

**SUSTAINABLE DOMESTIC WATER CONSUMPTION IN A CHANGING CLIMATE: A
CASE STUDY OF AGENEBODE**

BY

Emike Victory DOKPESI (Miss)

LSC2006905

**A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF ENVIRONMENTAL
MANAGEMENT AND TOXICOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY
OF BENIN, BENIN CITY. IN PARTIAL FULFILMENT FOR THE REQUIREMENTS
FOR THE AWARD OF BACHELORS OF SCIENCE DEGREE (B.Sc.) IN
ENVIRONMENTAL MANAGEMENT AND TOXICOLOGY**

DATE

NOVEMBER, 2025

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DATE

NOVEMBER, 2025

CERTIFICATION

This is to certify that this research titled **Sustainable Domestic Water Consumption In A Changing Climate; A Case Study Of Agenebode** was carried out by **Dokpesi Emike Victory** and presented to the Department of Environmental Management and Toxicology, Faculty of Life Sciences, University of Benin, Benin City; in partial fulfilment of the requirement for award of Bachelor of Science (B.Sc.) in Environmental Management and Toxicology. It was conducted under stable conditions, was carefully supervised and subsequently approved as having met the requirements for the award of Bachelor of Science degree in Environmental Management and Toxicology.

Dr. S. ODIANA Ph.D

(PROJECT SUPERVISOR)

Date

PROF. E. T. AISIEN

(HEAD OF DEPARTMENT)

Date

DECLARATION

I, **Dokpesi Emike Victory**, declare that **Sustainable Domestic Water Consumption In A Changing Climate; A Case Study Of Agenebode** is my own work and that all sources that I have used or quoted have been acknowledged by means of complete references and that this work has not been submitted before for any other degree at any other University.

DOKPESI EMIKE VICTORY

Date

DEDICATION

This project is dedicated to God Almighty for seeing me through the entire process of this project and to my parents and siblings for their moral and financial support and for encouraging me when I needed it the most.

ACKNOWLEDGMENTS

I wish to express my profound gratitude to God Almighty, who sustains all life, for giving me the knowledge, wisdom and understanding during this time. I sincerely want to acknowledge my parents, Mr. & Mrs. Festus Ayemhe Dokpesi, for their unwavering support; love and financial assistance throughout this journey; and my siblings, Peace, Theophilus, Joyce and Gideon, for their love and support during this period. I also would appreciate and thank my supervisor, S. Odiana Ph.D, for his unwavering support and for always making out time to guide and encourage me all through the process of this project. I really appreciate all you have done for me sir and may God bless you and your family. I want to sincerely appreciate Prof. E.T. Aisen, the head of department of the department of Environmental Management and Toxicology; Dr. Eghomwanre, A. F., my genial course adviser, who is always ready to listen and assist, whenever I needed help; and to all my lecturers for all their efforts throughout my academic journey. Finally, I would like to thank my friends, Joanne, Jessica, Oghenefejiro, Purity, Esther, Oghosa, Ose and Delight supporting and encouraging me throughout this project. And to the friends EMT gave me, Anita and Omose, just to mention a few who made my journey in EMT fun and memorable, I am genuinely grateful for all you have contributed in my life. God bless you all

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ABSTRACT

Climate change has become a significant global threat in the 21st century. This has led to various crises, including irregular precipitation patterns, flooding, melting ice caps, and droughts. These changes are driven by both natural factors and human activities such as greenhouse gas emissions, changes in Earth's orbit, fossil fuel combustion, and tectonic movements. One of the most critical impacts of climate change is the water supply crisis. This study aims to assess how climate change influences the sustainability of water supply in Agenebode. Data was collected by distribution of one hundred and fifty hard-copy Likert-scale questionnaires to respondents and analyzed using descriptive and correlation statistics through the use of Statistical Package for Social Sciences (SPSS). The result shows that there is minimal vulnerability of water supply to climate change, the people do not behave in a way to cope with the impact of climate change, socioeconomic and cultural factors have less influence on domestic water consumption patterns and sustainability and there are little challenges in implementing sustainable water management practices. Therefore, it is seen that the people in the study area have minimal challenges in sustaining domestic water supply in a changing climate. It is recommended that the promotion of climate-resilient infrastructure capable of withstanding floods and droughts is essential for sustainable water management in vulnerable communities.

CHAPTER ONE

1.1 BACKGROUND OF THE STUDY

Water is a vital resources needed for the sustenance of life (Anake *et al.*, 2013).Climate change has been a major global threat especially in the 21st Century. Climate is the average weather conditions of the Earth that spans over a long period of time while climate change is the variability that occurs as a result of different natural and human activities for a long period of time. According to IPCC(2007), Climate change is a change in the state of the climate that can be identified by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer .

