of its population residing in urban areas followed by Latin America and the Caribbean (81%), Europe (74%), Oceania (68%), and Asia (50%). In contrast, Africa remains predominantly rural with only 43% of its population living in urban areas (UN, 2019).

According to statistics from the United Nations, the proportion of the urban population in SSA increased from 27% in 1990 to 37% in 2014, with an average annual growth rate of 1.4%. This indicates the significant pace at which urbanization is occurring in the region, (UN, 2014). The population of Somaliland is about 5 million as of 2023-year report. The population of Hargeisa is also 1.2 million people, accounting for nearly one-quarter of Somaliland's overall population, , (Hargeisa Local Government, 2022) . However, based on rural-urban migration and the city's overall expansion, everyone believes the current population exceeds 1.5 million, (MNPD, 2021).

Hargeisa has nine major districts (Ahmed Dhagah, Ga'an Libah, Mohamoud Haybe, Mohamed Mooge, 26 June, Ibrahim Kodbour, Mo'alin Harun, 31 May, and the recently founded district of Ga'ma Dhere), Hargeisa local government (2023). The current urban water infrastructure system is insufficient for the nine districts. This demonstrates that the city's

residents are in severe need of clean water. The Hargeisa Water Agency (HWA) has an optimistic outlook regarding the provision of adequate water to the entire city. Currently, the Hargeisa Urban Water Supply Upgrading (HUWSUP) is a project funded jointly by the European Union (EU), Somaliland Development Fund (SDF), the Somaliland Government and UN-Habitat which was intended for repairing the existing wells as well as for finding new and alternative sources of water.

## **1.2. Statement of the Problem**

According to the Somaliland government and FAO (2021), around 55% of the Somaliland population resides in rural zones, while the remaining (45%) reside in cities. According to the UK Department for International Development (DFID), 65% of Hargeisa's estimated 1.2 million residents depend on water trucked owned by the private tankers and donkey-cars vendors that acquire water from unsafe and poorly maintained sources of water. Generally, Hargeisa is one of Somalia's most densely populated and fastest-growing cities, particularly in Somaliland. When compared to other cities and towns in Somaliland, the city has relatively better socioeconomic infrastructure and basic needs services, including water supply, which has served as a pull factor leading to large migration of people from other regions of the country, especially rural areas. However, due to rapid urbanization in the city, the water supply in the city has got more and more stress. In 1974, Hargeisa had an estimated population ranging from 175,000 to 180,000 residents (HWA, 2023). When the water infrastructure was originally constructed by the Chinese in 1972 from a small village Geed Deeble (located approximately 30 km North of Hargeisa City), it was designed to provide the water needs of approximately 300,000 individuals, which was roughly equivalent to the city's population at that time. Although, the water supply source from Geed Deeble rebuilt multiple times during the 1980s, the upgrading of the source didn't solve the shortage of water.

Currently, the HWA is facing challenges in meeting the estimated demand (9,000-24,000 m<sup>3</sup> per day) of water. Nowadays, there are 13 operational boreholes or wells to the entire Hargeisa City that service as a water supply source, which is not sufficient to satisfy the current demand. Most parts of Hargeisa city lack access to water distribution and the availability of the urban piped water system is restricted certain area of the city. Only 35% of the population in Hargeisa has access to some form of piped water supply (UN-Habitat, HUWSUP, 2022). The recently constructed houses located on the outskirts of Hargeisa have never seen the convenience of a functioning water tap. As the result, HWA faced challenges in distributing and supplying water to many parts of the city.

Initially, a rotational system was implemented where water was distributed equally to each household on alternate nights (one night for one certain area and the second night for another area and so on). However, as the city's population expanded, this approach became unsustainable. To address these challenges, several projects are underway to repair and expand the pumps and pipes connected to the existing water wells and find alternative options.

This study is designed to evaluate the effects of urbanization on water supply in Hargeisa City. The objectives are to figure out economic, environmental, social, management, and policy issues associated with water supply and urbanization.

### **1.3. Objectives of the Study**

#### **1.3.1. Main Objective**

The main objective of this study was designed to assess the effects of urbanization on water supply in Somaliland by considering Hargeisa City as the study focus area.

#### **1.3.2. Specific Objectives**

The specific objective of this study was:

- To evaluate the economic factors that affect water supply in Hargeisa city
- To address the environmental factors that affect water supply in Hargeisa city
- To identify the social factors that affect water supply in Hargeisa city
- To evaluate urban water management system in Hargeisa city

### **1.4. Research Questions and the Hypothesis**

#### **1.4.1. Research Questions**

- What are the economic factors that affect water supply in Hargeisa city?
- How do environmental factors affect water supply in Hargeisa city?
- What are the social factors that affect water supply in Hargeisa city?
- What are the key factors to consider when evaluating the water management system in Hargeisa city?

#### **1.4.2. Working Hypothesis**

- Null Hypothesis (H0): There is no significant relationship between urbanization and its associated factors, and water supply system in urban areas.
- Alternative Hypothesis (H1): Urbanization and its associated factors, has a significant positive impact on water supply system in urban areas.

## CHAPTER TWO: LITERATURE REVIEW

### 2.1. Definitions of Urbanization

Considering the diversity of urban definitions, international reporting and comparisons of urban populations inspire a degree of consistency, but the variances can be misleading. The minimum size in most countries with size restrictions ranges from 1,000 to 5,000. Extremes include Sweden, where a built-up area with at least 200 households separated by no more than 200 meters is defined as urban, and Mali, where censuses prior to 1987 used a cut-off of 5,000, the 1998 census used a cut-off of 30,000, and the 2009 census used a cut-off of 40,000, (Mcgranahan, 2014). According to various definitions of urbanization, it is generally acknowledged that urbanization indicates a population shift from rural to urban settlements. The urban population share is the best demographic measure of the urbanization level, and the urbanization rate is the rate at which that proportion is expanding. From a demographic standpoint, the urban population share is the best indicator of urbanization, and the urbanization rate is the rate at which that proportion is growing, (Mcgranahan, 2014). The swiftness with which Africa is expected to enter the 'urban age' is unprecedented. While the continent remains primarily rural, it is one of the world's fastest urbanizing regions.

Over the next 40 years, Africa's urban population is forecast to more than triple, from 395 million in 2010 to 1.339 billion in 2050, accounting for 21% of the world's projected urban population (Güneralp et al., 2018). Urban areas, which are rising in population and land cover, pose dangers to the continent's ecosystems and biodiversity, but they also provide opportunities for conservation. The growing urban population, particularly in SSA, puts further strain on already inadequate infrastructure and introduces new governance issues, (Güneralp et al., 2018).

Table 1: Urbanization rates (% per year) by the world from 1950 to 2050, (Mcgranahan, 2014).

<b>Population growth rates</b>	<b>1950-1960</b>	<b>1960-1970</b>	<b>1970-1980</b>	<b>1980-1990</b>	<b>1990-2000</b>	<b>2000-2010</b>	<b>2010-2020</b>	<b>2020-2030</b>	<b>2030-2040</b>	<b>2040-2050</b>
World	1.8	2.0	1.9	1.8	1.4	1.2	1.1	0.8	0.6	0.5
SSA	2.2	2.5	2.8	2.8	2.6	2.5	2.4	2.2	2.0	1.8
Northern Africa	2.5	2.6	2.7	2.6	1.6	1.5	1.1	0.9	0.6	0.6
Asia	2.0	2.3	2.1	2.0	1.5	1.1	0.9	0.6	0.4	0.2
Europe	1.0	0.8	0.6	0.4	0.1	0.2	0.1	0.0	-0.1	-0.2
Latin America and the Caribbean	2.8	2.7	2.4	2.0	1.6	1.2	1.0	0.7	0.5	0.2
Northern America	1.8	1.2	1.0	1.0	1.1	1.0	0.8	0.7	0.6	0.5

Oceania	2.2	2.1	1.6	1.6	1.4	1.6	1.4	1.1	0.9	0.7
<b>Urbanization rate</b>										
World	1.3	0.9	0.7	0.9	0.8	1.0	0.8	0.7	0.6	0.6
SSA	2.9	2.7	2.1	1.6	1.3	1.2	1.2	1.2	1.1	1.0
Northern Africa	2.0	1.7	1.0	1.0	0.6	0.6	0.5	0.6	0.7	0.6
Asia	1.9	1.2	1.4	1.8	1.5	1.7	1.3	1.0	0.8	0.7
Europe	1.1	1.0	0.7	0.4	0.1	0.3	0.3	0.3	0.3	0.3
Latin America and the Caribbean	1.8	1.5	1.2	0.9	0.7	0.4	0.3	0.2	0.2	0.2
Northern America	0.9	0.5	0.0	0.2	0.5	0.4	0.3	0.2	0.2	0.2
Oceania	0.7	0.6	0.0	-0.1	0.0	0.0	0.0	0.1	0.1	0.1
<b>Urban population growth rates</b>										
World	3.2	2.9	2.6	2.7	2.3	2.2	1.9	1.5	1.2	1.0
SSA	5.2	5.3	4.9	4.5	4.0	4.0	3.8	3.6	3.4	2.8
Northern Africa	4.5	4.4	3.7	3.7	2.5	2.2	2.0	1.8	1.5	1.2
Asia	3.9	3.5	3.5	3.7	3.0	2.9	2.2	1.6	1.2	0.9
Europe	2.1	1.8	1.2	0.8	0.2	0.4	0.4	0.3	0.2	0.1
Latin America and the Caribbean	4.6	4.2	3.6	3.0	2.4	1.7	1.3	1.0	0.7	0.4
Northern America	2.7	1.8	1.0	1.2	1.6	1.3	1.1	0.9	0.8	0.6
Oceania	3.0	2.8	1.7	1.5	1.4	1.7	1.4	1.2	1.0	0.8

### 2.1.1. Urbanism

Urbanism refers to the examination, planning, and implementation of strategies to develop and transform cities and urban areas. Urban studies are a multidisciplinary field that covers different aspects of city life, such as the organization, growth, and administration of cities, as well as the social, cultural, and economic interactions within urban settings (Ellis, 2002). Urbanism, on the other hand, refers to the fashion of living or the features of the way of life of people who reside in urban regions. Urbanization and urbanism, while sometimes used interchangeably, are distinct concepts. Urbanization signifies the growth and development of urban regions, whereas urbanism pertains to the lifestyle and manner of living of the people who reside in these urban areas. These influences encompass sociological, psychological, educational, technological, industrial, historical, philosophical, legal, military, political, scientific, and other dimensions (Sinclair, 2017).

### 2.1.2. Urban Population

Urban population dynamics pertains to the study of the changes and movements in the population of urban areas throughout time. The proportion of urban residents is increasing at a rapid pace, making them the majority of the population. The majority of individuals reside in developing nations, with an increasing percentage residing in the largest urban areas. The

majority of the world's largest cities are currently located in developing nations, and their populations are expanding to unprecedented magnitudes. The urban population is experiencing a significantly higher rate of growth compared to rural areas, either due to natural increase (the disparity between births and deaths) or due to migration from rural regions. Nevertheless, the rural population in developing nations will persistently increase. Population dynamics, which refer to the factors that drive the increase and migration of populations, are crucial in the process of urbanization (Rafael, 1986).

### **2.1.3. Urban Growth**

The United Nations defines "urban growth" as the increase in the proportion of a country's population living in urban areas over time. Urban growth pertains to the social, economic, and environmental aspects of sustainable development. Government initiatives aimed at encouraging sustainable urbanization and population redistribution are crucial for effectively implementing the 2030 Agenda for Sustainable Development Goals (SDGs), as stated by the United Nations in 2020. Sharma, (2017) states that metropolitan areas are consistently grappling with issues of water scarcity and urban flash floods. Urban land area has undergone a twofold increase, resulting in a significant impact on the hydrological cycle. Consequently, urban development disrupts water availability, water recharge, and the water cycle.

## **2.2. Urbanization in Africa**

The African continent will experience urbanization as one of its most significant and far-reaching shifts in the 21st century. Since 1990, the number of cities in Africa has experienced a twofold rise, rising from 3,300 to 7,600. Furthermore, the total population of these cities has grown by 500 million individuals. Due to their youthful demographics and dynamic transformation, Africa's urban centers are experiencing the fastest growth globally. Their influence on Africa's economic, social, and political terrain in the forthcoming decades is expected to be significant. Urbanization offers significant prospects for expediting advancements towards the 2030 and 2063 development goals, as well as for fostering continental integration within the framework of the African Continental Free Trade Area (AfCFTA).

For African officials, this also involves significant obstacles in strategizing, overseeing, and funding urban expansion at both the local and national scales. Across several regions in Africa and other areas, there exists a widespread negative perception regarding the external consequences of urbanization and its influence on progress. This has impeded the efficiency

of policy procedures aimed at integrating urbanization into Africa's development objectives. The present study provides solid evidence, gathered from 2,600 cities across 34 nations, demonstrating urbanization in Africa leads to improved economic outcomes and greater standards of living. According to the African Development Bank Group (2022), African cities generally surpass their respective countries in various socio-economic aspects. Furthermore, the disparity between the performance of African cities and the national averages is greater in comparison to many other regions worldwide.

### **2.3. Urbanization in Somalia**

In 2019, roughly 7.1 million Somalis lived in urban areas, while the remaining people living in rural areas. Somalia has the world's greatest rate of urbanization. Somalia's population continues to migrate from rural to urban areas in search of better opportunities and basic necessities, (Hamdi Ali, 2020). Somalia is promptly urbanizing, with 46% of the population living in cities, and the yearly growth rate for urban regions is quite high - around 4.3% (WB, 2020). According to projections, Somalia would add another 3.8 million citizens to its urban regions by 2030, and another 11.6 million by 2050, tripling its urban population in 30 years, (World Bank, 2020).

These projections may underestimate urban population growth because recent shocks have forced rural Somalis to seek shelter in cities. The majority of the 2.6 million internally displaced people (IDPs) are estimated to live in Somali cities (World Bank Group, 2021). Almost all of the hundreds of thousands of Somali refugees who have returned from refugee camps have settled in cities. Given that these settlements are mostly in urban areas, this implies that 54% of Somalis reside in cities, compared to the estimated 46% (Figure 1). Somalia, which was originally nearly totally rural, is being shifted by this remarkable amount of fast urbanization.

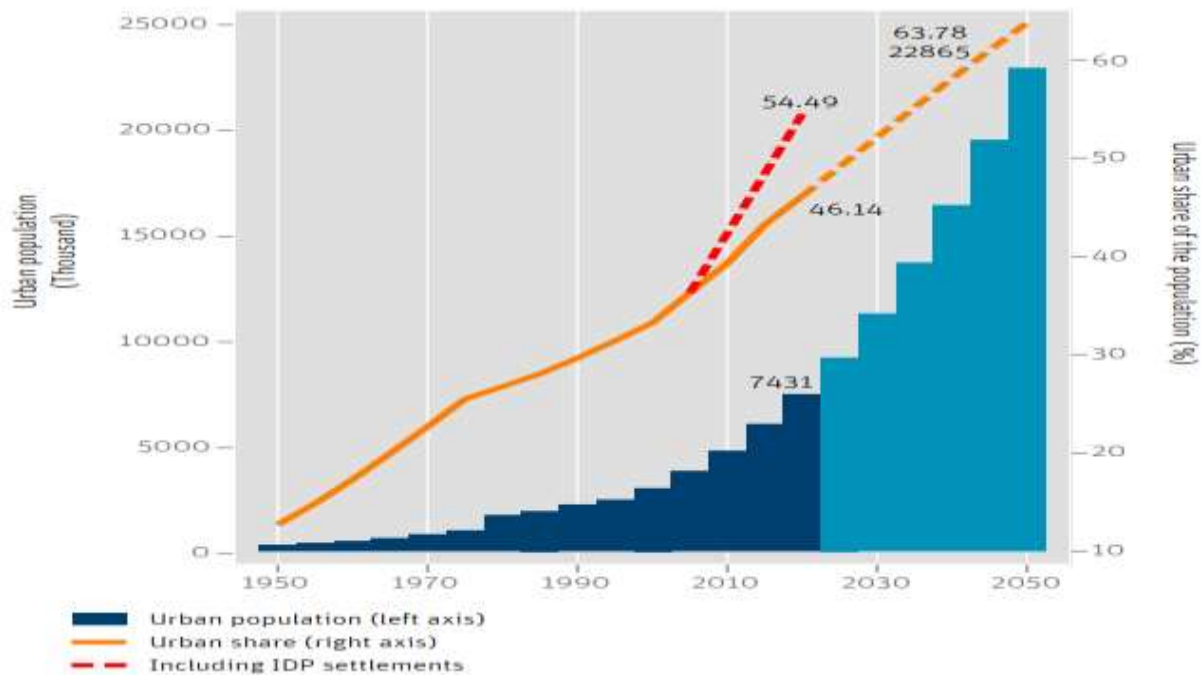


Figure 1: Urbanization in Somalia (World Bank Group, 2020).

It is argued that in the early 21<sup>st</sup> century, population growth and economic dynamics are the most important determinants of water supply–demand balance, and that many existing urban water delivery systems will be unable to meet both current and future demands of the people they serve (Etikala et al., 2022). Furthermore, climate change causes changes in rainfall patterns, notably changes in extreme wet and dry periods, exacerbating land-use changes that represent a serious threat to urban hydrology by altering natural watersheds.

Sustainable access to safe drinking water is essential to human health and well-being. Despite significant progress in closing the gap between water demand and supply, (Adams et al., 2019) indicated that over 844 million people, many of whom live in SSA, continue to lack access to better and safely managed drinking water sources. In Somalia, water was mostly provided by shallow wells and boreholes built, drilled, and operated by people and small businesses. Later, beginning in the early 2000s, private companies began drilling boreholes on the outskirts of towns and establishing pipe networks serving city centers and more wealthy areas, in part as a result of a series of UNICEF water investments and collaborations, (Hagmann, 2022). Water delivery and usage patterns reflect existing inequities in urban areas. The wealthy have bottled and piped water, the poor have shallow wells, and the urban middle class has a combination of piped and alternative water sources. Water expenses, for example, are a considerable hardship for urban households in urban settings, ranking second only to food expenses. Water pricing and quality are also affected by location and season, with prices rising during dry spells and droughts, (Hagmann, 2022).

### **2.3.1. Urbanization in Somaliland**

According to the Ministry of National Planning and Development's report "Somaliland in Figures, 2011," the estimated population of Somaliland in 2009 was 3.85 million. Approximately 55% of the population consists of nomadic pastoralists, while the remaining 45% reside in urban and rural areas. A nomadic pastoral society predominates in Somaliland, where herding livestock is the main source of income. This occupation serves as the main source of both sustenance and income for 70% of the population, encompassing both rural pastoral and urban groups. According to the Somaliland Central Statistics Department (2018), crop production is the second highest priority after livestock.

Approximately 55% of the communities in Somaliland reside in rural regions; however, less than 20% consume the accessibility to improved water supplies, and approximately 88% lack access to universal sanitation. This issue requires immediate attention and is further complicated by: (i) ongoing conflicts; (ii) limited precipitation and intricate hydrogeology in the region; (iii) the crucial role of pastoralist livelihoods in the economy; and (iv) inadequate or non-existent local government structures.

Somaliland is seeing a rapid process of urbanization, resulting in the emergence of a new demographic that is particularly susceptible to hardship: the urban poor. This category encompasses impoverished pastoralists, economic migrants, and those who are unable to sustain themselves due to a dearth of viable livelihood prospects. Due to the limited scope of private sector companies, there are only a few employment prospects available. The primary urban areas are inhabited by IDPs and individuals who have returned to their homes. There are several informal settlements with an estimated population of approximately 100,000 IDPs currently residing in settlements in the main city of Hargeisa in Somaliland. According to UNICEF in 2015, the water distribution network of the HWA is unable to reach the IDP settlements. In the same year 470 water kiosks were intended to serve the poor is not suitable for them due to their locations. Over 60% of the kiosks are situated in economically affluent areas of the city that have access to piped water connections. The kiosks are in adequately designed and vulnerable to hygienic risks. There are no policies or regulations in place that support equal and economical access to safe drinking water for poor and needy individuals.

### **2.4. Urbanization and Water Resources**

According to recent estimations, the proportion of people residing in urban regions worldwide has surpassed that of those living in rural areas, with 55% currently residing in urban areas. It is projected that this ratio will increase to 60% by the year 2030 (Population

Reference Bureau, 2018). Furthermore, the majority of the present and future increase in the urban population is taking place in developing nations. In these countries, the rate of urban population growth surpasses both the global and national averages. Additionally, the PRB stated in 2018 that a sizable portion of this growth is attributable to natural population growth rather than migration from rural to urban areas.

The population residing in informal settlements in SSA experienced a two-fold increase from 1990 to 2012. Notably, urban centers including Lagos, Kinshasa, Dar es Salaam, Nairobi, and Lusaka witnessed a population doubling process within fifteen years (UN-Habitat, 2014). The evident difficulty that this presents is the mounting pressure to provide services such as water and sanitation to meet the growing demand; many cities are struggling to meet this challenge adequately (Horman, 2020).

#### **2.4.1. Water Overview**

Water, an essential requirement for humans, is a vital resource that impacts several elements of human life, including environmental sustainability, economic progress, and overall well-being. In 2013, the UN-Water recognized that water plays a crucial role in attaining security, sustainability, development, and human well-being. The scarcity of fresh water is regarded as a significant challenge for humanity. UN-Water advocates for the inclusion of water security in the post-2015 development agenda as a component of the SDGs. Populations are provided with access to secure, ample, and reasonably priced water to fulfill fundamental requirements for drinking, sanitation, and hygiene. This is done to protect health and overall well-being, as well as to uphold basic human rights (UN-Water, 2013). The issue of global food security is intricately connected to the availability of water (Falkenmark, 1997). Furthermore, the growing population exerts a higher pressure on freshwater resources. Water resource management is becoming more crucial due to the scarcity, limited availability, high cost, and challenging exploitation of new local and national water sources (Delli, 1998). Due to water scarcity, countries in arid and semi-arid regions may be compelled to explore the option of utilizing water resources from international river basins (Biswas, 1996). On a global scale, freshwater accounts for about 2.5% of the total water on Earth. The majority of easily accessible freshwater resources are located in rivers and lakes that one or more independent nations share (Shiklomanov, 1997).

#### **2.4.2. Minimum Water Requirements Litre Per Capita Per Person Per Day**

For personal and domestic use, all human beings have the right to adequate, safe, acceptable, physically accessible, and affordable water (United Nations Committee on Economic, Social,

and Cultural Rights, 2003). To guarantee sustainable and healthy urban living, a minimum quantity of water should be accessible for drinking, food preparation, basic hygiene, bathing, and sanitation. The minimum daily water demand, as determined by the World Health Organization (WHO), is approximately 50 to 100 liters per capita per day (LPCD). The WHO-established minimum water demand is restricted to off-site water supply access and excludes residential properties with piped water (WHO 2003). The management of resources, primarily water management, poses a significant challenge to urban sustainability. Adequate water supply is critical for healthy urban living, but millions of people worldwide continue to lack access to clean water (Melissa, 2021). At the most fundamental level, water is required for direct drinking, food preparation, and cleanliness for hygiene purposes. More than two billion people inhabit nations faced with severe water scarcity. According to recent estimations, water stress affects 31 nations to the degree of 70% (which is considered to be the minimum threshold of water stress) intensity. Twenty-two more nations are experiencing severe water stress at levels exceeding 70%, (UN, 2018). It has been estimated that over four billion people, which is equivalent to roughly two-thirds of the total population of the globe, are affected by acute water scarcity during at least one month of the year (Mekonnen et al., 2016).

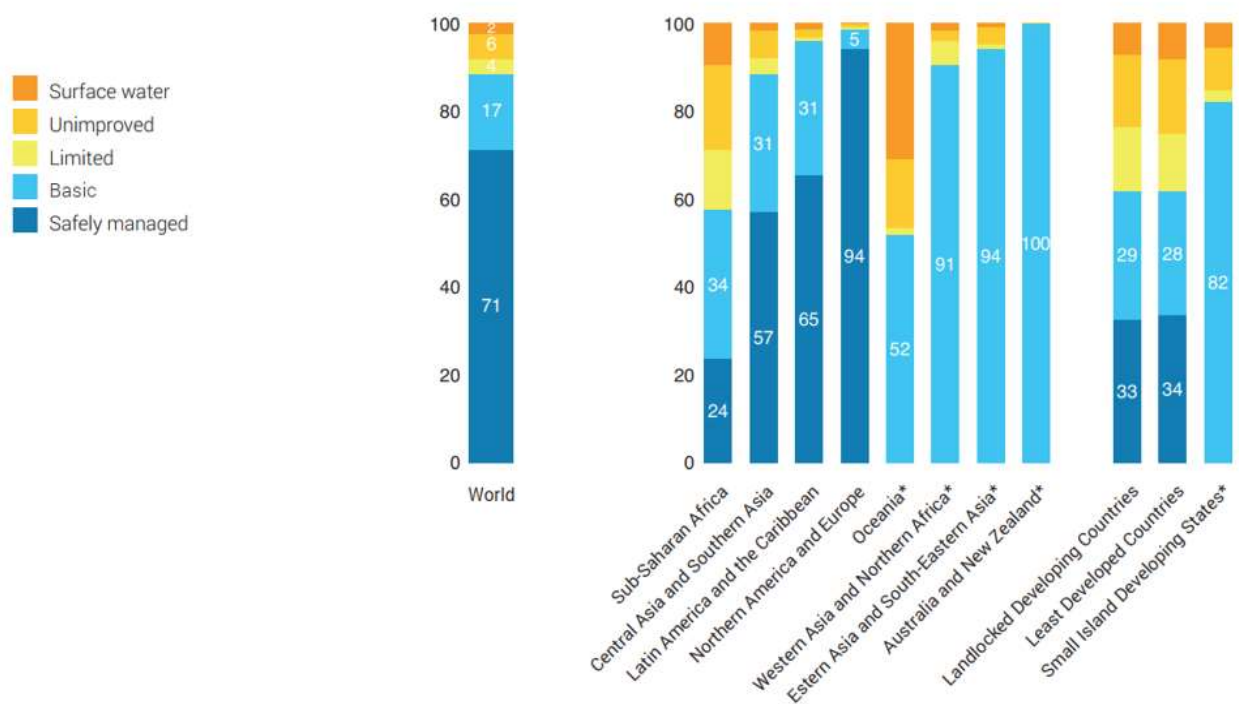


Figure 2: Water demand consumptions on the world (WWAP, 2019).

## **2.5. Economic Factors on Water Supply**

The following statement associates the economic value of water with its market price: in a market system, the price of water defines its economic value and helps to distribute it among different applications. This system has the ability to allocate water and its complementary resources to the uses where they can provide the most overall economic benefit, (Hanemann, 2014).

### **2.5.1. Pricing Strategies and Tariff Structures**

A third of the world's population still lacks access to sanitation and safe, potable water; 2.1 billion people continue to lack this basic human right, while 4.5 billion continue to lack sanitation facilities compatible with the SDG6 objectives. Approximately 675,000 premature casualties occur each year due to inadequate sanitation, water, and hygiene. An estimated 470 billion US dollars are lost annually on a global scale due to water insecurity and inadequate sanitation. Water insecurity for existing irrigators costs USD 94 billion annually, USD 260 billion annually from inadequate water supply and sanitation, and USD 120 billion annually from urban property inundation damages (Sadoff, et al. 2015).

Moreover, in some global regions, water-related damages to property, health, agriculture, and income may cause sustained negative growth and a 6% decline in GDP by 2050 (World Bank, 2016). Investment requirements significantly surpass existing financing inflows. Although projections of water security investment requirements vary, they all suggest that the magnitude of such investments should be substantially increased. The range of global estimates is between USD 6.7 trillion and USD 22.6 trillion by 2050 (Winpenny, 2015). Household with the pipeline connections in Hargeisa, Somaliland, spend \$1.5 per cubic meter to HWA, whereas the lower income families lacking pipeline water networks pay 7.5 USD per one cubic meter to private suppliers. This indicates that the existing urban water supply in Hargeisa city is unfair and the distribution of water among the city's citizens is unequal. Due to the expensive cost of private water suppliers, the poorest families in Hargeisa pay nearly five times more for water compared to those with access to main consumption (Farah, 2015).

### **2.5.2. Affordability of Water**

In the majority of Somalia, water scarcity persists; in some regions, the price of water has increased by as much as 60 percent, compelling the most vulnerable households to travel considerable distances in quest of potable water. Water price increases were documented in March 2021 in certain regions of Somalia and Somaliland, specifically in the vicinity of Jariiban and Dahar. In these areas, the median cost of a 200-liter container of water costs

approximately \$9, and in Dahar, it is priced at \$6.5. Additionally, Hobyo and Xarardhere both recorded the highest average water prices per barrel of 200 liters, at \$6.5, (UN Children's Fund, 2021). This was primarily attributable to inadequate Deyr precipitation, which prevented the replenishment of groundwater sources.

The water prices in certain regions of south Somalia and Somaliland exhibit small variations compared to the prices observed between December and March. This indicates a 60% rise in the price per barrel from December to February, which is consistent throughout most years. In addition, inadequate regulation of private water suppliers frequently results in high prices, compelling households to travel long distances and obtain water from hazardous open wells. In addition, water prices in most regions of Somaliland, especially the eastern half, have significantly increased compared to the previous reporting period. However, there are a few places, such as Borama and Gebiley, where water prices have stayed unchanged. According to the WASH Cluster report from 2021, the cost of 200 liters of water has risen by 40% in Caynabo, going from \$2.5 to \$3.5. In Hargeisa, the price has climbed by 42%, going from \$3.5 to \$5, compared to the previous month.

As mandated by legislation, water tariffs for each water supply system must, at a minimum, encompass the comprehensive annual expenses associated with production, maintenance, and enhancement of water works. The National Water Law contains the relevant provisions (paragraphs 64.1, 65.2, 65.3, 67.1, 68.1, 68.2, and 69.1), (National Water Act, Law No.49/2011).

The tariffs are determined by negotiations between the Ministry, District, and the Water Provider, following the Guidelines provided by the Ministry responsible for water. In addition, the Water vendor, who is responsible for operating a water system under an Operating Contract, is required to provide lease fee payments to the holder of the right of use. The lease fee will be determined through mutual agreement between both parties and the Ministry, following the criteria provided by the ministry responsible for water affairs.

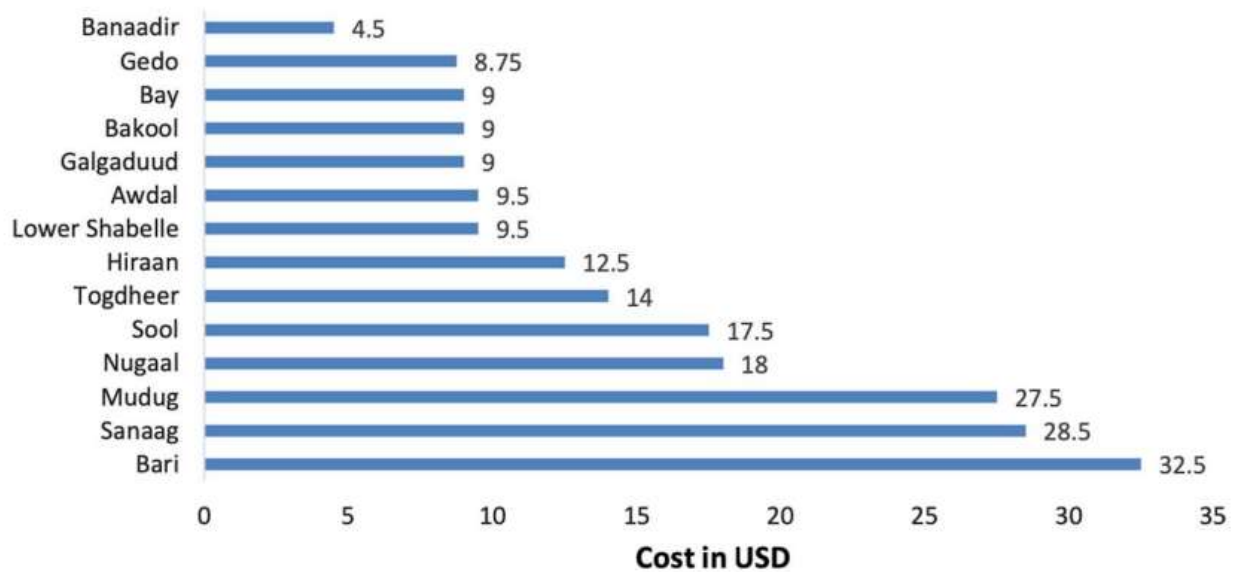


Figure 3: Water prices for one cubic meter in some areas of Somalia, (Khaldoon, 2021).

As clarified by the author in his paper, the aforementioned figure depicts the fluctuating per-cubic-meter water costs across various regions of Somalia. The figure illustrates that the price of water has risen significantly in these regions and poses significant challenges for individuals living in poverty, given their greater vulnerability and their inability to afford a sufficient water supply on account of their constrained financial incomes.

### 2.5.3. Water Supply Infrastructure Status

The majority of Somaliland's water comes from dug shallow wells that have been collapsed within dry riverbeds. Throughout the year, these water sources often do not have adequate water. If it is required, sand or underground dams are constructed, or boreholes are excavated. Boreholes may not always be the greatest solution because of worries about the quality of the water or economic conditions. In such circumstances, communities may take advantage of surface water and construct hafirs or balleys. Berkads are often used for the purchase of household items; however, during the rainy seasons, they need the assistance of water trucks to be filled. On the other hand, in many cities, the primary water source is the water transported to the community by private tankers. Trucks are frequently refuelled from shallow wells or production boreholes located up to 100 kilometres away, which are maintained by the public or private sector, (Ministry of Water Resources Development, 2019b).

### 2.5.4. Cost of Water Supply Construction

The expenses of water supply infrastructure building have been examined to determine the needed unit. The prices of different water supply components were significantly varied, even

when drilling depths and distance from Hargeisa were included. The following Table displays assessment findings and sample unit costs.

Item	Units	Unit cost (USD)	Comments / source of information
New borehole drilling and test pumping	metre depth	400	Contractor bids
Hydrogeological survey	borehole	5,000	Depends on number of boreholes and distance and specifications of survey
Drilling contract management		5,000	Estimate
Drilling 200 m	borehole	60,000	Suppliers
Drilling supervision		1,000	Senior supervision Estimate
Test pumping		5,000	New estimate
Test pumping supervision		2,500	New estimate

Figure 4: Unit of construction costs, (Ministry of Water Resources Development, 2019).

## 2.6. Environmental Factors Affect the Water Supply

Climate change has become a major global issue with wide-ranging consequences for water supply systems globally. Climate change has diverse impacts on water resources, including shifts in rainfall patterns, more frequent and intense extreme weather events, higher temperatures, and changes in hydrological cycles, (UN-Water, 2019). The aforementioned changes present serious threats to the supply and quality of water, intensifying water strain and scarcity in numerous areas. According to Almer 2017, in Africa, the region has already encountered challenges with scarce water resources and high susceptibility to climate fluctuations, the effects of climate change on water availability are especially severe. The projected changes in precipitation patterns and heightened occurrence of droughts and floods are predicted to exacerbate the already overwhelmed water infrastructure, endangering water security, agricultural production, and public health.

In Somalia, climate change's effects on water availability are a major worry due to its location, dry and semi-arid environment, and frequent droughts. The country's rain-fed agriculture and pastoralism make it vulnerable to precipitation changes. Climate forecasts predict a decline in annual rainfall, worsening water scarcity, and threatening water-dependent livelihoods. Recently, droughts caused by climate change in Somalia, decreased precipitation by 30–60% between 1995 – 2018. During the period from 2015-2017, recurrent droughts displaced millions, resulting in food insecurity, substantial livestock losses, and 70% agricultural failure, (Linda Et al, 2018). Harmed by food and water scarcity,

humanitarian crises impacted more than 2.7 million individuals in 2021. Therefore, to ensure the improvement of resilience and water availability for future generations, Somalia needs climate change adaptation, improved water infrastructure, community-based water management strategies, and sustainable livelihood diversification.

### **2.6.1. Land use Changes and Pollution**

Land use changes and pollution are major global water supply problems, especially in Africa. Rapid urbanization, deforestation, agricultural expansion, and industrialization have transformed land cover and usage patterns on stress water resources and water supply systems. Deforestation lowers plant cover and soil stability, causing soil erosion, sedimentation, and water storage capacity loss. Thus, water quantity and quality suffer, affecting water delivery system reliability and resilience. Urbanization increases impermeable surfaces, interrupting the hydrological cycle and worsening stormwater runoff. Expanding agricultural techniques frequently involve intense fertilizer and pesticide use, which pollutes surface and groundwater and reduces water supply.

Similarly, in Africa the complex correlation between adjustments in land utilization and pollution concerning water provision is especially noteworthy, considering the continent's substantial dependence on farming, limited availability of potable water, and difficulties in enforcing appropriate laws and regulations about the environment.

### **2.6.2. Water Contamination in Somalia/Somaliland**

In the absence of an adequate supply, people experience despair and become susceptible to illness due to their fragile state. It is crucial to take into account the relationship between water supply and sanitation. With a decline in supply, the already scarce resources are distributed, leading to water pollution. The primary water source in Somalia, accounting for 80% of the total water supply, is groundwater. However, groundwater is heavily contaminated as a result of various factors, such as the widespread use of pit latrines and shallow underground tanks, frequent open defecation, the coexistence of livestock and humans at water sources, and improper disposal of wastewater. The survey carried out in 2019 at water points by the UNICEF Somalia Country Office reported significant levels of fecal contamination in water supplies at the source, point of collection, and point of use. In the absence of effective mechanisms to oversee the quality of water, the spread of diseases is unavoidable. Moreover, the absence of proper education regarding sanitation exacerbates preexisting problems, as vulnerable groups are unaware of water contamination and the potential hazards associated with drinking such water.

Type of Land Degradation	Direct Causes	Indirect Causes
<b>Physical</b>		
Water erosion Wind erosion Compaction Surface sealing and crusting	Overgrazing Creation of dirt roads across grazing lands Topography of grazing lands Improper farming techniques	Lack of appropriate knowledge and skills Short-term planning horizon Lawlessness Lack of functional NRM structures Weak tenure and resource access rights
<b>Biological</b>		
Loss of vegetative cover Loss of biodiversity Invasion of nuisance species Loss of habitat	Increased climate variability Wood harvesting, especially for charcoal Shifting cultivation	Climate change Increased demand for resources Lack of access to capital High reproductive rates
<b>Chemical</b>		
Salinisation	Poor drainage	Overclearing Poor flood control systems

Figure 5: Types of land degradation and its causes, (Ministry of Water Resources Development, 2019).

According to the above table (types of land degradation and its causes) shows that; overgrazing and poor farming techniques are the primary factors directly responsible for physical degradation. Over the past two decades, there has been an increase in overgrazing and deforestation in the Maroodi Jeeh (Hargeisa) and Gebiley regions, which has caused a negative impact on agricultural production due to climate change, (Ministry of Water Resources Development, 2019b).

In Biological degradation results in a decline of ecosystem cover, diminished biodiversity and habitat, and the encroachment of troublesome species. In spite of overgrazing, the primary direct factor contributing to biological degradation is the harvesting of wood, particularly for the production of charcoal. In the end, chemical degradation of land causes salinization. This significantly contributes to poor surface and groundwater quality. The causes of rising salinity are unclear. According to the World Health Organization (2011), some Somaliland chemical exposures are below WHO guidelines and many regions have salinity levels beyond the recommended limit for human consumption.

### 2.6.3. Domestic Solid and Commercial Wastes

According to WHO in 2011 environmental health study predicted that Two Hundred Twenty-Eight tons of residential waste are taken daily from Hargeisa City, while Eighty-Seven tons remain abandoned daily. The assessment indicated that the dumpsite is in a “dire state” due to indiscriminate solid waste dumping, causing pollution of surface and groundwater.

World Health Organization (WHO) statement declared that, “Plastic bags, domestic waste, and rubbish bags with human feces and food are hanging from trees, scattered in unoccupied houses, or left on plots of land. Urine-filled plastic bottles, chemical trash, spent engine and

motor oil, petrol station spills, and abandoned automobiles indicate improper waste management. Small-scale industries like soap-making, hide-and-skin processing, water filtering, food processing, and furniture manufacturing are growing. These businesses increase solid, liquid, and chemical waste that the public encounters daily in food, water, air, and consumer products. Hospitals have biohazardous and biological waste, including disposable medical items including needles, syringes, vials, gloves, surgical dressings, and expired pharmaceuticals”.

## **2.7. Social Factors That Affect Water Supply**

### **2.7.1. Water on Social Development**

Water provides a wide variety of productive prospects; therefore, investments in water for commercial and agricultural purposes, among others, can be regarded as catalysts for expansion. Development and management of water resources can additionally safeguard societies from the destructive effects of water, such as flash floods, and provide for fundamental human needs, such as a dependable water supply. Management of water resources is therefore a prerequisite for development and inversely, an increase in national growth is contingent upon the implementation of water management systems that are both effective and efficient, (Ministry of Water Resources Development, 2019c). Researchers discovered that every country must attain water security before pursuing sustained socio-economic development. Thus, countries that are developing should prioritize strategic investments in water management, institutions, and infrastructure. Financial return models for water sector investments show that a large amount of public investment is needed to provide water security in infrastructure, regulation, and management.

In Somalia, cultural traditions and beliefs have a significant impact on water consumption and conservation. The pastoralist society puts a high value on livestock, and water is crucial for their well-being. Traditional water management practices, including seasonal migration and community water sharing, have been growing to help livestock survive in dry regions. Additionally, traditional water conservation measures, such as the building of underground storage systems known as "berkads" or "hafirs," contribute in the collection and storage of rainfall for usage during dry seasons. Community water management systems, promote fair access to water resources. Gender roles also play a role, with women and girls often responsible for collecting water.