This profound shift in Climate cannot be overly emphasized without a detailed look at the impact on water supply. The availability of quality drinking water is a powerful environmental health determinant (WHO,2011). Flooding and drought have been a major water crises caused by climate change (Pizzorni *et al.*,2024). Pollutants and faecal from flood water intrudes into domestic water supply thereby impacting it's quality. Climate change is associated with increase in temperature which can lead to drought, melting of ice caps whose runoff contribute to rise in sea level. Rise in Sea water level can lead to intrusion into coastal aquifer which can contaminate fresh water. (Basack *et al.*,2022)

In Nigeria, the major effect of climate change is flooding, drought and desertification. Over the past decades, the average number of rainy days has decreased, and when rain does occur, it is often in short, intense bursts that lead to flash floods rather than effective groundwater recharge. Surface water bodies, such as rivers, streams, and lakes (mostly Lake Chad, which has shrunk by over 90% in recent decades), are receding or drying up entirely. This directly reduces the

availability of water for domestic use, agriculture, and livestock. Wells and boreholes are either drying up completely or requiring much deeper drilling, making access to potable water more difficult and expensive. Beyond the direct impacts on water quantity,

Some areas have generously benefited from climatic conditions, experiencing increased rainfall and water runoff compared to pre-recorded historical documents in those locations. However, in areas like Agenebode, the negative impacts of climate change, such as increased cases of drought, can impair water quality and domestic water consumption, outweighing the advantageous effects. The different effects of climate change on domestic water availability include increased temperature, extreme weather events, and changes in precipitation patterns, which can lead to build up of algal blooms caused by warmer water temperatures. Runoffs from extreme rainfall events increase the amount of pollutants entering water bodies, and decreased water flow caused by drought can increase the concentration of pollutants (APHA, 2019). This can impact water quality by affecting dissolved oxygen, micropollutants, and pathogens, thereby affecting the sustainability of domestic water supply (Delpha, 2009). This highlights the need to assess the various ways in which climate change affects domestic water consumption in Agenebode.

Agenebode, a Community found in Etsako East LGA, Edo State being a riverine community faces its primary water challenges from excessive flooding of the River Niger annually. Etsako East Local Government Area, where Agenebode is located, is the third most water-stressed local government area in the Edo North region (Momoh *et al.*, 2021). This information indicates that water sustainability is being threatened, which could affect domestic water consumption.

1.2 STATEMENT OF THE PROBLEM

Universal access to safe drinking water is not merely a convenience but a fundamental human need and a recognized human right (UNICEF, 2023). This principle forms the bedrock of the United Nations Sustainable Development Goal 6 (SDG 6), which ambitiously aims to ensure clean water and sanitation for all by the year 2030. However, the realization of this critical goal is severely hindered by the escalating impacts of climate change, a challenge accurately felt in many vulnerable communities across Nigeria. In Agenebode, a vital riverine town in Edo State, the most significant obstacle to achieving this Sustainable Development Goal is the recurrent and increasingly severe annual flooding, a direct consequence of its geographical closeness and vulnerability to the River Niger.

Agenebode's unique location along the banks of River Niger renders it highly susceptible to flooding. The town experiences annual flooding, a phenomenon that has intensified due to altered precipitation patterns and increased river discharge, often aggravated by upstream dam releases. This chronic flooding leads to a widespread and dangerous contamination of the town's water sources. The pollutants introduced during these torrent are hazardous; agricultural pesticides, commonly used in the surrounding farmlands, are washed into the river, faecal matter from pit toilets, which are the most common sanitation infrastructure in Agenebode, overflows and contaminates water and contaminants from the market, situated close to the river, are swept into the water bodies. The direct result of this contamination is a significant degradation of drinking water quality, making it unsafe for consumption.

This alarming contamination has a direct and devastating impact on public health, leading to recurrent outbreaks of waterborne diseases such as cholera, diarrhoea diseases, and typhoid fever. For many residents of Agenebode, the River Niger serves as a major source of water supply,

whether directly or through its influence on groundwater, making them highly vulnerable to these waterborne pathogens when the river is in flood. Furthermore, the boreholes and wells, which are intended to provide safer alternatives, are often not constructed to a quality suitable to withstand the intensity of these annual floods. Their shallow depths or unprotected wellheads allow floodwaters to infiltrate, rendering them equally contaminated and unusable. The consequence is that women and children, traditionally burdened with water collection, are forced to trek increasingly long distances in search of alternative, often unreliable or equally unsafe, water sources. This task not only consumes valuable time that could be spent on education or productive activities but also contributes to significant physical strain and stress-related diseases.