### 2.7.2. Socioeconomic Disparities and Access to Clean Water

On a global scale, around 1.2 billion people still need clean water and 2.6 billion lack basic sanitation (WHO, 2014). In SSA, there are significant inequities among low-income groups, including rural and peri-urban inhabitants. Access to better water and sanitation is strongly linked to both a healthy and productive life and environmental sustainability (UNICEF, 2014). Poor drinking water, sanitation, and hygiene practices contribute to 6.3% of deaths globally (Emenike et al., 2017). According to OCHA in 2023, in Somalia the IDPs camps in Baidoa (Bay region), Afgooye (Shebelle region), and Dhobley (Lower Juba region), most of those newly arrived report issues with water access. They are unable to meet their basic water demands due to high costs, distance to water points, and chronic supply issues. Many households from the most affected areas are relocating to other places to get water. However, these migrations increase community disagreements and social tensions. High water expenses in most locations have led families to send children miles away to water sites supposed to have abundant water, preventing them from education. Travelling far to get water puts women and children in danger of physical and sexual abuse. Due to the enormous number of people who rely on that water, current water sources may soon run out.

### 2.7.3. Water and Sanitation

Water is scarce, typically lacks quality, and quantity, and is far from homes or settlements. Distance makes water gathering time-consuming and risky, with girls and women at risk of attacks and children experiencing respiratory issues from carrying jerry cans on their heads, causing spine compression. The UNICEF surveyed water collection duties. See following Figure for survey results which indicates that adult women, often teenage girls, have an excessive workload.

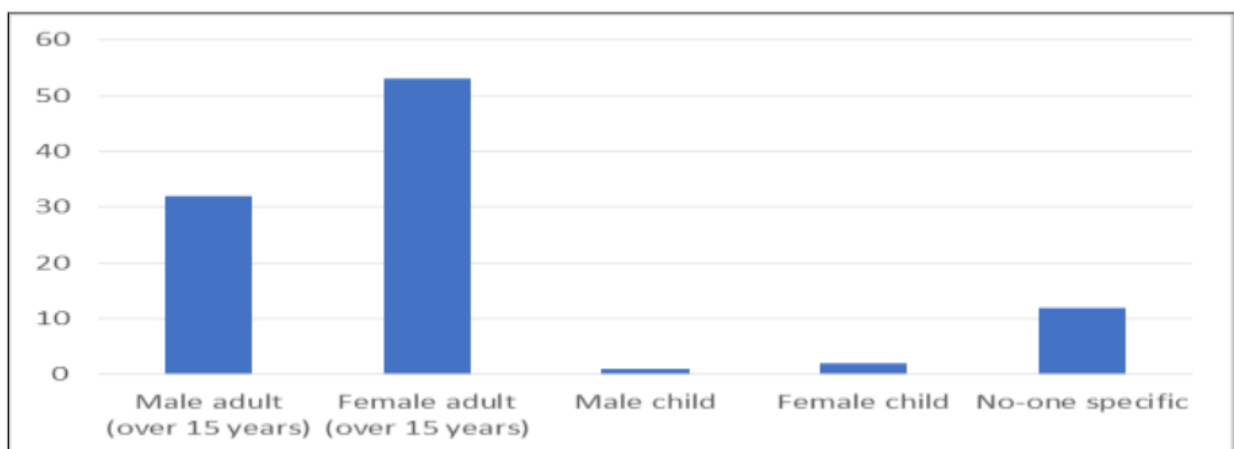


Figure 6: Gender-based duties regarding the distribution of water collection, (UNICEF KAP survey, 2015).

According to Ministry of Water Resources Development (2019), approximately 74% of Somaliland's population has access to latrines, 19% to hand washing facilities, 7% to water and soap, and 4% to water, soap, and drainage. Only a small percentage of IDPs have access to hand washing after using latrines, which is a significant source of hygiene-related disorders including diarrhoea. The poor hygiene scores may be attributed to the large nomadic population. Only 19% of households have access to hand washing facilities, highlighting the need for clean water and hygiene training in both nomadic and non-nomadic families.

## **2.8. Water Management System**

### **2.8.1. Hargeisa Water Agency Supply Operations Management**

Over 200,000 individuals in Hargeisa, the capital of Somaliland, are presently supplied with water services by HWA, a state-owned enterprise. 21,000 residential connections, 400 water kiosks, and 3 water tanker standpipes cover the water network maintained by the utility. The utility presently provides services to 30% of the urban population, notwithstanding its constrained infrastructure and storage capacity. Southern households rely on alternative water sources, which are frequently five to six times more expensive and are delivered by tankers. The majority of these connections are located in the northern half of the city, (HWA, 2019).

The HWA sources its water from 12 boreholes in Geed Deeble, situated 20 km from the city. The aquifers in this region have consistently provided the city with a dependable supply, maintaining stable produce even through the drought in 2016-2017. The borehole water is pumped to a reservoir at the Geed Deeble Pumping Station where four booster pumps push the water up a 300 m gradient to the Chinese Reservoir, Hargeisa main reservoir. The borehole pumps run for 23 hours daily and draw out an average of 50m<sup>3</sup> per hour. The overall production of water is not currently measured, but it is approximated to be 13,500 m<sup>3</sup>/day, (HWA, 2019). This exceeds the HWA figures, which rely on an estimated water volume distributed from the Chinese Reservoir.

Table 2: HWA borehole pump estimated yield, (HWA, 2019).

<b>Pump ID</b>	<b>Pump Size kW</b>	<b>Year of Installation Year</b>	<b>Estimated Potential Yield m<sup>3</sup>/hr</b>	<b>Current Pumping Hours hrs</b>	<b>Current Operating Yield m<sup>3</sup>/day</b>
K3	18.5	2000	40	23	913
K4	26.0	2005	45	Not in use	Not in use
K5	18.5	1991	52	23	1,198
K6	18.5	2003	64	23	1,477
K7A	15.0	2002	47	23	1,090
K7B	22.0	2013	63	23	1,449
K8	18.5	1991	55	23	1,263
K9	15.0	2001	34	23	778
K10	22.0	2013	63	23	1,440
K11	18.5	1999	40	23	911
K12	18.5	2003	38	23	871
K13	18.5	2012	45	Not in use	Not in use
K14	18.5	2010	45	23	1,035
K15	22.0	2010	50	23	1,151

### **2.8.2. Hargeisa Urban Water Supply Upgrading Project (HUWSUP)**

The existing transmission pipeline was constructed as part of a project funded by China in the 1970s. It comprises two parallel 300mm pipes that can deliver up to 9,000 m<sup>3</sup> of liquid to the Chinese Reservoir daily. The Hargeisa Urban Water Supply Upgrade Project (HUWSUP) is currently constructing a new 600mm pipeline to boost capacity to 25,000 m<sup>3</sup>/day funded by donors. The project includes rehabilitating the well field collector network, constructing the New Geed Deeble Pumping Station (NGDPS), and boosting water production by rehabilitating existing boreholes and drilling new ones in Geed Deeble, Las Dur, and Hora Haadley. These measures will boost HWA's water supply by 50% to reach an estimated 15,000 m<sup>3</sup> a day. The existing pipeline will be decommissioned once the HUWSUP project is finished according to the current plans. The HUWSUP project was originally planned to be launched in April 2018 but has experienced construction setbacks and it was operationalized by the end of 2019, (HWA, 2019).

However, the current water supply in Hargeisa is not adequate to fulfill the requirements of the expanding urban population. The increasing urbanization and population growth have overtaken the capacities of the water projects, even though a new pipeline have been constructed and other efforts have been taken to increase water capacity. As a result, it is of the utmost need to immediately search for other sources of water and to launch new initiatives on a wide scale in order to alleviate the critical water crisis that is now occurring in Hargeisa. Despite the fact that the current project is good, it is not capable of meeting the ever-increasing demand for water. Therefore, quick action is required in order to guarantee a sustainable water supply for the people living in the city.

Additionally, the researcher's field observation of photographs taken during the visit to the HUWSUP field site clearly shows that there has been significant improvement in the water supply infrastructure in the city. The field visit focused on demonstrating the construction and installation of newly built water distribution pipes, pumping stations, and storage facilities. The project team's dedicated efforts are evident in their rigorous attention to detail and use of modern engineering techniques. The project will have a beneficial effect on the local community, as seen by the increased availability of clean and dependable water, which is reflected in the expressions of happiness and thankfulness on the faces of people.



Figure 7: Hargeisa Urban Water Supply Upgrading Project field visit (Photo by the Author, 2024).

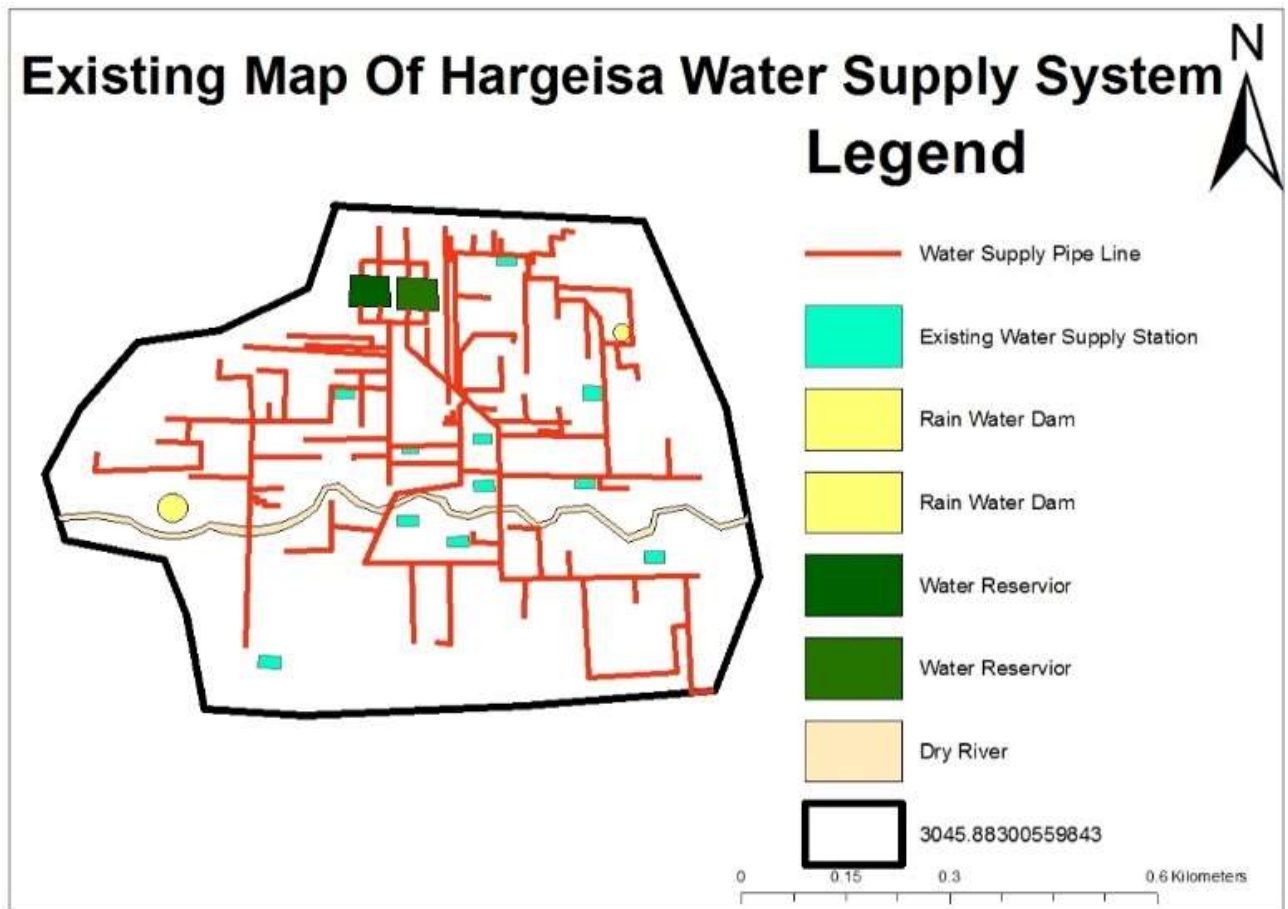


Figure 8: current design of the water supply system in Hargeisa City (Bashe, 2019).

The above layout figure shows the town's water supply system, showing serious shortcomings in the water distribution plan and pipeline network, notably in the study area and surrounding communities. The total system suffers from insufficient infrastructure, with just two water reservoirs in close proximity to one another, worsening the problem of water scarcity. Furthermore, the current layout design is out of date and does not include suitable operating and maintenance practices. Furthermore, the water station setup is inefficient, indicating flaws in the survey design. In the lack of a comprehensive water delivery infrastructure, water trucking has developed as a significant source of water during the dry season. However, the percentage of water provided by pipeline remains tiny in comparison to total water demand. Insufficient water reservoirs within the water supply agency increase the issues, adding to a citywide lack of suitable water storage capacity.

### **2.8.3. Private Water Vendors**

In several cities in Somaliland, the main source of water is a system where water is delivered by tankers. These trucks are usually filled from privately or publicly operated boreholes or shallow wells situated very far away from the towns. Tankers' role in transporting water to urban and rural Somaliland is essential, particularly for future water supply for large parts of the population. Tanker water is used by a greater number of households than water utility providers' supply and distribution systems. However, it is crucial to recognize that water tankers, while necessary for water delivery, may sometimes result in higher price rates. As an example, the Joint Committee for Private Water Associations states that increasing fuel prices leads to elevated expenses for water, which are then transferred to customers. The correlation between petrol prices and water costs underscores the complex economic factors involved in water delivery. It could be important to evaluate the potential effects of these price hikes on the accessibility and affordability of water, particularly for marginalized people. On the other hand, Donkey carts are used alongside water tankers for water distribution in Somaliland, particularly in urban areas. These humble modes of transportation serve a crucial role in maintaining the availability of water to nearby areas. Donkey carts are highly esteemed for their capacity to navigate through small streets and access locations that bigger vehicles may not be able to reach.



Figure 9: Tanker and donkey car vendors (Photo by the Author, 2024).

## 2.9. Water Related Policies and Acts

The National Water Act 2011 (NWA) and the Somaliland Food and Water Security Strategy 2011 (FSWS) are two national documents that are seen to be particularly significant for the creation of the Water Resource Management and Investment Plan (WRMIP). Both emphasize the availability of water for irrigation, livestock, fisheries, and urban and rural populations. Both fail to account for the possibility of various forms and degrees of industrial growth and as a result, they do not support the advancements outlined in the NDPII aims, which aim to improve trade balance and increase income. Somaliland's growth is reliant on the environment and the climate since the region prioritizes subsistence based only on agriculture, livestock or fishery, completely excluding industrial development, including extraction, (MWRD, 2019).

### **2.9.1. Draft Water Regulations for Water Act Enforcement in Somaliland**

As review analysis of water regulations in the Republic of Somaliland, specifically the draft regulations dated December 2005 is reviewed. This review aims to evaluate the effectiveness of these regulations in managing water resources, promoting equitable access, and ensuring sustainable water management practices. The review begins by analyzing the Water Right Regulations (Regulation I), which outline the registration procedure for water rights, numbering of water rights, advertisement of water right claims, updating of water rights, and provisions for cancellation and compensation. The regulations also address water rights for livestock and agriculture, as well as obligations related to motorization and registration. Next, the Abstraction Permit Regulations (Regulation II) are examined, focusing on the determination of abstraction capacity, the permit procedure, updating of permits, granting criteria, restrictions, suspensions, expropriation, cancellation, and abstraction fees. The Threshold Capacity and Abstraction Fees are also discussed. Ownership Regulations (Regulation III) are reviewed, including the divestiture agreement template, handover agreement for non-public water infrastructures, and rules for depreciation principles. The Public Water Supply Regulations (Regulation IV) are analyzed, encompassing operating contracts, lease fees, technical standards for public water supply, and the establishment of Water Management Units. The review also includes an examination of the Drilling Regulations (Regulation V), addressing drilling reports and protection areas, as well as the Water Quality Regulation (Regulation VI), focusing on quality standards for water intended for human consumption and compensation for unsafe water provision.

Lastly, the Water Tariff Regulations (Regulation VII) are reviewed, covering the water tariff structure for customers, and the penalty and fine schedules provided in the annexes.

### **2.9.2. Somaliland National Water Policy**

The Somaliland National Water Policy, approved in June 2004, outlines a comprehensive framework for the management and development of water resources in Somaliland. The policy recognizes the need for a holistic approach to water management and the importance of considering water as an economic good. It acknowledges the role of self-organized community groups and emphasizes the involvement of women in decision-making processes. The policy sets objectives and principles for the water sector, including ensuring access to safe and reliable water supply, promoting integrated water resource management, and enhancing institutional capacity. It identifies priorities such as improving domestic water supply, managing surface water resources, and building capacity through training and

education. The policy outlines the powers and responsibilities of the Ministry of Water and Mineral Resources, including planning, investment, and supervision of water projects. It also highlights the importance of coordination among various actors in the water sector, including central ministries, line ministries, international agencies, and local water authorities. The policy addresses the issue of unclear ownership of water infrastructure and emphasizes the need for effective policy implementation, monitoring, and decentralization. It discusses the goals of the tariff policy, aiming to ensure affordable water services while covering the costs of service provision.

### **2.10. Management of Water Tariffs**

The management of water supply systems in both urban and rural parts of the country is carried out by a range of approaches, such as public-private partnerships, community management, public management, and individual management. The Ministry of Water Resources Development is responsible for the general administration of these systems, while the Ministry of Water Resources maintains regional offices and representatives in certain cities. The majority of rural water supplies are overseen by the community, employing local personnel who are not subject to the Ministry's oversight. Out of the six major cities, five have water supplies that are controlled by water agencies accountable to the Ministry of Water Resources Development. Borama has a water supply administered through a collaboration between the public-private partnership, while Lughaya has a different system also including public-private partnerships (PPP). The efficient functioning and administration of pumped water sources are hindered by the limited use of these supplies by the whole population of a settlement or town just during the dry season. During the rainy season, people collect free water from protected and unsafeguarded shallow wells. The price of a jerry can of water fluctuates, ranging from 300 to 2500 SLS. The cost tends to be greater during the dry season and in locations where water has to be delivered across long distances. The mean price for one cubic meter of water is USD 12.5, but in Hargeisa, it is USD 1.2 per drum or USD 5 per cubic meter, (MWRD and HWA, 2019).

## CHAPTER THREE: METHODOLOGY

### 3.1. Study Area

The British Somaliland Protectorate became independent on June 26, 1960, and was the first Somali country to become a member of the United Nations. A week later, Somaliland and Somalia Italian united to form the Somali Republic. Their union was never ratified by their respective Parliaments, and their 65-year-old union remained an informal partnership with no legal binding. Consequently, the initially hopeful union of the two young countries ended in disaster and culminated in a brutal ten-year civil war between Somalia and Somaliland until they separated in 1991 (SCPD, 2009). Now, Somaliland is a self-declared independent country located in the Horn of Africa.

Hargeisa, the capital city Somaliland, is the focus area of the current study (Figure 12). The population of Hargeisa is 1.2 million people, accounting for nearly one-quarter of Somaliland's overall population, according to (MNPD, 2021). However, based on rural-urban migration and the city's overall expansion, everyone believes the current population exceeds 1.5 million. Hargeisa has nine major districts (Ahmed Dhagah, Ga'an Libah, Mohamoud Haybe, Mohamed Mooge, Ibrahim Kodbour, 26 June, 31 May, Mo'alin Harun, and the recently founded district of Ga'ma Dhere), (Hargeisa local government, 2023). For the study in the city of Hargeisa, two major sub-cities/districts (Ahmed Dhagah, 26 June) have been selected within the city for their water supply and distribution.

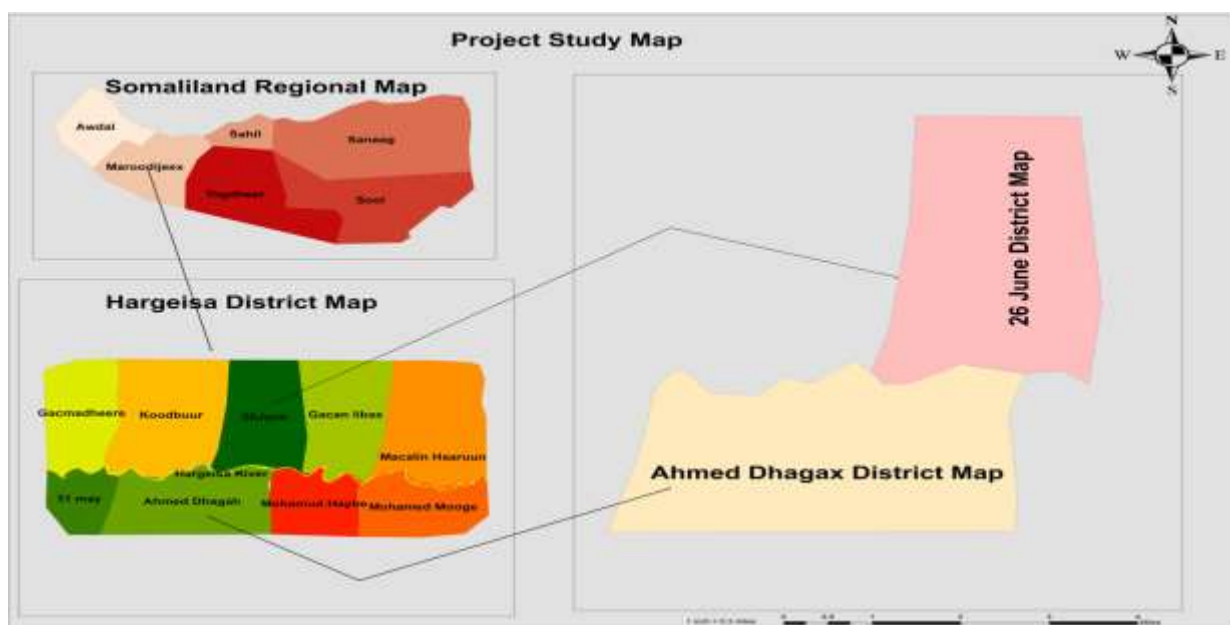


Figure 10: Map of the Study Area.

Ahmed Dhagah is one of the oldest districts in Hargeisa. The district is not covered by municipal water or HWA but water is sold in tankers by private water truckers and donkey cars. In the absence of connected pipes, some of the residents of the district have drilled boreholes for domestic water use. Some part of the district is connected to HWA’s pipe water but the majority of the households still depend on hand-dug wells and private bono for domestic purposes.

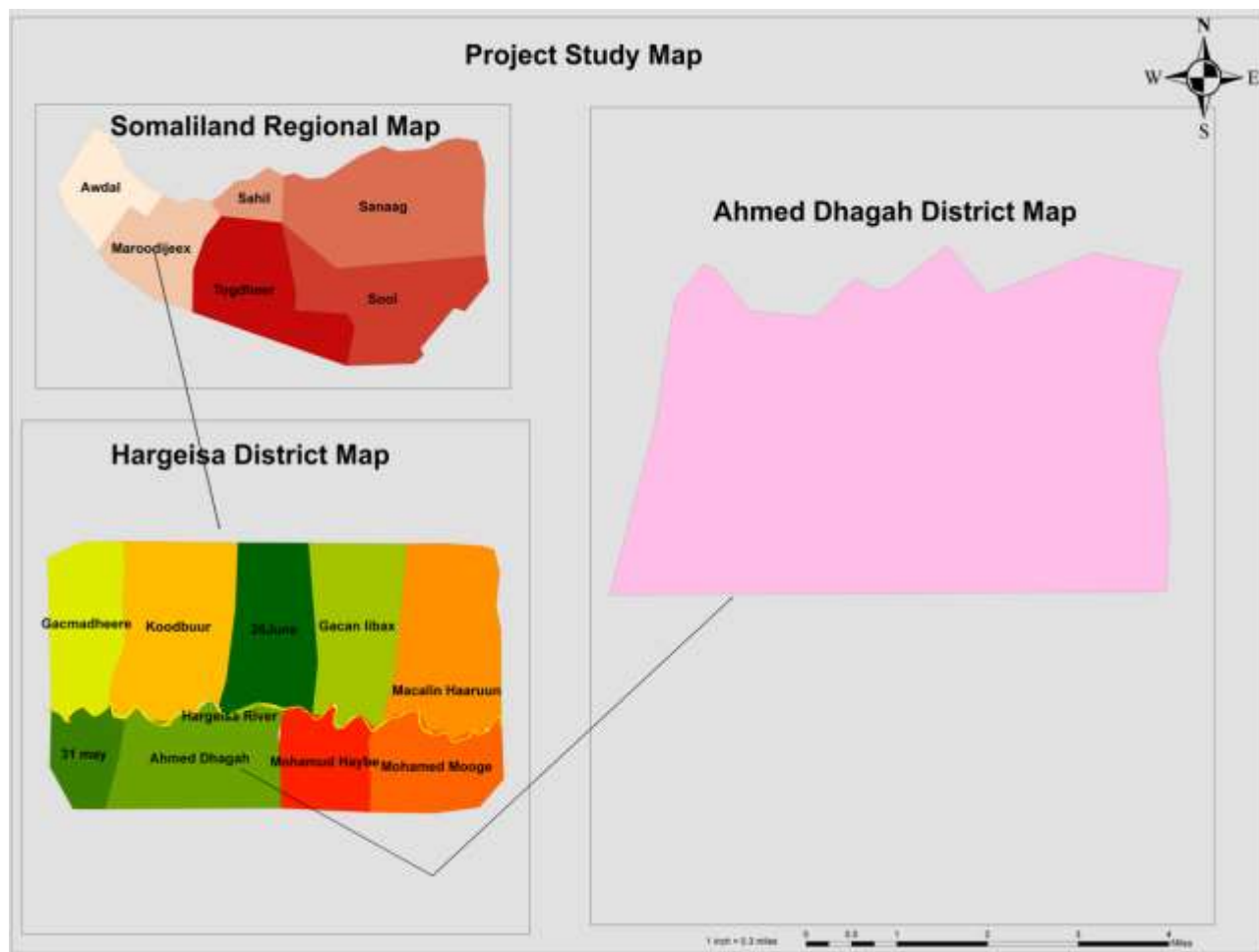


Figure 11: Map of Ahmed Dhagah District.

The 26 June is also one of the oldest sub-cities in Hargeisa. According to the Hargeisa local government in 2021 the district has 21,997 households. Most of the 26 June district households rely on the HWA as their primary source of drinking water. The HWA plays a crucial role in providing clean and safe water to the residents of this district. However, it is noteworthy that the 26 June district stands out as the only district that receives its water supply directly from the agency. This district has a comprehensive infrastructure in place, ensuring that every house within its boundaries is connected to a tap for easy access to water.

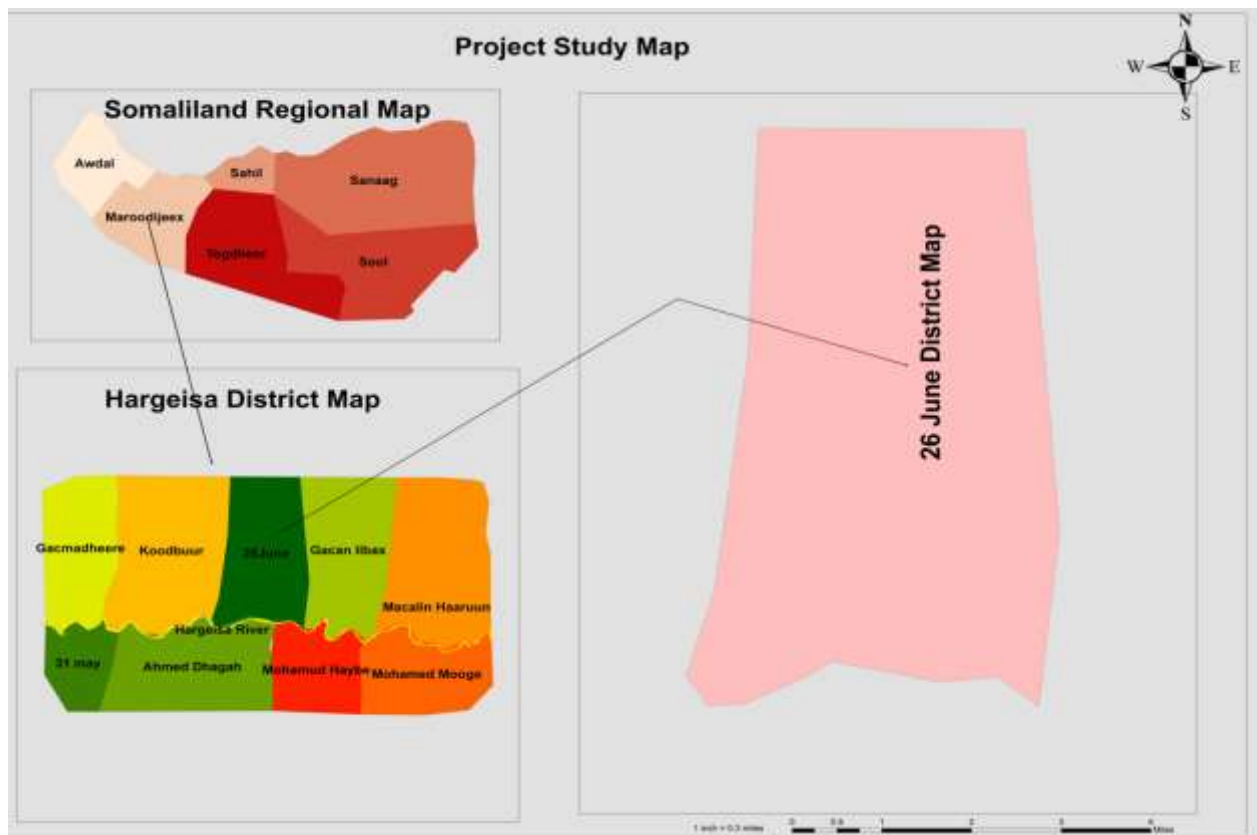


Figure 12: Map of 26 June District.

Hargeisa is characterized by a semi-arid climate, with winters that are typically warm and summers that are typically hot. However, despite its location in the tropics, Hargeisa frequently experiences weather that is neither extremely hot nor extremely cold. This is because of the high altitude at which it is situated. This is a characteristic that is not frequently observed in areas that have climates that are classified as semi-arid. The city receives an average of 500 millimeters of precipitation yearly, with the majority of its precipitation falling between April and September. Temperatures in Hargeisa range from 18 degrees Celsius (64°F) in December and January to 24 degrees Celsius (75°F) in June, according to Haas (2019). Dozens of springs have been identified and exploited in Somaliland, where they are more common in karst aquifers. Most people in Somaliland get their drinking water from aquifers, although poor quality water often means that boreholes go abandoned. The Eocene Karkar Limestone, Auradu Limestone and Taalex Limestone are important karstic aquifers in Somaliland and Puntland, along with thick, unconsolidated sediment aquifers up to 100 meters thick formed in the past 2.5 million years of the

Quaternary in wadi locations throughout the county. Fractured Pleistocene basalt flows, particularly near Las Dhure and Agabar have potential as aquifers. The Yesomma Sandstone is a high-productivity aquifer.

### **3.2. Research Design**

This study employed both quantitative and qualitative approaches (mixed approach) in presenting the primary and secondary data that are relevant and significant to the study. Because the mixed approach coped more information required for the study in analyzing numeric data and non-numeric data precisely. Therefore, quantitative and qualitative research approaches were proposed as very useful for this study to use questionnaires, structured interviews, and field observation to achieve the mentioned specific objectives. In the study, the quantitative approach was used to gather full data that related to numeric form through questionnaires to collect data from all respondents of households of selected two villages (Siinay and Goljanno) from the two districts (Ahmed Dhagah and 26 June) and the qualitative approach was used to express the data from experiences and opinions of Government officials and private water truckers in Hargeisa city.

The conceptual framework of this study is shown in Figure 13. This conceptual framework analyzes the interconnected components and correlation between urbanization and water provision in Hargeisa City. It considers the economic, environmental, and social aspects that are key components. Water demand, quality, and infrastructure finance are influenced by economic factors including income levels, investment activity, and economic policies. Environmental issues such as climate change, pollution, and the availability of water resources have an impact on the sources, quality, and availability of water. Population increase, urban migration, and socio-cultural practices influence water demand, consumption patterns, and the water demands of communities. The water management system, including infrastructure, policy, and community interaction, influences the allocation, quality, and conservation of water.

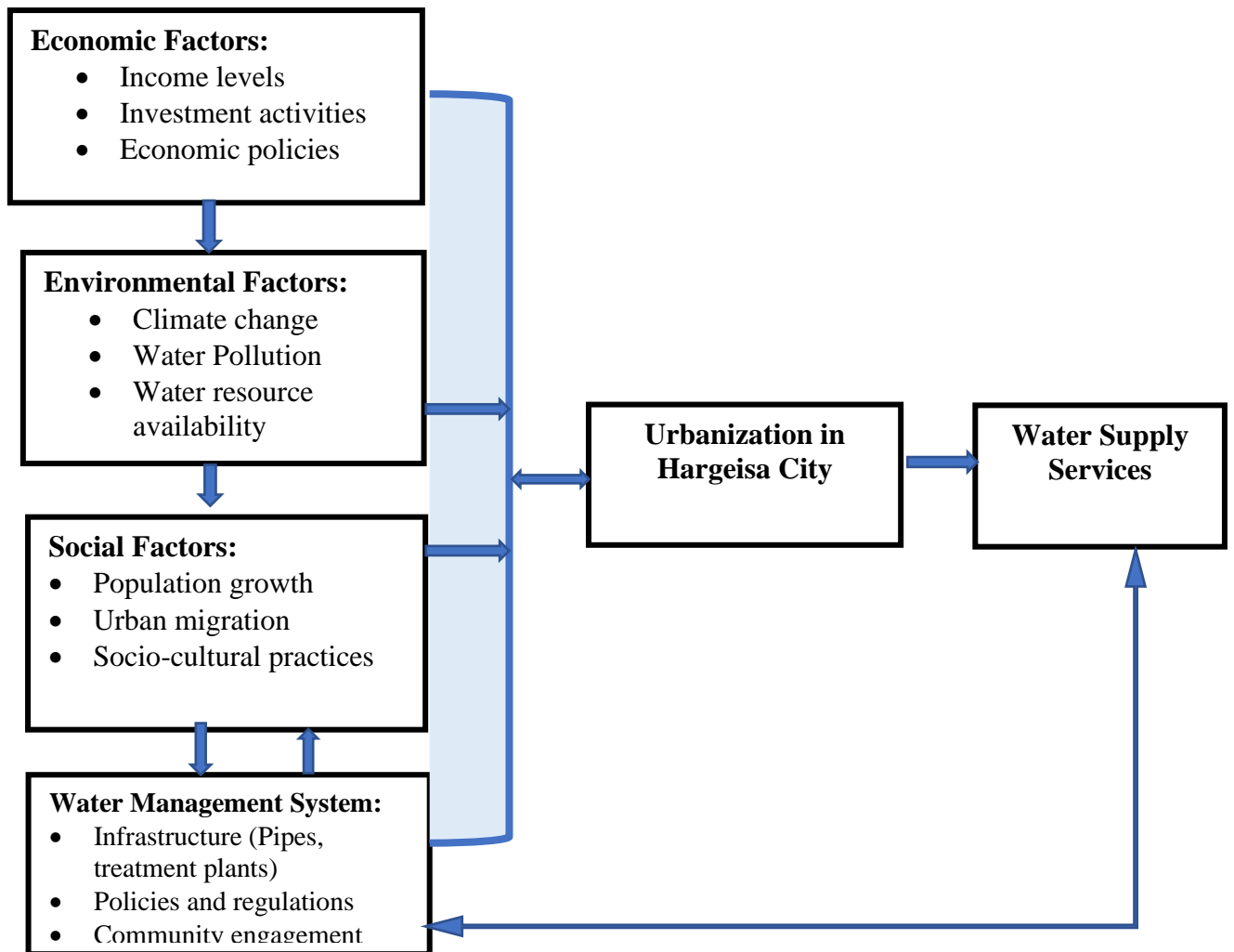


Figure 13: Conceptual Framework.

### 3.3. Methods of Data Collection

The researcher used quantitative data which is gathered from questionnaire methods of data collection; however, to support the quantitative assertion the study was supplemented by qualitative data generated from the structured interview and observation methods of data collection.

#### 3.3.1. Primary

Primary data was collected through various methods including questionnaire, structure interview, and field observation.

The questionnaires were administered to gather reliable data and information from the residents which couldn't be obtained through interviews and document review which related to how they are serviced. A total of 198 questionnaires were prepared in the form of close-ended form. The questionnaires have the benefit of reaching large areas simply and speedily.

In the study, the English version of the questionnaires was translated into the local language, and they were distributed to all selected respondents from two preferred districts' households to get sufficient and unbiased responses from these stakeholders regarding their opinions about the challenges and the effects of urbanization on water supply system in the city. Closed-ended questions were largely used to formulate easy data analysis and the fact that the majority of the target population was illiterate and needed easy translation. Finally, to facilitate completing questionnaires with ease hence the format adopted.

Structured interviews were conducted with the senior government officials of the water supply sector and the officials of the private water truckers' companies in Hargeisa city. Since, they are key informants and most involved in the process or have knowledge about the issue of the water supply and it's affecting factors. Regarding their responsibilities, through structured and unstructured interviews guide were employed. The structured interview guides were used as a base for having pre-defined questions to immediately start interviews to the key informants and unstructured interview will be enabled to follow up unclear responses from respondents to collect utmost information who have firsthand information about the effects of urbanization and associated factors on the water supply system.

The field observation was conducted to appreciate the trends of the outward water supply issues. It was done during the period of data collection. The study areas observed from urbanization levels, such as areas with high population density; water sources and water supply infrastructure, such as boreholes/wells, and the condition of pipelines, treatment plants, and reservoirs or storage facilities, in terms of the households, workplaces and all environment conditions in the city supported by checklists and photos.

### **3.3.2. Secondary**

The researcher was engaged gathered secondary data sources from the national, and regional governments, city and district administration documents, reports, different books, published and unpublished papers and journals on the urbanization effects on water supply systems and related factors such as; economics, environments and social aspects.

## **3.4. Sample Techniques and Sample Size Determination**

### **3.4.1. Target Population**

Due to the high number of the population in the city, as well as the cost and time constraints, the researcher selected two districts in Hargeisa city. Nine sub-cities make up Hargeisa City; however, the research concentrated on two of the most important sub-cities or districts, named Ahmed Dhagah and 26 June. The total number of households that were elected to be

part of the target population in the districts of 26 June and Ahmed Dhagah was 40,743, as stated by the Hargeisa Municipality in 2021. The districts are clustered for thirteen (13) villages, which are as follows: Goljanno, Cayngal, Durriya, Almis, Waaheen, and Idaacadda for the 26 June district; and Siinay, Ahmed Guray, Half London, Badhka, Akara, October, and Masalaha for the Ahmed Dhagah district (Appendix 5). This study focuses on two villages: one village was chosen from the district of 26 June, which is called Goljanno, and the second village was chosen from the district of Ahmed Dhagah, which is called Siinay. These areas are more significant to the researcher to classify the major factors behind the scarcity of water in the city and to witness the water supply issues in Hargeisa City.

### **3.4.2. Procedure of Sampling**

To ensure the reliability of the study, the researcher selected and implemented a sampling procedure from a variety of respondents, with a particular focus on the target areas from where the study was conducted. The potential sources of data and information include government officials, private water providers, and individuals who are part of the household in the research areas. Procedures of sampling is shown in **Appendix 6**.

### **3.4.4. Sample Size Determination**

The sample size was computed by employing the following strategies to determine the sample. The researcher selected 7,650 households from Ahmed Dhagah and 26 June Villages, in Hargeisa, to represent the target population of 40,743 households in the Ahmed Dhagah and 26 June districts. The Yamane formula specifies that when the target population is listed below 10,000, the following formula is applied to figure out the necessary sample size from the target population (Eq. 1):

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

Where, n= required sample size, N= the total number of households in the villages of Ahmed Dhagah and 26 June districts e= Error/Precision Degree – 7% = 0.07

Therefore, the researcher adopted a confidence level of 93%, which refers to e= 7% = 0.07 and N= 7,650, which gives a total value of n=198 household respondent in (table 3).

Table 3: Sample size of households in Ahmed Dhagah and 26 June districts, government institutions, and private water trucks.

<b>Sampling location</b>	<b>Total number population</b>	<b>Total sample size</b>
Siinay-village	3350	87
Goljanno-village	4300	111
Hargeisa water agency	3	2
Ministry of water resources	3	1
Private water trucks	3	2
<b>Total</b>	<b>7659</b>	<b>203</b>

### **3.5. Data Analysis**

After data collection, questionnaires were examined for errors and put into SPSS Version 26 for processing. Upon data processing, answers were classified and numbers for analysis. Percentages, averages, frequencies, and standard deviations were employed for quantitative data analysis. The analysis comprised descriptive and inferential statistics including frequency tables and graphs. Descriptive statistics using frequency, percentage was subjected to assess the effects of Urbanization on water supply system. In identifying the socio-economic factors affecting water supply, Pearson correlation between variables related to household income, water service sources, and associated costs was used to find the correlation of variables. The significance of the coefficient (p) was used to test the hypothesis by comparing p to the critical significance level at (0.05).

### **3.6. Ethical Consideration**

In this study data collection was started by taking an endorsement letter from the PAUWES, clarifying the purpose of the study as it is for the sake of education only to whom it may concern including respondents and the respondents did not be asked to write their names. Efforts were made to ensure confidentiality and mitigate any possible conflicts of interest. Moreover, the paper must be free from plagiarism. The researcher kept any secrets confidential. Permission was also obtained from HWA for carrying out this research.

## **CHAPTER FOUR: FINDINGS AND DISCUSSIONS**

### **4.1. Demographic Description and Response Rate of Respondent**

During the process of data collection, careful efforts were made to ensure the acquisition of high-quality and reliable data for this study. A total of 198 households were selected from the study villages to gather information from the target population under study, specifically focusing on households residing in the two districts (Ahmed Dhagah and 26 June) of Hargeisa city.

The distribution of the 198 questionnaires was conducted in a systematic manner, employing appropriate sampling techniques to ensure representativeness of the target population. The questionnaires were handed out to eligible respondents, who were selected based on predetermined criteria to ensure the study's objectives were effectively addressed. Out of the 198 questionnaires distributed, an impressive response rate was achieved, with 191 questionnaires being returned by the diligent and cooperative respondents. This high response rate is indicative of the participants' willingness to contribute to the study and their recognition of its significance. However, it is important to acknowledge that seven questionnaires were not returned due to the unavailability and discarded of responsible individuals within those households. Despite this small proportion of non-responses, the overall response rate (96%) remains commendable and does not significantly undermine the validity and reliability of the collected data.