Beyond the immediate crisis of flooding, Agenebode also experiences broader climatic shifts manifested as altered precipitation patterns. This includes not only more intense rainfall events but also prolonged dry spells and erratic timing of the rainy seasons. Such irregularities directly impact natural hydrological processes, leading to inadequate groundwater recharge. Over time, this results in declining groundwater tables and the drying up of shallow wells and boreholes, contributing to overall water scarcity. While Agenebode's direct vulnerability is flooding, these broader climatic changes contribute to a national picture of water stress,

In light of these pressing and interconnected climate-induced challenges, the ability of Agenebode to achieve universal access to safe and sustainable domestic water is severely compromised. The current water supply infrastructure and community coping mechanisms are evidently insufficient against the backdrop of a changing climate. There is a critical knowledge gap concerning the precise impacts of these climatic shifts on Agenebode's unique water systems and the most effective, localized strategies for building resilience. Therefore, this study is essential to comprehensively investigate the specific ways in which climate change affects

domestic water supply in Agenebode and to identify viable, context-specific solutions that can safeguard this vital resource for the community.

1.3 AIMS AND OBJECTIVE AIMS

This study aims to assess the impacts of climate change on domestic water supply in Agenebode, Edo State, and to identify strategies for enhancing its sustainability.

OBJECTIVES

1. To identify the role of climate change in impacting domestic water supply in Agenebode.
2. To assess the qualitative impacts of climate change on various domestic water sources in Agenebode.
3. To check the vulnerability of existing domestic water supply infrastructure to climate change impacts in Agenebode.
4. To explore the current coping strategies employed by households and local institutions in Agenebode to manage climate-induced challenges to domestic water supply.
5. To determine the implications of climate change for sustainable water availability and management in Agenebode.

1.4 SIGNIFICANCE OF THE STUDY.

This research directly addresses an impact of climate change on domestic water supply within riverine communities like Agenebode. While focus are on global water resources, there are gap in detailed insights into their implications at the community level, particularly in highly susceptible settlements like

Agenebode. This research will, therefore, provide significant information on hydrological shifts, patterns of water quality degradation, infrastructure vulnerabilities, and household coping mechanisms unique to local context.

Specifically, this findings can inform resilient water infrastructure development, ensure the creation of effective early warning systems for floods, and improve water quality monitoring protocols tailored to the unique challenges of regions like Agenebode.

Crucially, this research is designed to yield benefits for the local community of Agenebode by precisely identifying the most critical vulnerabilities of their water sources and assessing the effectiveness of existing coping strategies which can lead to tangible improvements in residents' access to safe and sustainable water.

CHAPTER TWO

LITERATURE REVIEW

2.1 CONCEPT OF CLIMATE CHANGE

2.1.1 OVERVIEW AND DEFINITION OF CLIMATE CHANGE

Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. These changes have a broad range of observed effects on the Earth. According to IPCC(2007), Climate change is a change in the state of the climate that can be identified by changes in the mean and / or the variability of its properties, and that persists for an extended period, typically decades or longer . Over the years, the world has been experiencing a changing climate which reflects drastically in the melting of ice caps, sea level rise, seasonal shift, ocean acidification, changes in precipitation pattern and global temperature increase. Climate Change can either be detected easily by humans which are the change in the temperature of the earth and also the weather conditions while there are some changes which cannot easily be felt.

The Earth is warnings at a faster than the Ice age period. Climate change can be caused naturally without human intervention. This include solar activity, volcanic eruption, Earth orbital changes and some other factors such as plate tectonics and change in ocean currents. The mean length of 11 years sun cycle known as the schwanbe cycle are playing an important role in climate change variability, (Hiroko *et al.*,2010) During volcanic eruption, greenhouse gasses such as Sulphur dioxide and Carbon dioxide which promotes global warming are emitted . Earth Orbital change also known as Milankovitch cycles also play a role in climate change by altering the amount and distribution of solar energy across the earth. Anthropogenic cause of climate change refers to human activities that contribute to climate change. This is referred to as the key

driver of climate change compared to the natural cause. Thus include burning of Fossil Fuel, Deforestation, Industrial Processes and Transportation. This human activities are seen as major human activities that contribute to climate change. Human day to day activities which should be overlooked can also contribute to climate change such as taking long showers, use of incandescent lightning, eating of meat and use of single use plastics can also contribute to this change.

Researchers has agreed that climate change effect are one of the major challenges faced by mankind as it leaves humans with an irreversible consequence.(Luo., 20220) The effects of climate change in different dynasties may have be hidden and not obvious but in the long tales of history, this climate variability was not just a coincidence which was overlooked in history and this has lead to the rise and fall of different dynasties such as the collapse of the Ming dynasty, The Rise and Fall of Ancient Indian Civilization, The Rise and Fall of Ancient Indian Civilization and even the Viking settlers of Greenland, in the far north Atlantic have been said to have been affected by climate change.(Zheng *et al.*, 2014; WEF, 2019; Luo, 2020)There have been argument among scientists that the devastating impacts of climate change for nature and human poses an existential threat to human civilization..