In addition to the questionnaire-based data collection, interviews were conducted with a selected group of government and private water supplier officials. The purpose of these interviews was to gain insights from key stakeholders and obtain a deeper understanding of the research topic. A total of seven officials were identified and approached for interviews, out of which five interviews were successfully conducted. Considering the robustness of the data collected through the questionnaires and interviews, it can be confidently stated that the information obtained is sufficient and valid for the subsequent analysis of the study.

The demographic results provide a comprehensive understanding of the background characteristics of the respondents participating in the study. The distribution of gender, age, marital status, education level, occupation, income level, and household size demonstrate the diversity within the sample population and serves as a foundation for the study. The results of the demographic characteristics are summarized in Table 4.

Table 4: Background information of the respondents.

Description	Category	Respondents	
		Frequency (n)	Percentage
1. Sex	Male	53	28
	Female	138	72
2. Age	18 – 25 years	34	18
	26 – 35 years	53	28
	36 – 45 years	70	37
	45 and above years	34	17
3. Marital status	Single	46	2
	Married	134	70
	Divorced	11	6
4. Level of education	Illiterate	72	38
	Primary/secondary	80	42
	Bachelor degree	25	13
	Master degree	14	7
5. Occupation	Housewife	95	50
	Daily labor/Employee	64	34
	Business owner	14	7
	Unemployed	18	9
6. Income level	< \$200-400	19	10
	\$400-600	106	55
	\$600 above	66	35
7. Household size	2-4	18	9
	4-8	100	52
	8-12	61	32
	12 and above	12	7

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In line with Table 4, most (72%) of the sample respondents were female, while a minor (28%) proportion of sample respondents were male. This could be due to the traditional gender roles in which women primarily assume the responsibilities of childcare and household management. However, it is noteworthy that both genders actively participated in the survey.

In the age distribution of the respondents revealed variations across different age groups, shedding light on the age composition within the sample. The majority of respondents fell within the age range of 26-45 years, with 53 (28%) and 70 (37%) respondents between 26-35 and 36-45 years, respectively. Additionally, 34 (18%) respondents were in the 18-25 years age group, while 34 (17%) respondents were 45 years and above (Table 4). This age distribution suggests a relatively balanced representation of different age cohorts within the sample, enabling a comprehensive examination of perspectives across various life stages.

The respondents' marital status exhibited diversity, with three distinct categories: Single, Married, and Divorced. Among the respondents, 46 (24%) were single, indicating a significant proportion of unmarried individuals within the sample. The majority (n=134, 70%) of respondents were married, suggesting a higher representation of married individuals, potentially reflecting the prevalence of marriage within the target population. A smaller (n=11, 6%) percentage of respondents were divorced, indicating a relatively lower frequency of divorced individuals, possibly indicating the stability of marital unions within the study's context.

The educational attainment of the respondents showcased variations across different levels, providing insights into the educational backgrounds within the sample. The largest (n=72, 38%) group respondents who were categorized as illiterate, indicating a significant proportion of individuals lacking formal education. A substantial (42%) proportion had a primary or secondary level of education, potentially reflecting the occurrence of basic education within the target population. Furthermore, 25 (13%) respondents held a bachelor's degree, while 14 (7%) respondents possessed a master's degree, suggesting a smaller but notable presence of individuals with higher education qualifications within the sample. The obtained findings brightened the varied educational backgrounds of the respondents, thereby providing a comprehensive insight into the educational landscape within the specific context

of the study. According to the Somalia National Bureau of Statistics data in the year 2022, it has been reported that the adult literacy rate in Somalia stood at 41%. This statistic indicates the proportion of adults within the population who possess the basic reading, writing, and numeracy skills necessary to effectively participate in various aspects of daily life, including education, employment, and civic engagement. The figure of 41% suggests that a significant portion of the adult population in Somalia still faces challenges in acquiring essential literacy skills, which can have far-reaching implications for socio-economic development, including hindered opportunities for personal growth, limited access to information, and reduced capacity for active participation in the social and economic spheres.

The distribution of occupations among the respondents provided insights into their employment status and professional roles, contributing to a comprehensive understanding of the workforce composition within the sample. The largest (50%) occupational group represented in the sample was housewives. Additionally, 64 (34%) respondents were engaged in daily labour or employed in various sectors, indicating a significant presence of working individuals, potentially representing the broader occupational landscape of the target population. A smaller (7%) were business owners, suggesting entrepreneurial involvement within the sample. Lastly, 18 (9%) respondents were unemployed, indicating a relatively lower representation of individuals currently without employment, potentially reflecting the economic conditions within the study's context.

In line with the occupational status of the respondents, the employment rate in Somalia was estimated to be 27.5% in the year 2022. Subsequently, an analysis of the data reveals a consistent downward trend in the employment rate over the period spanning 2008 to 2022, with an average annual decline of 0.2%. It is important to note, however, that before this period, the employment rate exhibited a marginal increase from 28.2% in 2005 to 28.2% in 2008, (World Data Atlas, 2022). On the other hand, the data indicates that the majority (73%) of the Somali population currently faces unemployment. This alarming statistic underscores the severity of the unemployment crisis in Somalia. The income levels of the respondents showcased variations in their financial situations, providing insights into the economic landscape within the sample. Among the respondents, 19 (10%) had an income level below \$200-400, indicating a proportion of individuals with lower income, potentially representing a segment of the population facing financial challenges. The majority (55%) of respondents fell within the income range of \$400-600, reflecting a significant portion of respondents with moderate income levels, suggesting a sizable middle-income group within the target population. Furthermore, 66 (35%) respondents reported an income of \$600 and

above, signifying a relatively higher income bracket within the sample, potentially representing individuals with greater financial resources.

The distribution of household sizes among the respondents indicated variations in family compositions, offering insights into the structure of domestic units within the sample. Among the respondents, 100 (52%) had a household size of 4-8 members, implying a significant representation of moderate-sized families within the target population. A substantial amount, 61 (32%), had a household size of 8-12 members, reflecting a considerable presence of larger families within the sample. Additionally, 18 (9%) respondents had a household size of 2-4 members, suggesting a smaller family structure in the study's context. Lastly, 12 (7%) respondents had a household size of 12 members and above, indicating a minority of respondents with extended family arrangements.

#### **4.2. Economic Factors that Affect Water Supply in Hargeisa City**

Under this objective the research finds to examine the economic factors that affect the water supply in Hargeisa city directly or indirectly related to water supply in the city. Main source of water service, pipeline connection to households, average monthly cost of piped tap, utilization private water suppliers such as water trucks or donkey carts, water supply availability, changes in water prices, and how economic condition of households affects access to water supply were investigated under this objective.

Furthermore, significant attention was dedicated to the expertise of senior government officials and private water vendors with regards to sharing their knowledge pertaining to the urban water supply system in the city of Hargeisa, as well as its related factors.

##### **4.2.1. Water Sources, Storage, and Pipeline Connection**

Figure 14-a, presents data on the primary sources of water service for households which are categorized as Government (HWA) and others sources such as hand dug well, rainwater harvest, water tucks, and donkey cars.

The findings reveal that a majority (n=108=57%) of the surveyed households rely on the HWA as their main water service provider. The HWA is a government-operated institution tasked with the provision of water to the residents. The HWA was established in 1974 to operate the newly constructed bulk water supply which was built by the Chinese. It is an independent water supply utility that is mandated with the supply of water for the city of Hargeisa. The HWA enjoys fiscal and administrative autonomy. Current, it has permanent staff of 329, which is 100% paid by agency from its own income, (HWA, 2024).

It was also identified that 43% (83 households) of respondents depend on alternative sources

for their water supply. These alternative sources encompass diverse means such as hand dug wells, rainwater harvesting, water trucks, and donkey cars. Hand dug wells refer to manually excavated wells, whereas rainwater harvesting involves collecting and utilizing rainwater. Water trucks deliver water to households, and donkey cars are also used for water transportation in Hargeisa City. The prevalence of these alternative sources shows that a considerable number of households in the survey rely on decentralized or self-sustained approaches to meet their water needs.

(Figure 14-b) shows that the capacity of water storage tanks employed by households. Results indicated that nearly half (~50%) of the surveyed households possess water storage tanks with a capacity below 10 m<sup>3</sup>. This finding shows that a significant portion of households rely on relatively smaller storage tanks, which may necessitate more frequent refilling or indicate constraints in terms of water storage capacity. In contrast, approximately 41% of the surveyed households possess water storage tanks with a capacity of 10-20 m<sup>3</sup>. Moreover, 11% of the surveyed households possess water storage tanks with a capacity exceeding 20 cubic meters. These larger water storage tanks signify that a minority of households can store a significant volume of water, potentially affording them extended periods of self-sufficiency. Additionally, it is worth noting that some of these households also maintain indoor farms that require irrigation, further emphasizing the importance of their substantial water storage capacity.

Figure 14 c-d, provides insights into the presence of residential pipelines and the average monthly cost of piped tap water. The first question (Figure 14-c) examined whether respondents had a pipeline connected to their residences or not. The results revealed that a majority (58%=110 individuals) of respondents, reported the presence of a pipeline, indicating that a significant portion of the population in the surveyed area has access to piped water services. Conversely, 42% (81 individuals) reported the absence of a residential pipeline, suggesting that a considerable portion of the population relies on alternative water sources or delivery methods.

Moving on to the second question (Figure 14-d), which focused on the average monthly cost of piped tap water, respondents were provided with different cost categories. The findings indicated that a substantial (41%) proportion of respondents with a residential pipeline reported an average monthly cost of less than \$20. This suggests that a significant number of households have relatively affordable access to piped tap water. Additionally, 11% respondents mentioned a cost ranging between \$20 and \$35, indicating a slightly higher expenditure for a smaller segment of the population. A smaller (5%) proportion of

respondents also reported a cost exceeding \$35. Notably, a significant proportion of respondents, constituting 44% (84 individuals), reported no cost associated with piped tap water, which indicates that they do not receive running water supply services from the government.

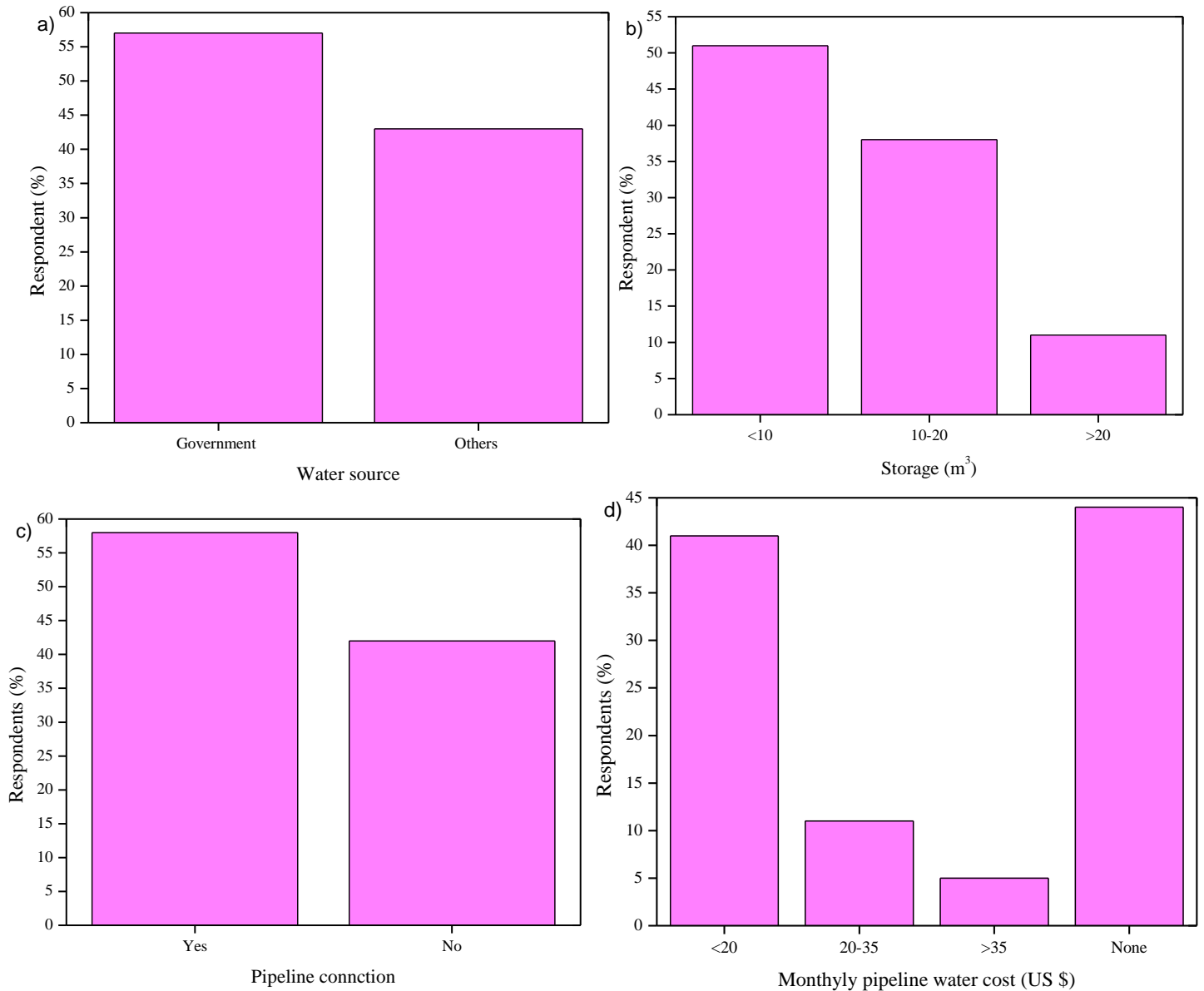


Figure 14: Economic related issues on water (a) main source of water, (b) storage of water, (c) pipeline connection of household, and (d) monthly cost of tap water from pipelines.

#### 4.2.2. Utilizing Private Water Suppliers and Average Monthly Cost

Table 5: Utilizing private water suppliers and average monthly cost.

No	Description	Category	Frequency	Percentage
1.	Do you utilize private water suppliers such as water trucks (booyadle), or donkey cars (biyoole) for your household?	Yes	95	49
		No	96	51
2.	If yes, what is your average monthly cost for private water providers?	< \$20	14	7
		\$20-35	57	30
		\$35-50 and above	24	13
		None	96	50

Table 5 studies the utilization of private water suppliers, such as water trucks or donkey cars, by respondents to get water service. The data exposed that nearly half (49%) of the respondents reported that they are getting water using private water suppliers. This suggests that a considerable portion of the population relies on alternative sources for their water needs, potentially due to the limited availability or reliability of the piped water supply.

Regarding the average monthly cost of private water suppliers (Table 5), the findings indicate some variability in expenditure patterns. A small (7%) proportion of respondents reported a cost below \$20, suggesting that a minority of households can access private water suppliers at a relatively lower cost. In contrast, a larger (30%) segment of respondents indicated a cost ranging between \$20 and \$35, indicating a relatively higher expenditure for a significant portion of the population. Moreover, 13% (24 individuals) respondents mentioned that costs exceeding \$35, suggesting that a minority of households face higher expenses for securing their water supply. It is worth noting that the majority (50%) of respondents, reported no cost associated with private water suppliers, which implies that they do not utilize such services and have alternative arrangements from the government (HWA) for water provision.

#### 4.2.3. Availability Rate of Water and Supply Services Cost

Table 6: Rate of availability of water in and cost of the current water supply services.

No	Description	Category	Frequency	Percentage
1.	How would you rate the availability of water supply in Hargeisa city?	Good	36	18
		Average	93	48
		Poor	62	34

2.	Are you satisfied with the current water supply services in terms of the cost?	Satisfied	21	11
		Neutral	76	40
		Dissatisfied	94	49

The Table 6 explores respondents' perceptions of water supply availability in Hargeisa city. The data discovered that a relatively small (18%) proportion of respondents rated the availability of water supply as good. This suggests that a minority of individuals in the surveyed area perceive the water supply to be consistently reliable and sufficient for their needs. In contrast, the majority of respondents, 48% (93 individuals), perceived the water supply availability as average, indicating a perception of moderate adequacy or occasional fluctuations in water availability. Furthermore, 34% (62 individuals) of respondents regarded the water supply availability as poor, highlighting a significant segment of the population that perceives the water supply as inadequate or unreliable.

The second question in Table 6 also examined respondents' satisfaction levels with the current water supply services, specifically in terms of cost. The findings indicated that a relatively small (11%) part of respondents, expressed satisfaction with the cost-related aspects of water supply services. This suggests that a minority of individuals in the surveyed area find the cost associated with accessing water supply services to be reasonable or affordable. In comparison, 40% (76 individuals) of respondents indicated a neutral stance, suggesting that a significant portion of the population does not strongly agree or disagree with the cost-related aspects of water supply services. The majority (49%) of respondents expressed dissatisfaction with the cost-related aspects of water supply services, indicating that a considerable segment of the population finds the cost of accessing water supply to be burdensome or unaffordable.

Regarding the characterization of these changes in water prices, the majority of respondents, 54% (103 individuals), perceived a significant increase in water prices. This indicates that the rising costs of water have been widely recognized by a significant segment of the population. In contrast, 46% (88 individuals), noticed a slight increase in water prices. This suggests that a notable portion of the population perceives a more moderate or subtle increase in water costs. These findings highlighted the impact of changing water prices on the perceptions and experiences of individuals in the surveyed area.

#### 4.2.4. Influences of Household Economic Conditions on Access to Water Supply

Table 7 shows influence of household economic conditions on access to water supply. The data revealed that a smaller (33%) proportion of respondents strongly agreed with the notion that household economic conditions significantly affect access to water supply. This suggests that a minority of individuals firmly believe that financial constraints or economic circumstances play a crucial role in determining their ability to access water services. In contrast, the majority (67%) of respondents agreed a broader recognition that household economic conditions do have an impact on water access, albeit to varying degrees.

Table 7: Household economic conditions on access to water supply.

No	Description	Category	Frequency	Percentage
1.	Have you noticed any changes in water prices in Hargeisa City in the past year?	Yes	191	100
		No	0	0
2.	If yes, how would you describe the changes in water prices?	Significant increase	103	54
		Slightly increase	88	46
3.	Do you think the economic condition of households affects access to water supply?	Strongly agree	62	33
		Agree	129	67

#### 4.2.5. Correlation between Household Income and Water Service Source.

Table 8 shows the relationships between variables related to household income, water service sources, and associated costs. The Pearson correlation coefficients and significance values provide insights into the strength and significance of these relationships. First, the correlation analysis revealed a significant negative correlation ( $R^2=-0.246$ ,  $p = 0.001$ ) between monthly household income and the main source of water service. This suggests that as monthly household income increases, there is a tendency for households to rely less on the main source of water service. This finding may be attributed to higher income households having the means to access alternative sources of water, such as private water suppliers or other water sources.

Additionally, a significant negative correlation ( $R^2=-0.15$ ,  $p = 0.034$ ) was observed between the average monthly cost of piped tap water and the main source of water service. This implies that as the average monthly cost of piped tap water increases, households may seek alternative sources of water, reducing their reliance on the main water service. Higher costs of piped tap water could drive households to explore more economical options or invest in technologies that reduce their dependence on the main water supply. Furthermore, the utilization of private water suppliers showed a significant positive correlation ( $R^2=0.14$ ,  $p = 0.018$ ) with the average monthly cost for private water suppliers. This indicates that as households make greater use of private water suppliers, the associated average monthly cost tends to increase. The positive correlation suggests that households opting for private water suppliers may incur higher expenses, potentially due to factors such as delivery charges, infrastructure maintenance, or the need for specialized water treatment systems.

Moreover, there was a significant positive correlation ( $R^2=0.17$ ,  $p<0.05$ ) between the utilization of private water suppliers and the average monthly cost for private water suppliers. This finding suggests that as households rely more on private water suppliers; their average monthly expenditure for this service tends to rise. The positive correlation implies that the utilization of private water suppliers may involve additional costs beyond the standard water service, such as fees for water truck deliveries or maintenance of private water infrastructure. The analysis of the correlation (Table8) suggests that districts relying on government-provided or piped tap water as their main water sources tend to exhibit higher levels of urbanization compared to districts without government water supply. For example, the 26 June District, which receives tap water from the HWA, signifies a centralized water supply system associated with urban areas. In contrast, the Ahmed Dhagah District relies on private water vendors and demonstrates a less urbanized profile.

Table 8: Variables related to household income, water service sources, and associated costs.

<b>Variables</b>	<b>Correlation</b>	<b>Monthly HHI</b>	<b>Source of water</b>	<b>Monthly cost of tap water</b>	<b>Private water suppliers</b>	<b>Cost for private water supply</b>
Monthly HHI	$R^2$	1.00	-0.246	-0.154	0.146	0.173
	P-value	NC	0.001	0.034	0.044	0.018
Source of water	$R^2$	-0.246	1.00	0.636	-0.630	-0.716
	P-value	0.001	NC	<0.05	<0.05	<0.05
Monthly cost of piped tap water	$R^2$	-0.154	0.636	1.00	-0.999	-0.840
	P-value	0.034	<0.05	NC	<0.05	<0.05

Use of private water suppliers	R <sup>2</sup>	0.146	-0.630	-0.999	1.00	0.840
	P-value	0.044	<0.05	<0.05	NC	<0.05
Cost for private water supply	R <sup>2</sup>	0.173	0.716	0.840	0.840	1.00
	P-value	0.018	<0.05	<0.05	<0.05	NC

NC=Not computed, P-value= <0.05 is considered significant, HHI=Household income

The presence of government-provided or piped tap water in a district serves as an indicator of urbanization due to the infrastructural requirements and governance capacity associated with these water supply systems. Urban areas typically possess the necessary infrastructure, including water treatment facilities and distribution networks, to provide reliable piped tap water. Moreover, the responsibility of the government in supplying tap water reflects a stronger administrative capacity commonly found in urban districts. Conversely, districts depending on private water vendors indicate a decentralized water supply system, which is more prevalent in rural or peri-urban areas lacking centralized water infrastructure. Reliance on private water vendors has limitations in public service provision and infrastructure development, characteristic of less urbanized or economically disadvantaged areas. These observations highlight the association between water sources, urbanization, and socio-economic dynamics within districts. However, it is important to note that urbanization is a multifaceted process influenced by various factors beyond water supply, such as population density, economic activities, and social dynamics.

On the other hand, the analysis of the interviews conducted with senior government officials and the private water vendors officials in Hargeisa City regarding the economic challenges faced in providing a reliable and affordable water supply is associated with a questionnaire. The interviews showed the limitations imposed by limited financial resources, high operational costs, and revenue collection difficulties. The first major challenge identified by the officials is the *“limited availability of financial resources, which hinders the investment in infrastructure development, maintenance, and upgrades necessary to meet the water demand of the growing urban population”*. This limitation leads to inadequate coverage and service interruptions, impacting the reliability and accessibility of the water supply. The officials stressed the need for adequate funding to address this challenge effectively. Another significant economic challenge emphasized by the officials is the *“high operational costs associated with water treatment and distribution which includes expenses related to energy, chemicals, equipment, and skilled personnel. The officials noted that these costs strain the budget and directly affect the affordability of water services for the residents of Hargeisa City”*. Adequate funding was emphasized as *crucial for addressing these economic*

*challenges effectively. The officials stressed the importance of constructing and expanding water treatment plants, reservoirs, distribution networks, and pumping stations to meet the increasing water demand resulting from rapid urbanization. Additionally, sufficient budget allocations enable regular maintenance, timely repairs, and replacements of ageing components, ensuring the reliability and efficiency of the water supply system. The officials acknowledged that financial resources play a vital role in facilitating the adoption of advanced technologies for monitoring, control, and leak detection. These technological advancements contribute to the reduction of water losses and operational costs in the long run, ultimately supporting the sustainability of the water supply system. To enhance water supply accessibility and affordability, the officials reported the implementation of various strategies and initiatives. One such strategy is the establishment of PPPs, which leverage the collaboration with private entities to improve the efficiency and effectiveness of water service provision. These partnerships bring in additional financial resources, technical expertise, and innovation, ultimately contributing to the affordability and quality of the water supply as SHABA water Company in Borama city practiced. The officials also mentioned the implementation of *tariff reforms to ensure a fair and sustainable pricing structure for water services that reflect the true cost of service provision while considering the affordability concerns of low-income households.* Furthermore, demand management initiatives have been implemented, including *public awareness campaigns and water conservation programs to manage water demand and promote efficient water use practices among residents, reducing wastage and ensuring the availability of water for all.* Finally, in the section on economic factors, the officials underlined their proactive approach in seeking grant funding and support from international organizations and donors for infrastructure development projects, capacity building, and technical assistance, further strengthening the government's efforts to improve water supply accessibility and affordability.*

Moreover, the private water supplier's officials stated that *“the economic dynamics and factors that impact the water supply industry in Hargeisa City, particularly in terms of pricing, demand, and market competition, are significant considerations for private water suppliers. Pricing decisions are influenced by various factors, including operational costs, market demand, and competition. Private water suppliers in Hargeisa City employ strategies to determine the pricing of water delivery services, taking into account factors such as operational costs, market conditions, and customer willingness to pay. They face economic challenges in accessing and securing water sources for their business operations which limit the availability and reliability of water sources, water scarcity, competition for water*

*sources, and associated expenses for accessing and maintaining water sources. Managing costs associated with water acquisition, transportation, and maintenance is crucial for the profitability of private water trucking businesses in Hargeisa City. Private water vendors closely monitor operational expenses, optimize routes and loads, and ensure timely equipment maintenance to minimize costs. Balancing affordability and financial sustainability are a key consideration for private water truckers. They aim to offer competitive prices that align with market demands and customer expectations while covering operational costs and maintaining a reasonable profit margin”.*

### **4.3. Environmental Factors that Affect Water Supply in Hargeisa City**

Under this objective, the research finds to examine the environmental factors that affect the water supply in Hargeisa city which are; the main source of water service, quality of water, water pollution issues, types of water contamination, water quality testing and monitoring measures, climate change impacts on water availability, and the current water management practices which are mitigating the environmental impacts on the water supply in Hargeisa city. Besides, significant attention was dedicated to the expertise of senior government officials and private water vendors with regards to sharing their knowledge pertaining to the urban water supply system in the city of Hargeisa, as well as its related factors.

#### **4.3.1. Sources and Quality of Water Supply in Hargeisa City**

Table 9 shows the prevalent sources of water utilized for domestic water supply in Hargeisa City. It categorizes the responses into two options: Groundwater (wells, boreholes) and I do not know. Analysis of the data indicates that a substantial majority (75%) of respondents commonly rely on groundwater sources such as wells and boreholes for their water supply in Hargeisa City. Wells are typically manually dug or drilled to access water stored underground, while boreholes are deeper wells that tap into aquifers. This finding underscores the significance of groundwater as a prominent and dependable source of water for a considerable segment of Hargeisa City's population. Conversely, a smaller (25%) proportion of respondents expressed uncertainty regarding the sources of water commonly used for their domestic supply. This examines that some individuals may lack awareness of the specific sources of their water supply or possesses limited knowledge regarding the water infrastructure in Hargeisa City.

Table 9: Assessment of water source and quality concerns in Hargeisa City.

No	Description	Category	Frequency	Percentage
1	Source of commonly use in Hargeisa City	Ground water	142	75
		I don't know	49	25
2.	How concerned are you about the quality of water supplied in Hargeisa City?	Concerned	162	85
		Neutral	17	9
		Not concerned	12	6
3.	Have you ever experienced water contamination issues in Hargeisa City?	Yes	84	44
		No	107	56
4.	If yes, what type of water contamination issues have you encountered?	Sediments or	84	44
		Turbidity		
		None	107	56
5.	How satisfied are you with the water quality testing and monitoring measures implemented in Hargeisa City?	Satisfied	107	56
		dissatisfied	84	44

Question 2 in the Table 9 inspects respondents' level of concern regarding the quality of water supplied in Hargeisa City. The responses were categorized as "Concerned," "Neutral," and "Not concerned." The findings reveal that a significant number (n=162 or 85%) of respondents expressed concerns about the water quality, while a smaller proportion had a neutral stance (9%), and a minority reported not being concerned (6%). Question 3 explores the respondents' experiences of water contamination issues in Hargeisa City (Table 9). The responses were dichotomized as "Yes" or "No." The results indicate that 44% of the respondents reported experiencing water contamination issues, while 56% did not encounter such issues. For Question 4, which targeted those who answered "Yes" to Question 3, respondents were requested to specify the type of water contamination issues they had encountered. The provided categories were "Sediments or turbidity" and "None." The findings indicate that all (100%) respondents who reported experiencing water contamination issues related to sediments or turbidity, while none of them reported encountering other types

of contamination. Question 5 designed to assess respondents' satisfaction with the water quality testing and monitoring measures implemented in Hargeisa City. The satisfaction levels were classified as "Satisfied" and "Dissatisfied." The results reveal that 56% of the respondent's expressed satisfaction with the implemented testing and monitoring measures, while 44% expressed dissatisfaction.

Indeed, the water quality information gathered from HWA (Appendix 4) indicates that good/poor quality compared to WHO standards (Table 10).

The physical parameters of the water sample were analyzed for HWA and then compared to the standards established by the World Health Organization (WHO). The pH level was determined to be 7.77 by measurement. The appropriate range, as specified by the World Health Organization (WHO), is between 6.5 and 8.0. Regarding turbidity, the recorded measurement yielded a value of 0.235 NTU. Upon comparing the water sample with the World Health Organization (WHO) standard of 5 NTU, it was noted that the turbidity level exhibited a significant decrease. The conductivity measurement yielded a result of 103.5  $\mu\text{S}/\text{cm}$ , which is far below the established norm of 1500  $\mu\text{S}/\text{cm}$ . In a similar vein, the TDS value obtained was determined to be 51.22 mg/L, indicating a result below the established threshold of 1000 mg/L. Furthermore, the salinity measurement yielded a value of 102 parts per million (PPM), which falls below the World Health Organization's target of 1000 PPM. Hence, the samples of water exhibit physical properties that fall inside the permissible range.

On the other hand, the examination of water quality in HWA shows that the chemical parameters measured are within the acceptance range established by WHO. The recorded levels of sodium (11 mg/L), sulfate (19 mg/L), iron (0.01 mg/L), potassium (2 mg/L), fluoride (0.18 mg/L), and chloride (3.3 mg/L) all fall below the WHO's corresponding requirements, which stand at 200 mg/L, 250 mg/L, 0.3 mg/L, 12 mg/L, 1.5 mg/L, and 250 mg/L, respectively. According to the findings, the water quality in Hargeisa City a little bit satisfies the requirements set by the WHO, showing that it's appropriate for consumption and the absence of significant health risks.

Table 10: Water quality of Hargeisa city and WHO/FAO standard

<b>Physical Parameter</b>				
Parameter	Unit	HWA Results	WHO standard	Instrument/method
pH	-	7.77	6.5-8.0	pH meter
Turbidity	NTU	0.235	5	Turbidity meter
Conductivity	μS/cm	103.5	1500	Multiparameter meter
TDS	mg/L	51.22	1000	Multiparameter meter
Salinity	PPM	102	1000	Multiparameter meter
<b>Chemical Parameter</b>				
Calcium	Nil	Mg/l	300	Uv-vis spectrophotometer
Sodium	11	Mg/l	200	Uv-vis spectrophotometer
Nitrate	Nil	Mg/l	50	Uv-vis spectrophotometer
Nitrite	Nil	Mg/l	3	Uv-vis spectrophotometer
Total Hardness	Nil	Mg/l	500	Uv-vis spectrophotometer
Sulfate	19	Mg/l	250	Uv-vis spectrophotometer
Iron	0.01	Mg/l	0.3	Uv-vis spectrophotometer
Manganese	Nil	Mg/l	0.5	Uv-vis spectrophotometer
Potassium	2	Mg/l	12	Uv-vis spectrophotometer
Flouride	0.18	Mg/l	1.5	Uv-vis spectrophotometer
Chloride	3.3	Mg/l	250	Uv-vis spectrophotometer
Copper	Nil	Mg/l	2	Uv-vis spectrophotometer

According to MWRD in 2019, Somaliland's water sources include boreholes, shallow wells, springs, dams, pans, and rainfall collection. Safe sources of water are only boreholes, shallow wells, and protected springs. Nevertheless, these sources could still be contaminated with fecal matter if they are not constructed in a correct manner. In order to reduce the possibility of adverse effects, water may be subjected to either boiling or chlorination before its distribution or at the customer's dwelling. Hafirs, as additional water sources, need filtering to get rid of soil particles and organic matter before to chlorination. One additional obstacle is

the high salt content of the underground water in a substantial part of the country, mainly due to the presence of rocks that may dissolve in the eastern area. The rainwater that penetrates this geological formation becomes somewhat salty, and if the formation is exposed at the surface, it may also impact the quality of surface water in hafirs and balleys.

Additionally, there are currently no functional water and wastewater quality control laboratories in the country, except the HWA has a basic water laboratory where they regularly assess the quality of the water that is usually provided to the district on 26 June. Furthermore, please see **Appendix 4**, which contains a sample test carried out by the HWA. This test provides a further understanding of their comprehensive quality testing methods. On the other hand, most of the other districts/sub-cities in Hargeisa depend on private tankers and Donkey cars to provide them with water. These private vendors do not have the required infrastructure to do quality tests on the water they deliver to customers, making it hard to determine or distinguish the water's quality. The tankers transport water directly from the well to the relevant places or households where it is distributed.

#### **4.3.2. Water Sources Protection and Awareness of Climate Change Impacts on Water**

Table 11, explores the importance of protecting natural water sources and respondents' awareness of climate change impacts on water availability in Hargeisa City. The Table comprises four questions designed to investigate respondents' perceptions and understanding. The first question assesses respondents' opinions regarding the importance of protecting natural water sources in and around Hargeisa City. The responses were classified as "Very important." The findings indicate unanimous agreement among all respondents (100%) about the significance of safeguarding natural water sources, highlighting their recognition of the high importance attributed to this issue. The second question investigates respondents' awareness of climate change impacts on water availability in Hargeisa City (Table 11). The responses were categorized as "Yes" or "No." The results indicate that all (100%) respondents demonstrated awareness of the influence of climate change on water availability, indicating a high level of knowledge among the surveyed population. For the third question, respondents who acknowledged climate change impacts in question two were asked to specify the observed or heard impacts on water supply in Hargeisa City (Table 11). The provided categories included "changes in water availability in natural sources and decreased rainfall" and "flooding events." The findings indicate that the majority (90%) of respondents mentioned changes in water availability and decreased rainfall as climate change impacts on water supply, while a smaller (10%) proportion highlighted flooding events. The fourth

question aimed to gauge respondents' perception of the effectiveness of current water management practices in mitigating environmental impacts on the water supply in Hargeisa City (Table 11). The effectiveness levels were categorized as "Effective," "Neutral," and "Ineffective." The results indicate that a small (6%) proportion of respondents considered the current practices effective, a larger (49%) proportion had a neutral opinion, and a significant number (45%) perceived the practices as ineffective.

Table 11: Natural water sources and respondents' awareness of climate impacts on water.

No	Description	Category	Frequency	Percentage
1.	How important do you think it is to protect the natural water sources (e.g., lakes, dams, aquifers) in and around Hargeisa city?	Very important	191	100
2.	Are you aware of any climate change impacts on water availability in Hargeisa city?	Yes	191	100
		No	0	0
3.	If yes, what climate change impacts have you observed or heard of in relation to water supply in Hargeisa city?	Changes in water availability in natural sources and decreased rainfall	172	90
		Flooding events	19	10
4.	How effective do you think the current water management practices are in mitigating the environmental impacts on the water supply in Hargeisa city?	Effective	12	6
		Neutral	95	49
		Ineffective	84	45

On the other hand, the interview of senior officials from government agencies, mentioned *“Several factors impacted the availability and quality of water resources in the region. These include concerns about water source sustainability, pollution, climate change, seasonal variations, and meeting the water demand of the citizens. Water source sustainability is a significant challenge in Hargeisa City due to limited availability and the potential depletion of groundwater sources. Pollution also poses a threat to water resources, with improper*

waste management practices and small industrial activities contributing to water contamination and degraded water quality. Climate change has a profound impact on the water supply infrastructure and availability in Hargeisa City. Changes in rainfall patterns, rising temperatures, and prolonged droughts result in reduced water availability and increased stress on existing water resources. In the mitigation of these effects, the government has implemented various adaptation measures and plans including proposals for investments in water storage and conservation infrastructure, promotion of water-efficient practices, and exploration of alternative water sources.

In terms of the seasonal variations in Hargeisa City significantly affect water availability and the region experiences distinct dry and wet seasons, with rainfall primarily occurring during the wet season. During the dry season, water availability is significantly reduced, leading to increased demand for alternative water sources and potential water scarcity issues. As well, population growth, limited water sources, and infrastructure challenges sat difficulties in meeting the entire water demand and to address that, the government is working on expanding water infrastructure, implementing demand management strategies, and exploring alternative water sources to ensure an adequate and reliable water supply for the city's residents. To protect water sources, watersheds, and groundwater reserves for a sustainable water supply, the government has taken several steps. It includes the implementation of regulations and policies to prevent pollution and protect water sources from contamination. Sustainable land management practices are promoted to safeguard watersheds, and monitoring and research are conducted to effectively manage groundwater resources. Public awareness and education campaigns are also emphasized to encourage responsible water use and conservation practices among citizens”. Additionally, the spokesman for private water associations (trucks) said “As a private water vendor in Hargeisa City, we encounter several environmental challenges that influence our operations. These challenges include water source sustainability, pollution, and climate change impacts. Water source sustainability is a concern due to limited availability and the potential depletion of groundwater sources as the sources are far from the city. Pollution, primarily from improper waste disposal and industrial activities, contaminates water sources and affects their quality. Climate change impacts, such as changes in rainfall patterns and increased frequency of droughts, also exacerbate water scarcity and availability. To mitigate the environmental impact of our water delivery services, we incorporate environmentally friendly practices in various aspects of our operations. Water conservation is a key focus, and we take measures to minimize water wastage during transportation and delivery. This includes utilizing

*efficient water storage and delivery systems that minimize leakage and spills. Moreover, we actively collaborate with local environmental agencies and community organizations to raise awareness about the importance of water conservation and environmental sustainability by engaging in educational initiatives, and we promote responsibility for water usage among customers and the broader community”.*

#### **4.4. Social Factors that Affect Water Supply in Hargeisa City**

Under this objective the research discoveries to investigate the social factors that affect the water supply in Hargeisa city which includes level of awareness among residents regarding water conservation practices, socio cultural norms and practices influence water usage patterns, community participation in water management initiatives, and social barriers or challenges that hinder effective water management and access in Hargeisa city. important courtesy was also dedicated to the expertise of senior government officials and private water vendors with regards to sharing their knowledge pertaining to the urban water supply system in the city of Hargeisa, as well as its related factors. Table presents findings related to water conservation awareness, sociocultural norms, practices, and community participation in water management in Hargeisa City. In the first question, "how do you agree it is for residents to be aware and educated about water conservation and its impact on water supply in Hargeisa City?" total of 191 respondents (100%) strongly agreed that it is important for residents to be aware and educated about water conservation and its impact on water supply. The second question explored the influence of sociocultural norms and practices on water usage patterns in Hargeisa City. Among the respondents, 111 (58%) strongly agreed, while 80 (42%) agreed that sociocultural norms and practices do indeed influence water usage patterns (Table 12). The third question aimed to assess the level of community participation in water management initiatives in Hargeisa City. The majority of respondents rated the level of community participation as moderate, with 89 (46%) expressing this view. Additionally, 80 respondents (42%) perceived the level of community participation as low, and 22 respondents (12%) considered it to be very low.

*Table 12: Various social factors related to water supply in Hargeisa City.*

<b>No</b>	<b>Description</b>	<b>Category</b>	<b>Frequency</b>	<b>Percentage</b>
1.	How do you agree it is for residents to be aware and educated about water conservation and its impact on the water supply in Hargeisa City?	Strongly agree	191	100
		Disagree	0	0

2.	Do you believe that sociocultural norms and practices influence water usage patterns in Hargeisa City?	Strongly agree	111	58
		Agree	80	42
3.	How would you rate the level of community participation in water management initiatives in Hargeisa City?	Moderate	89	46
		Low	80	42
		Very low	22	12
4.	Are there any social barriers or challenges that hinder effective water access and management practices in Hargeisa city?	Yes	191	100
		No	0	0
5.	If yes, please select the main social barrier or challenge that hinders effective water management and access in Hargeisa city:	Limited infrastructure	62	33
		Socio-economic disparities	39	20
		Lack of community awareness	10	5
		Political factors influencing water policies	80	42
6.	How satisfied are you with the level of community engagement and involvement in decision-making processes related to water supply in Hargeisa city?	Satisfied	60	30
		Neutral	47	25
		Dissatisfied	62	33
		Very dissatisfied	22	12
7.	How do you think social inequalities impact access to water supply services in Hargeisa city?	Unequal infrastructure	32	17
		Economic disparities	13	7
		Lack of awareness	84	44
		Discrimination in resource allocation	62	32

When asked (question 12) about social barriers or challenges hindering effective water access and management practices, all 191 respondents (100%) acknowledged their existence, indicating the presence of obstacles that need to be addressed (Table 12). For those respondents who identified social barriers or challenges, they were asked (question 5) to select the main barrier (Table 12). Among the options provided, the most commonly chosen

barrier was limited infrastructure for water distribution, which is selected by 62 (33%) respondents. Other significant barriers included socio-economic disparities affecting access, chosen by 39 (20%) respondents lack of community awareness on water conservation, selected by 10 (5%) respondents, and political factors influencing water policies due to corruption, chosen by 80(42%) respondents.

Regarding community engagement and involvement in decision-making processes related to water supply (question 6), respondents expressed varying levels of satisfaction (Table 12). A total of 60 respondents reported being satisfied, 47 expressed a neutral stance, 62 were dissatisfied, and 22 were very dissatisfied with the level of community engagement and involvement. Lastly, the impact of social inequalities (question 7) on access to water supply services in Hargeisa City was examined (Table 12). Respondents identified several factors contributing to this issue. Among them, 32 respondents (17%) believed that unequal infrastructure played a significant role. Economic disparities, such as income levels and prices for water, were seen as impacting access by 13 respondents (7%). Lack of awareness of water practices was identified by 84 respondents (44%) as a contributing factor. Additionally, discrimination in resource allocation, specifically the unfair distribution of water supply, was mentioned by 62 respondents (32%).

In line with the interview with the government officials mentioned in Hargeisa City, there are several social factors play a crucial role in shaping water demand and consumption patterns. Population growth is a significant factor, as an increasing population naturally leads to higher water demand. Cultural practices also influence water consumption, with certain activities, such as water-intensive agriculture or traditional water usage habits, contributing to higher demand and socio-economic conditions and education levels impact access to water-saving technologies and awareness about efficient water use practices. They said that they employed various strategies, including conducting public awareness campaigns through community meetings, workshops, and media outreach which focused on educating residents about the importance of water conservation, providing practical tips on efficient water use, and encouraging behavioral changes to reduce water consumption. However, ensuring equitable access to water supply services across different socio-economic groups in Hargeisa district presents challenges and barriers that need to be addressed. Socio-economic disparities resulted in unequal access to basic services, including water supply. Low-income communities may face difficulties in accessing clean and reliable water sources or may rely on informal water vendors, which has less quality and high-water cost. To address these issues, the government officials mentioned that they have *implemented various measures*;

*include developing water infrastructure in underserved areas, subsidizing water tariffs for low-income households, and implementing targeted programs to improve access to water supply services for marginalized communities. In addition, initiatives are undertaken to ensure community engagement and participation in decision-making processes, enabling their specific needs and concerns related to water supply to be taken into account.*

On the other hand, the private water vendors replied that they have consider *social factors such as demographic makeup, socio-economic status, and customer preferences when determining the locations and timing of water deliveries in Hargeisa City. Understanding cultural norms helps tailor services to meet specific requirements. Social factors, such as cultural practices, social inequalities, and community engagement, play a significant role in influencing the demand for and access to water delivery services in different areas of Hargeisa City. Cultural practices and norms impact the water consumption patterns and preferences of communities. For example, some communities may prioritize water for domestic use as an emergency, while others may have specific water requirements for special occasions or cultural practices. As well, social inequalities also affect the demand for and access to water delivery services because areas with higher socio-economic status may have greater demand for convenient and reliable water delivery, while marginalized communities or low-income areas may face challenges in accessing these services due to affordability issues. It is important for us to consider these social inequalities and strive to ensure equitable access to water delivery services across different areas of the city.*

#### **4.5. Water Management System**

Under this objective the research finds to evaluate the water management system in Hargeisa city which are; the overall performance of the water management system, accessibility of water supply infrastructure, responsiveness of the water management authorities in addressing water-related issues and complaints, water supply disruptions or shortages, billing and payment system for water services, and how water management system in Hargeisa City is prepared to handle future population growth and increased water demand. At the same time, significant attention was dedicated to the expertise of senior government officials and private water vendors with regards to sharing their knowledge pertaining to the urban water supply system in the city of Hargeisa, as well as its related factors.

#### 4.5.1. Performance of Water System, Infrastructure Accessibility, and Management Authorities' Responsiveness

Table 13 grants the findings related to the overall performance of the water management system, the accessibility of water supply infrastructure, and the responsiveness of the water management authorities in Hargeisa City. In response to the question (question 1), "how would you rate the overall performance of the water management system in Hargeisa city?" majority of respondents expressed their dissatisfaction. Specifically, 49% respondents rated the performance as poor, while 35% respondents considered it to be average. A smaller (16%) proportion also rated the performance as good. Regarding the accessibility of water supply infrastructure (question 2), the responses most (42%) respondents expressed satisfaction, while 14% and 44% respondents remained neutral and get dissatisfaction, respectively on accessibility of domestic water in their respective areas of Hargeisa city. The question (question 3) assessing the responsiveness of the water management authorities in addressing water-related issues and complaints revealed a significant level of dissatisfaction. The 43% of respondents said that the authorities were not responsive at all (Table 13). Furthermore, 26 (14%) respondents expressed that the authorities were not very responsive. In contrast, only 17 (9%) respondents perceived the authorities as responsive, while 64 (34%) respondents held a neutral view.

Table 13: Performance of water, infrastructure accessibility, and authorities' responsiveness.

No	Description	Category	Frequency	Percentage
1.	How would you rate the overall performance of the water management system in Hargeisa city?	Good	31	16
		Average	66	35
		Poor	94	49
2.	Are you satisfied with the accessibility of water supply infrastructure (e.g., taps, water distribution network) in your area of Hargeisa city?	Satisfied	80	42
		Neutral	27	14
		Dissatisfied	84	44
3.	How would you rate the responsiveness of the water management authorities in addressing water-related issues and complaints in Hargeisa city?	Responsive	17	9
		Neutral	64	34
		Not very responsive	26	14
		Not responsive at all	84	43

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On the other hand, the interview for the government officials said *“In the past, the system has faced challenges in terms of inadequate infrastructure, limited regulations, and fragmented management. However, in recent years, efforts have been made to strengthen the system and address these shortcomings. The strengths of the current water management system include the establishment of regulatory frameworks and guidelines that ensure water quality standards and management systems. The system also facilitates coordination among stakeholders and provides oversight among water providers. Additionally, there have been investments in infrastructure development, such as water reservoirs and distribution networks, to enhance the reliability of the water supply. However, there are still weaknesses that need to be addressed. The system's limited capacity to meet the growing water demand and address infrastructure challenges leads to delays in meeting customer needs and improvements are needed to ensure a more flexible and responsive water management system. Policies and regulations are in place to govern water allocation, distribution, and monitoring and these policies outline guidelines for water extraction, licensing requirements for water providers, and standards for water quality and safety. Additionally, there are regulations in place to monitor water resources, including monitoring of groundwater levels and water quality testing. The effectiveness of these policies in ensuring sustainable water management depends on their implementation and enforcement. In terms of successful water management strategies or initiatives implemented in Hargeisa City, there have been several notable examples. For instance, the implementation of the HUWSUP which aimed: “To upgrade Hargeisa’s outdated water production and transmission system with new augmented infrastructure and provide the foundation for improved water access for the entire population of Hargeisa city”. Another successful strategy is the promotion of water conservation practices, such as rainwater harvesting (dams). Furthermore, investments in infrastructure development, including the expansion of water storage and distribution networks, have enhanced the reliability and efficiency of the water supply and the improvements have contributed to a more resilient water management system in Hargeisa City”.*

After being asked the following questions, the private water truckers provided their responses. 1. How does the current water management system impact your work as a private water trucker, both positively and negatively? 2. From your perspective, what improvements or changes would you suggest in the water management system in Somaliland particularly Hargeisa City to enhance the efficiency, reliability, and sustainability of the water supply? 3.

How does the coordination and collaboration between the private sector (water truckers) and government sector (the existing water management system) in Hargeisa City contribute to addressing water supply challenges, and how can this collaboration be further improved?

*They said “The current water management system has both positive and negative impacts on our work as a private water trucker. On the positive side, it provides a regulatory framework that ensures water quality standards (for HWA piped connections). However, the system's bureaucratic processes and licensing requirements can be time-consuming and costly, hindering operational efficiency and increasing expenses. Additionally, the system's limited capacity to address growing water demand and infrastructure challenges can make it difficult to meet customer needs promptly. From this perspective, several improvements can enhance the efficiency, reliability, and sustainability of the water management system in Hargeisa City, Somaliland. There should be a focus on upgrading and expanding infrastructure, including water treatment plants, distribution networks, and storage facilities, to ensure a reliable water supply. Investing in advanced technologies such as remote monitoring systems and leak detection technologies can improve operational efficiency and reduce water losses. Implementing smart metering systems would promote accurate billing and water conservation. Emphasis should be placed on water resource management and conservation practices, such as rainwater harvesting, groundwater recharge, and promoting water-efficient practices in industries, agriculture, and households. And finally, enhancing public participation through education campaigns and community engagement would foster responsibility and better water conservation practices.*

*The coordination and collaboration between the private sector (water truckers) and the government sector (water management system) in Hargeisa City contribute to addressing water supply challenges. Private water truckers play a significant role in meeting immediate water needs, while the government ensures regulatory oversight, quality standards and coordination among stakeholders. To further improve this collaboration, establishing regular and transparent communication channels between the sectors is crucial such as forums, workshops, or meetings where water truckers can share insights and suggestions with relevant authorities. Providing incentives and support mechanisms for private water truckers to invest in efficient and sustainable water delivery systems can also enhance collaboration and strengthen coordination and collaboration will enable the sectors to work together effectively, ensuring reliable and accessible water supply for the community.*

#### 4.5.2. Water Supply Disruptions, Billing/Payment System, and Implications

Table 14 emphasizes on water supply disruptions or shortages, issues with the billing and payment system, and their implications in Hargeisa city. Regarding the awareness of water supply disruptions or shortages, all (100%) respondents confirmed their awareness of such issues existing in Hargeisa city. Among those households who aware, the frequency of experiencing water supply disruptions or shortages varied. The most common response was experiencing these issues on a monthly basis, with 104 (54%) respondents reporting such occurrences. Additionally, 26 (13%) respondents said weekly disruptions, while 16 (10%) respondents experienced them occasionally. On the other hand, 45 (23%) respondents stated that they rarely or never faced water supply disruptions or shortages.

When it comes to issues with the billing and payment system for water services, 96 (51%) respondents mentioned the problem of billing and payments systems encountered in their village. Conversely, 95 (49%) respondents indicated that they had not experienced any issues with the billing and payment system. Among those who reported issues, the main problem identified was inaccurate billing, as reported by 82 (43%) respondents. Additionally, 14 (7%) respondents mentioned irregular billing cycles as their primary concern. In contrast, 95 (50%) respondents stated that they had encountered no issues with the billing and payment system.

Table 14: Water disruptions, payment system, and their implications in Hargeisa City.

No	Description	Category	Frequency	Percentage
1.	Are you aware of any water supply disruptions or shortages in Hargeisa City?	Yes	191	100%
		No	0	0
2.	If yes, how frequently do you experience water supply disruptions or shortages?	Weekly	26	13%
		Monthly	104	54%
		Occasionally	16	10%
		Rarely or never	45	23%
3.	Have you experienced any issues with the billing and payment system for water services in Hargeisa city?	Yes	96	51%
		No	95	49%
4.	If yes, please select the main issue you have encountered with the billing and	Inaccurate billing	82	43%
		Irregular billing	14	7%

payment system for water services:	cycles		
	None	95	50%

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#### 4.5.3. Future Preparation for Water Demand in Hargeisa

Figure mm illustrates the opinions regarding the level of preparedness of the water management system in Hargeisa City to address future population growth and the associated increase in water demand. According to the chart, a small number of respondents, comprising 7% of the total, expressed a “neutral” attitude, indicating a lack of certainty or a neutral viewpoint on the system's readiness to handle future challenges. In contrast, most (93%) of respondents believed that the water management system in Hargeisa City is inadequately prepared to cope with future population growth and the expected surge in water demand (Figure 15-a). This suggests a widespread concern among the surveyed individuals regarding the system's capacity and effectiveness. From this result it is possible to conclude that a significant number of respondents hold a negative perception regarding the system's ability to meet the projected growth and demand in the future.

As shown in Figure 15-b, the estimation of population of the Hargeisa City from 2005 up to 2023 which provides the demographic patterns that have occurred in city over the last two decades. This shows that the population size has been steadily growing from one year to the next. The fact that this is the case indicates Hargeisa City is undergoing a considerable amount of urbanization. The consistent increase in population indicates that there will be a growing demand for fundamental services such as water, healthcare, and other amenities that are vital to daily life. As a result of the growing population, there is an increased requirement to guarantee the provision of these services to satisfy the ever-increasing requirements of the citizens. The information that is shown in the Figure 15 illustrates the significance of urban planning and development strategies to meet the requirements of a population that is gradually increasing. It is necessary to create and improve enough infrastructures to provide support for the growing urban population in Hargeisa City. Likewise, according to the patterns that have been seen in population growth, it is expected that the population of Hargeisa City will continue to increase dramatically over the following years. Based on projections made by the Hargeisa Local Government- Department of Statistics (2023), it is predicted that the population of the city will reach 3.6 million by the year 2040.

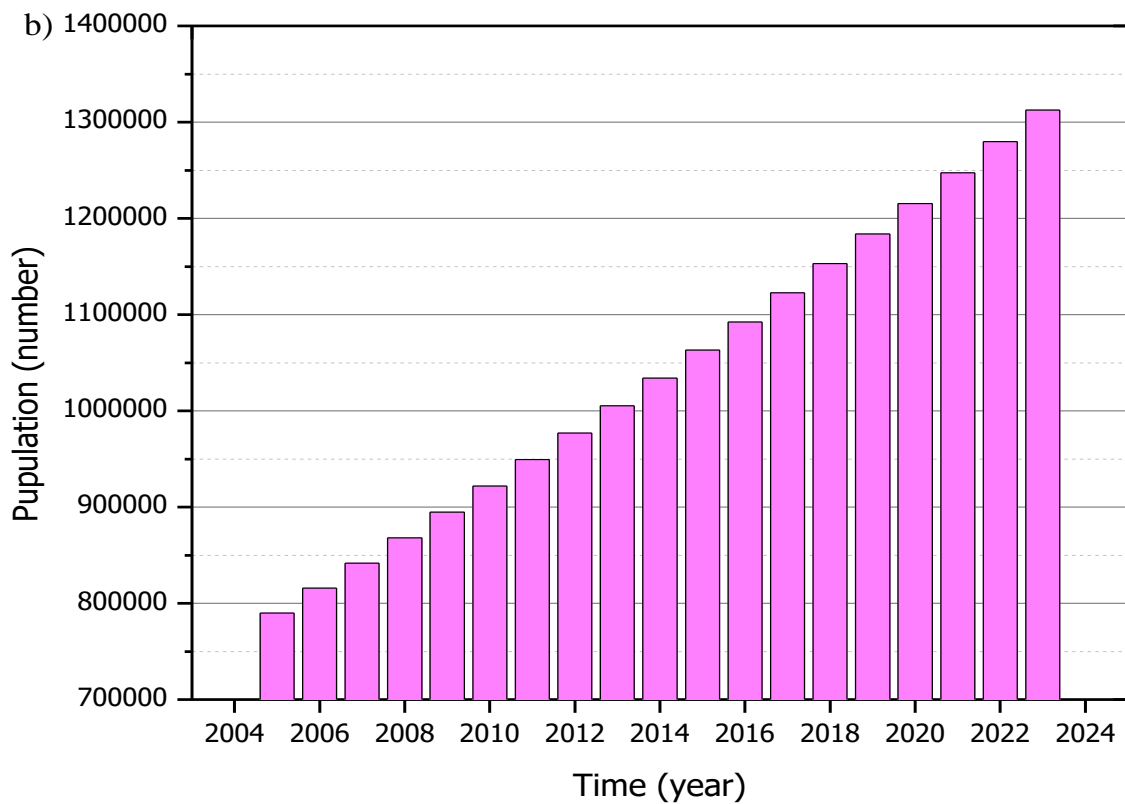
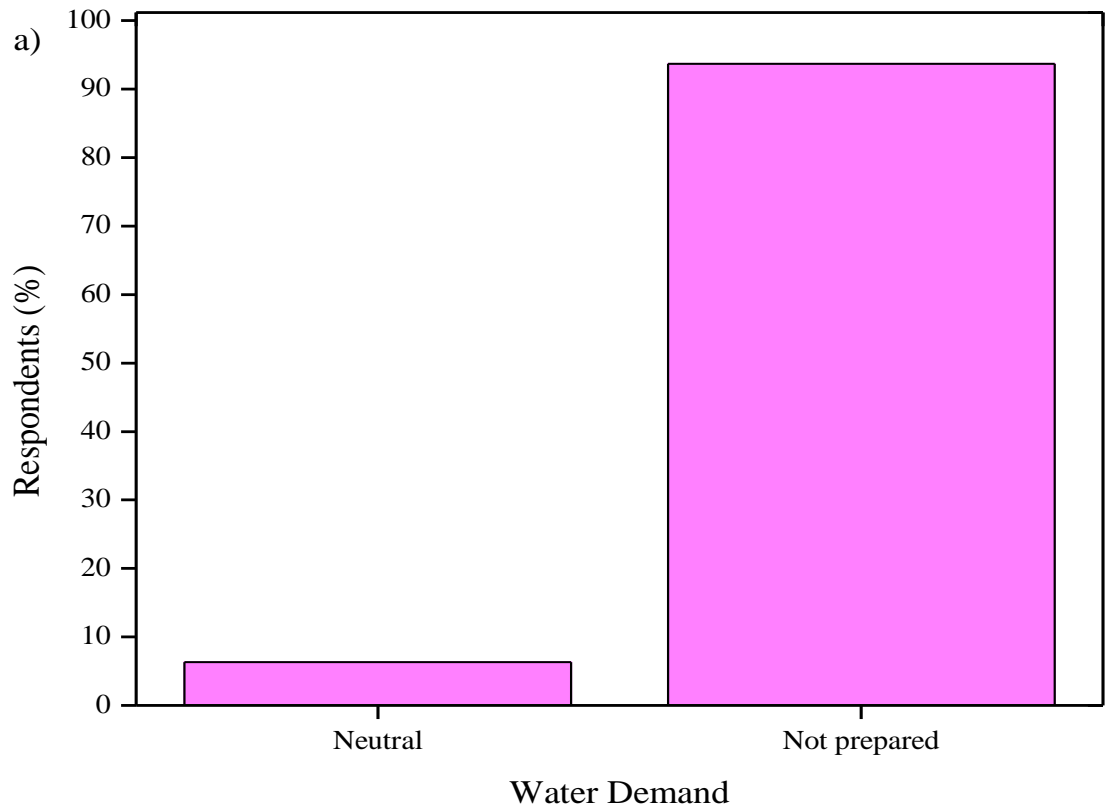


Figure 15: Future preparedness in Hargeisa City (a) water demand (Current study data), and (b) estimation of population of the Hargeisa city from 2005-2023 (Hargeisa Local Government-Department of Statistics, 2023).

The HWA reported an increase in the volume of water reaching Hargeisa City and the water availability was expected to rise from 9,000 to 24,000 cubic meters per day. However, when considering the population of Hargeisa, which is over 1.3 million, the water availability per person per day could estimate to be approximately **18 liters per capita per day**.

It is important to note that this water consumption falls below the standards set by the World Health Organization. The WHO recommends a minimum of 50 liters per person per day to meet basic needs and maintain hygiene, (WHO, 2017). Thus, the water consumption in Hargeisa is significantly below the recommended standard. Insufficient access to clean water can have severe consequences for public health and hygiene practices and leads to increase risks of waterborne diseases and make it challenging for individuals to maintain proper sanitation and hygiene practices.

Moreover, in the future, most respondents of the study stated that the government will not be adequately prepared to secure additional and alternative sources of water supply for the capital city Figure 15. By the year 2040, the population of Hargeisa is estimated to reach 3.6 million. If the given current situation is operating consistently, the water availability remains at 24,000 cubic meters per day, we can calculate the water availability per person to assess the adequacy of the supply. To determine the water accessibility per person, it should divide the total volume of water reaching Hargeisa by the projected population of 3.6 million the calculation yields an estimate of approximately **7 liters per capita per day**. It is crucial to note that this quantity is significantly lower than the (WHO) recommended standard. The WHO guideline accounts for basic needs such as drinking, cooking, sanitation, and hygiene practices. With a water availability of only 7 liters per person per day, the population of Hargeisa would face considerable challenges in meeting these fundamental requirements that is set achieve SDG 6.

## **CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS**

### **5.1. Conclusion**

This study aimed to assess the effects of urbanization on water supply in Hargeisa City, Somaliland. The findings of this research illustrated on the challenges and issues faced by the city in meeting the water demand of its growing urban population. The study highlighted the economic, environmental, and social factors influencing water supply in Hargeisa city.

Furthermore, it assessed the current urban water management system to identify opportunities for improvement. Water scarcity in Hargeisa has been exacerbated as a result of the increased demand for water caused by the city's accelerated urbanization. The challenges in providing clean and sufficient water to all populations have arisen due to the dependence on sole water sources and inadequate water infrastructure.

The sustainability of the rotating water distribution system has been endangered due to population growth. Urbanization has emerged as a worldwide phenomenon, given the expected increase in the world's population to 9.6 billion by the year 2050.

Developed nations have experienced urbanization as a result of industrialization and economic expansion, whereas developing countries, specifically those in sub-Saharan Africa, encounter the difficulties associated with accommodating swift population expansion in the absence of adequate infrastructure. The urban population in Sub-Saharan Africa, including Somaliland, has been consistently rising, with Hargeisa City emerging as one of the most rapidly expanding and densely inhabited areas. The existing water infrastructure in Hargeisa is insufficient to adequately respond to the demands of its growing population. Consequently, an estimated 65% of the population of the city is dependent on water transported from sources that are considered unreliable and poorly managed. Also, the research indicated the economic, environmental, and social factors that impact the provision of water. Economic considerations such as insufficient financing and budgetary limitations hinder the development of water infrastructure and maintenance. Environmental variables such as water shortage and pollution further intensify the issues related to water supply. Hargeisa City's water supply challenges have been influenced by several social factors, including growing populations, insufficient water access, and unequal distribution. In conclusion, with the existing water supply systems that Hargeisa City have, achieving SDG 6 in the city will be remain unachievable.

## 5.2. Recommendations

Grounded on the results and discussions of the research, the following likely recommendations are proposed;

- ✓ To enhance the affordability and accessibility of water, it is recommended to investigate possible options for subsidizing water expenses for low-income households and improve the implementation of tariff structures that are segmented according to income. Furthermore, to oversee private water vendors, it is recommended to institute regulations and standards, enforce adherence to them to prevent price kidnapping, guarantee water quality, and encourage cooperation between HWA and private water vendors to achieve improved cost reduction.
- ✓ To improve the water infrastructure, it is essential to allocate funds towards the development and expansion of the water infrastructure in Hargeisa City. The aforementioned activities include the repairs and maintenance of current wells, the establishment of freshwater reservoirs, and the expansion of the piped water distribution infrastructure.
- ✓ To reduce reliance on a lonely water source, it is crucial to look for alternative sources of water, tap into underground water reserves, explore water harvesting techniques, and consider the utilization of surface water alternatives, particularly with the prominence of the big valley in Hargeisa city.
- ✓ It should allocate adequate financial resources to the water sector to address the funding gaps. This includes attracting investments from both the public and private sectors, seeking international assistance, and exploring innovative financing mechanisms. Thus, this will enable the implementation of water infrastructure projects and ensure the long-term sustainability of the water supply system.
- ✓ Conduct public awareness campaigns to educate residents about the importance of water conservation and responsible water usage. Encouraging behavioral changes and promoting water-saving practices reduce water demand and alleviate the pressure on the water supply system in the city.
- ✓ Conduct regular monitoring and evaluation of the water supply system to assess its performance and identify areas for improvement. This includes monitoring water quality, assessing infrastructure efficiency, and evaluating the effectiveness of water management strategies. Continuous monitoring enables timely interventions and

ensures reliable and safe water supply to the residents of Hargeisa City, especially those who serve private vendors.

- ✓ To encourage collaborative efforts between government agencies, water utilities, and local communities, it should effectively manage the water supply system to ensure efficient and sustainable water management. This comprises implementing efficient water allocation systems, promoting water conservation practices, and improving water governance.

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## APPENDICES

### Appendix 1: Questionnaire for Households

The purpose of this questionnaire is to collect data that are imperative to “Assessing the Effects of Urbanization on Water Supply in Somaliland: A Case Study of Hargeisa City”. The data applied for the directing to academic research fulfilment of the Master Degree of Science (MSc) in Pan African University Institute for Water and Energy Science (incl. Climate Change – PAUWES). The information you provided in this questionnaire utilized only for the purpose of the study. Your genuine questionnaire response is highly valuable for the achievement of the objectives of the research.

Confidentiality is guaranteed, so please participate in filling out this questionnaire openly and honestly.

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Email: [mawliid108@gmail.com](mailto:mawliid108@gmail.com)./ Tell: +252634409103

Position: MSc student at PAUWES,

**I thank you, in advance for your collaboration.**

#### SECTION A: Characteristics of the Respondents

1. what is your sex?
  - a. Male .....
  - b. Female.....
2. What is your age?
  - a. 18 – 25 old.....
  - b. 26 – 35 old .....
  - c. 36 – 45 old .....
  - D. above 45 old.....
3. What is your marital status?
  - a. Single.....
  - b. Married.....
  - c. Widowed.....
4. What is your education level?
  - a. Illiterate.....
  - b. Primary/Secondary.....
  - c. Bachelor degree.....
  - d. Master degree.....
  - e. Other please specify.....
5. How many people live in your household?
  - a. 2 - 4.....
  - b. 4 - 8.....
  - c. 8 – 12.....
  - d. Above 12.....
6. What is your occupation?
  - a. Housewife.....
  - b. Daily labor/Employee.....
  - c. Business owner.....
  - d. Unemployed.....
7. What is your monthly household income?
  - a. < \$200-400.....
  - b. \$400-600.....
  - c. \$600 and above

**SECTION B: Economic Factors That Affect Water Supply in Hargeisa City**

1. What is the main source of water service for your household?  
a) Government (HWA) ..... b) Others (Hand Dug well, Rainwater harvest, Water truck, Donkey Cars.) .....
2. What is the capacity of your water storage tank in cubic meters?  
a) < 5 - 10 Cubic Meters.....b) 20 Cubic Meters.....c) More than 20 Cubic Meters.....
3. Is there a pipeline connected to your residence?  
a) Yes \_\_\_\_\_ b) No \_\_\_\_\_
4. If yes, what is your average monthly cost of piped tap water in your home?  
a) \$5-20..... b) \$20-35.....c) \$35-50..... d) None.....
5. Do you utilize private water suppliers such as water trucks (booyadle), or donkey cars (biyoole) for your household?  
a) Yes \_\_\_\_\_ b) No \_\_\_\_\_
6. If yes, what is your average monthly cost for private water suppliers?  
a) \$5-20..... b) \$20-35.....c) \$35-50..... d) None.....
7. How would you rate the water supply availability in Hargeisa City?  
a) Excellent (b) Good (c) Average (d) Poor (e) Very poor
8. Are you satisfied with the current water supply service in terms of the cost?  
a) Very satisfied b) Satisfied c) Neutral d) Dissatisfied e) Very dissatisfied
9. Have you noticed any changes in water prices in Hargeisa City in the past year?  
a) Yes b) No
10. If yes, how would you describe the changes in water prices?  
a) Significant increase b) Slight increase c) No change d) Slight decrease e) Significant decrease
11. Do you think the economic condition of households affects access to water supply?  
a) Strongly agree b) Agree c) Neutral d) Disagree e) Strongly disagree

**SECTION C: Environmental Factors That Affect Water Supply in Hargeisa City**

1. Are you aware of the sources of water used for the supply in Hargeisa city?  
a) Yes b) No
2. Which sources of water do you think are most commonly used for water supply in

Hargeisa city? (You can select multiple options)

- a) Groundwater    b) Surface water (e.g., rivers, lakes)    c) Rainwater harvesting  
d) Imported water    e) Other (please specify) \_\_\_\_\_

3. How concerned are you about the quality of water supplied in Hargeisa City?

- (a) Very concerned    (b) Concerned    (c) Neutral    (d) Not concerned    (e) Not at all concerned

4. Have you ever experienced water contamination issues in Hargeisa City?

- a) Yes    (b) No

5. If yes, what type of water contamination issues have you encountered? (You can select multiple options)

- a) Chemical pollutants    b) Microbial contaminants    c) Heavy metals    d) Sediments or turbidity  
e) Other (please specify) \_\_\_\_\_

6. How satisfied are you with the water quality testing and monitoring measures implemented in Hargeisa City?

- (a) Very satisfied    (b) Satisfied    (c) Neutral    (d) Dissatisfied    (e) Very dissatisfied

7. How important do you think it is to protect the natural water sources (e.g., rivers, aquifers) in and around Hargeisa city?

- (a) Very important    (b) Important    (c) Neutral    (d) Not important    (e) Not at all important

8. Are you aware of any climate change impacts on water availability in Hargeisa city?

- (a) Yes    (b) No

9. If yes, what climate change impacts have you observed or heard of in relation to water supply in Hargeisa city? (You can select multiple options)

- (a) Decreased rainfall    (b) Increased drought frequency    (c) Flooding events    (d) Changes in water availability in natural sources    (e) Other (please specify) \_\_\_\_\_

10. How effective do you think the current water management practices are in mitigating the environmental impacts on the water supply in Hargeisa city?

- a) Very effective    (b) Effective    (c) Neutral    (d) Ineffective    (e) Very ineffective

11. What suggestions do you have for improving the environmental conditions related to water supply in Hargeisa City?

#### **SECTION D: Social Factors That Affect Water Supply in Hargeisa City**

1. How would you rate the level of awareness among residents regarding water conservation practices in Hargeisa city?

a) Very aware (b) Somewhat aware (c) Neutral (d) Not very aware (e) Not aware at all

2. How important do you think it is for residents to be educated about water conservation and its impact on water supply in Hargeisa city?

a) Very important (b) Important (c) Neutral (d) Not important (e) Not at all important

3. Have you observed any differences in water usage behaviors between different socio-economic groups in Hargeisa city?

a) Yes b) No

4. If yes, please describe the differences you have observed in water usage behaviors between socio-economic groups.....

5. Do you believe that sociocultural norms and practices influence water usage patterns in Hargeisa City?

a) Strongly agree (b) Agree (c) Neutral (d) Disagree (e) Strongly disagree

6. How would you rate the level of community participation in water management initiatives in Hargeisa City?

a) Very high (b) High (c) Moderate (d) Low (e) Very low

7. Are there any social barriers or challenges that hinder effective water management and access in Hargeisa city?

a) Yes b) No

8. If yes, please describe the social barriers or challenges that hinder effective water management and access in Hargeisa city.....

9. How satisfied are you with the level of community engagement and involvement in decision-making processes related to water supply in Hargeisa city?

a) Very satisfied b) Satisfied c) Neutral d) Dissatisfied e) Very dissatisfied

10. Are you aware of any social initiatives or programs aimed at improving water supply in Hargeisa city?

a) Yes b) No

11. How do you think social inequalities impact access to water supply in Hargeisa city?  
.....

**SECTION E: Water Management System in Hargeisa City**

1. How would you rate the overall performance of the water management system in Hargeisa city?

a) Excellent b) Good c) Average d) Poor e) Very poor

Are you satisfied with the accessibility of water supply infrastructure (e.g., taps, water distribution network) in your area of Hargeisa city?

- a) Very satisfied    b) Satisfied    c) Neutral    d) Dissatisfied    e) Very dissatisfied

2. How would you rate the responsiveness of the water management authorities in addressing water-related issues and complaints in Hargeisa city?

- a) Very responsive    b) Responsive    c) Neutral    d) Not very responsive    e) Not responsive at all

3. Are you aware of any water supply disruptions or shortages in Hargeisa city?

- a) Yes    b) No

4. If yes, how frequently do you experience water supply disruptions or shortages?

- a) Daily    b) Weekly    c) Monthly    d) Occasionally    e) Rarely or never

5. Have you experienced any issues with the billing and payment system for water services in Hargeisa city?

- a) Yes    b) No

6. If yes, please describe the issues you have encountered with the billing and payment system for water services.....

7. How effective do you think the water management authorities are in addressing water conservation and sustainable water use practices in Hargeisa city?

- a) Very effective    b) Effective    c) Neutral    d) Ineffective    e) Very ineffective  
b) No

8. How well do you think the water management system in Hargeisa City is prepared to handle future population growth and increased water demand?

- a) Very well-prepared    b) Well prepared    c) Neutral    d) Not well-prepared    e) Not prepared at all

9. Are you satisfied with the transparency and accountability of the water management authorities in Hargeisa city?

- a) Very satisfied    b) Satisfied    c) Neutral    d) Dissatisfied    e) Very dissatisfied

## Appendix 2: Structured Interviews for Government Officials

The purpose of this interview questions is to collect data that are imperative to “Assessing the effects of urbanization on water supply in Somaliland: A case study of Hargeisa city”. The data applied for the directing to academic research fulfilment of the Master`s Degree of Science (MSc) in Pan African University Institute for Water and Energy Science (incl. Climate Change – PAUWES). The information you provide in these questions have been utilized only for study purposes. Your genuine response is highly valuable for the achievement of the objectives of the research.

Confidentiality is guaranteed, so please participate in answering out this interview openly and honestly.

Researcher Name: Mawliid Mustafe Ahmed

Email: [mawliid108@gmail.com](mailto:mawliid108@gmail.com)./ Tell: +252634409103

Position: MSc student at PAUWES,

**I thank you, in advance for your collaboration.**

### Personal Information

- 1) Name.....
- 2) Your position in the organization.....
- 3) Educational Level.....
- 4) years of Experience in the office.....

- 
1. What are the primary economic challenges faced by your office in ensuring a reliable and affordable water supply in Hargeisa City?
  2. How do financial resources and budgetary allocations impact the development and maintenance of water infrastructure in Hargeisa City?
  3. Can you provide insights into any economic strategies or initiatives implemented to enhance water supply accessibility and affordability in Hargeisa City?
  4. How do financial resources and budgetary allocations impact the development and maintenance of water infrastructure in Hargeisa City?
  5. Can you provide insights into any economic strategies or initiatives implemented to enhance water supply accessibility and affordability in Hargeisa City?
  6. What are the major environmental challenges or risks that affect the availability and quality of water resources in Hargeisa City?

7. How does climate change affect the water supply infrastructure and availability in Hargeisa City? Are there any adaptation measures or plans in place to mitigate these effects?
8. Do seasonal variations affect water availability in the area? If yes please explain.....
9. Is the water available enough to meet the demand for the citizens of Hargeisa city?
10. Can you elaborate on the steps taken to protect water sources, watersheds, and groundwater reserves to ensure a sustainable water supply for future generations?
11. What are the key social factors that influence water demand and consumption patterns in Hargeisa City?
12. How does your office engage with the local community to raise awareness about water conservation and efficient water use practices?

### **Appendix 3. Structured Interview for Private Water Vendors Officials**

The purpose of this interview questions is to collect data that are imperative to “Assessing the effects of urbanization on water supply in Somaliland: A case study of Hargeisa city”. The data applied for the directing to academic research fulfilment of the Master Degree of Science (MSc) in Pan African University Institute for Water and Energy Science (incl. Climate Change – PAUWES). The information you provide in these questions have been utilized only for study purposes. Your genuine response is highly valuable for the achievement of the objectives of the research.

Confidentiality is guaranteed, so please participate in answering out this interview openly and honestly.

Researcher Name: Mawliid Mustafe Ahmed

Email: [mawliid108@gmail.com](mailto:mawliid108@gmail.com)./ Tell: +252634409103

Position: MS student at PAUWES,

**I thank you, in advance for your collaboration.**

#### **Personal Information**

- 1) Name.....
- 2) your position in the organization.....
- 3) Educational Level.....
- 4) years of Experience in the office.....

- 
1. How do you perceive the economic dynamics and factors that impact the water supply industry in Hargeisa City, particularly in terms of pricing, demand, and market competition?
  2. How do you determine the pricing of water delivery services as a private water trucker in Hargeisa City, and what are the main factors that influence your pricing decisions?
  3. As a private water trucker, what are the main economic challenges you face in accessing and securing water sources for your business operations in Hargeisa City?
  4. How do you manage the costs associated with water acquisition, transportation, and maintenance of your water trucking business in Hargeisa City, and what measures do you take to ensure profitability while providing affordable services to customers?
  5. How do you navigate the balance between providing affordable water delivery services to customers and ensuring the financial sustainability and profitability of your private water trucking business in Hargeisa City?

6. What environmental challenges do you encounter as a private water trucker in Hargeisa City, such as water source sustainability, pollution, or climate change impacts, and how do these challenges influence your operations?
7. How do you incorporate environmentally friendly practices in your water delivery services, including water conservation, waste management, or energy efficiency, to mitigate the environmental impact of your business in Hargeisa City?
8. As a private water trucker, what social factors do you consider when determining the locations and timing of water deliveries to meet the needs and preferences of different customer groups in Hargeisa City?
9. How do social factors, such as cultural practices, social inequalities, or community engagement, influence the demand for and access to water delivery services in different areas of Hargeisa City?
10. How does the current water management system impact your work as a private water trucker, both positively and negatively?
11. From your perspective, what improvements or changes would you suggest in the water management system in Somaliland particularly Hargeisa City to enhance the efficiency, reliability, and sustainability of the water supply?
12. How does the coordination and collaboration between the private sector (water truckers) and government sector (the existing water management system) in Hargeisa City contribute to addressing water supply challenges, and how can this collaboration be further improved?

## Appendix 4. Water Test Quality Data



### HARGEISA WATER QUALITY CONTROL LABORATORY SHAYBAADHK A HUBINTA TAYADA BIYHAHA HARGEISA



REF No: 2023-HWQCL-0119

TEST REPORT

DATE: 07/12/2023

Customer Details: ~~XXXXXXXXXXXXXXXXXXXX~~  
 Received Date: 06/12/2023  
 Sample Collected by: ~~XXXXXXXXXXXXXXXXXXXX~~  
 Sample received by HWQCL at a temperature of 20°C

Sample Description: ~~XXXXXXXXXXXX~~  
 Sample ID: 355  
 sample location: ~~XXXXXXXXXXXX~~  
 Analysis Date: 06/12/2023

Region: ~~XXXXXXXXXXXX~~  
 Time: 8:30am

Form: Liquid  
 Physical Condition: Good

PHYSICAL PARAMETER					
No	PARAMETER	RESULTS	UNIT	STANDARD VALUE	INSTRUMENT
1	PH	7.77	pH units	6.5 - 8.0	PH meter
2	TURBIDITY	0.235	NTU	5	Turbidity meter
3	CONDUCTIVITY	103.5	µS/cm	1500	Multiparameter meter
4	TOTAL DISSOLVED SOLIDS	51.22	mg/L	1000	Multiparameter meter
5	SALINITY	102	PPM	1000	Multiparameter meter
CHEMICAL PARAMETER					
6	CALCIUM	Nil	Mg/l	300	Uv-vis spectrophotometer
7	SODIUM	11	Mg/l	200	Uv-vis spectrophotometer
8	NITRATE	Nil	Mg/l	50	Uv-vis spectrophotometer
9	NITRITE	Nil	Mg/l	3	Uv-vis spectrophotometer
10	TOTAL HARDNESS	Nil	Mg/l	500	Uv-vis spectrophotometer
11	SULFATE	19	Mg/l	250	Uv-vis spectrophotometer

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**HARGEISA WATER QUALITY CONTROL LABORATORY**  
**SHAYBAADHKA HUBINTA TAYADA BIYHAHA HARGEISA**



12	IRON	0.01	Mg/l	0.3	Uv-vis spectrophotometer
13	MANGANESE	Nil	Mg/l	0.5	Uv-vis spectrophotometer
14	POTASSIUM	2	Mg/l	12	Uv-vis spectrophotometer
15	FLOURIDE	0.18	Mg/l	1.5	Uv-vis spectrophotometer
16	CHLORIDE	3.3	Mg/l	250	Uv-vis spectrophotometer
17	Copper	Nil	Mg/l	2	Uv-vis spectrophotometer

**References**

The methods for the determination of inorganic substances in water samples are analogous to the official methods of EPA / ASTM / APHA/ ISO or DIN.

**Remarks:** According to WHO guidelines, some of the starred parameters exceeded the maximum acceptable concentrations for drinking water, corrective action is required.



Reviewed by

Abdirahman Mohamoud Elmi  
 Laboratory Manager  
 Manager



Approved By  
 Mohamed Ali Darod  
 HWA General

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**Appendix 5. Ahmed Dhagah and 26 June districts household estimate,  
(Hargeisa Local Government, 2022).**

<b>No:</b>	<b>Village Clusters for A. Dhagah</b>	<b>Households Estimates</b>	A.Dhagah + 26 June clusters 18,746 + 21,997 = 40,743
<b>1.</b>	Siinay	3350	
<b>2.</b>	Ahmed Guray	2000	
<b>3.</b>	Half London	3050	
<b>4.</b>	Badhka	2325	
<b>5.</b>	Cakaara	1817	
<b>6.</b>	October	3119	
<b>7.</b>	Masalaha	3090	
<b>8.</b>	<b>Total</b>	<b>18,746</b>	
<b>Village Clusters for 26 June</b>		<b>Households Estimates</b>	<b>Total: 40,743</b>
<b>1.</b>	Goljanno	4,300	
<b>2.</b>	Cayngal	4100	
<b>3.</b>	Durriya	3767	
<b>4.</b>	Almis	4000	
<b>5.</b>	Waaheen	2300	
<b>6.</b>	Idaacadda	3530	
<b>7.</b>	<b>Total</b>	<b>21,997</b>	

### Appendix 6. Sampling procedure.

No	Target Respondents	Selection of Sample	Selection of Method	Methods of Data Collection
1	Government & PWS officials	Sampling without probability	Purposive Sampling	Predefined - Interview
2	Respondent of the Households	Sampling with Probability	Simple Random Sampling (SRS)	Questionnaires

### Appendix 7. HHs and Population estimate of Hargeisa city, (Hargeisa Local Government, 2022).

S/N	District Name	Number OF HHs	Population	Year
1.	Ahmed Dhagah	18,746	131,222	2022
2.	26 June	21,997	153,979	2022
3.	Ibrahim Kodbour	21,189	148,323	2022
4.	Mohamed Mooge	20,638	144,466	2022
5.	Mohamoud Haibe	19,200	134,400	2022
6.	31 May	16,833	117,831	2022
7.	Mo'allin Haroun	17,345	121,415	2022
8.	Ga'an Libah	18,900	132,300	2022
9.	Ga'ma Dhere	18,050	126,350	2022
<b>Total</b>		<b>172,898</b>	<b>1,210,286</b>	<b>2022</b>

## Appendix 8. List of Photos During Data Collection



Photo 1. Donkey Car Vendors in Hargeisa City.



Photo 2. Tanker Distributing a Water to household in Hargeisa City, 2024.



Photo 3. Hargeisa Urban Water Upgrade Project, (2024).



Photo 4. Researcher visit the Urban Water Extension Project in Hargeisa, (2024).



Photo 5. Researcher filling a questionnaire from household wife.