2.1.2 HISTORICAL OVERVIEW OF CLIMATE CHANGE

The Earth's has always changed through out history. The Earth was assumed to be colder than what it was today. (Notz, 2020) Although climate change has been as old as the discover of the Earth, research on climate change started in the 19th century when the ice age and a rise in the temperature was detected. This has further drive researches in climate change itself. Since the 20th century, researches and technologies has helped mitigate the global impact of climate change. From the use of GIS to monitor the climate to the use of GIS, IoT as well as drones and

aerial monitoring which has reduced the climatic change of the earth compared to when it was discovered in the 18th Century. This global problem would not have been acknowledged if it was not first discovered by Joseph Fourier a French physician in 1824 proposed that greenhouse effects, which he did not name that way. He described that earth traps heat similar to a hot box as calculate the temperature in a mathematical way. (Lynch, 2019) In 1956 Eunice Foote proposed that carbon dioxide and water vapour could cause in earth to warm three years before John Tyndall who demonstrated this theory did. (Joosse,2023) In 1896, Arrhenius calculated global climate sensitivity in proportion to carbon dioxide present in the atmosphere. In 1938, Guy Callender linked the global temperature change to human activities such as the burning of fossil fuels. Milankovitch researched on the astrological theory link to climate change such as the Orbital cycles which is today know as the Milankovitch cycles. (Ivanović, 2018) Gilbert Plass was a pioneer in calculating how solar and infrared radiation affect climate change.(Gavin,2010) Climate change stated gaining recognition in the past 50 years with the establishment of the Intergovernmental Panel On Climate change in 1979. Other organizations such as the United Framework on Climate change such was adopted in 1992 and the The Paris agreement which was created in 2015 has long been adopted to tackle the menace disturbing the earth.

2. 1.3 CLIMATE CHANGE TRENDS IN NIGERIA

Nigeria is identified as one of the countries highly vulnerable to climate change impact(Okafor,2025). According to world Bank 2021, ranked as 160 out of 181 countries in the 2020 ND-GAIN Index and this shows the extent of the country's vulnerability to climate change and other global challenges. Between 1960 and 2006, there was an increase in the country's average annual temperature by 0.8°C with a slight increase occurring since 1980 and the northern region was identified as those who experienced the greatest increase and also a decrease

in precipitation of 3.5 mm per month per decade. The most climatic event experienced in Nigeria include, extreme rain fall event leading to flooding, decreased precipitation which causes drought, and also heat waves and this climate is expected to continually change in Nigeria. Increased variability in rainfall and extreme rainfall events are expected across most of the country, Nigeria is classified among the top ten most vulnerable countries in the world to the impacts of climate change and natural hazards (Worldbank,2021) Climate change affect the geopolitical zones in Nigeria, with the southern region experiencing flooding which displaces people from their homes. This can be identified in the notorious 2012 floods, which affected 7 million people in 30 of the 36 states, displaced 2.3 million people, killed 363 people (Okafor *et al.*,2025) Sea level rise is expected to increase Nigeria's vulnerability to floods southern cities such as Lagos and coastal areas. Desert encroachment is also prevalent in the northern region due to altered precipitation . climate variability and change trends in Nigeria treatments different sectors in the country

2.1.4 RELEVANCE OF CLIMATE CHANGE TO WATER RESOURCES

According to UN water, climate change is a primary cause of water crisis. This increases water demand while reducing water supplies. Climate change makes water more reduced due drought called by delayed precipitation, more polluted from flooding which can wash faecal matter into the water and salt water intricate the fresh water body as a real of sea level rise. Climate change increases water demand as water is lost due to increased temperature and evaporation. Climate change can trigger the melting of the ice caps. As a result of increased temperature, warmer may create a good environment for the Growth of algae which can impact water quality. Climate change is often associated with sea level rise. As a result of altered precipitation and increased

temperature, this can lead to an increased evaporation of both surface and ground water leading to water crisis.

2. 2 CAUSES OF CLIMATE CHANGE

The Causes of climate change can be classified into two main driving force and this are the Natural Causes and Human Causes.

2.2.1 NATURAL CAUSES

This are climate change drivers that occur naturally.

1. **VOLCANIC ERUPTION:** This activity negatively contribute to climate change climate change through the release of gasses and aerosols into the atmosphere. Volcanic eruption is natural phenomenon whereby magna is forced out of a crater in the earth's surface. It is usually followed by ashes, dust and gases and this is caused by unstable earth's underground's temperature. *****REFERENCE***** The gases emitted during volcanic eruption include Carbon dioxide along side sulfur dioxide, Hydrogen sulfide, water vapor, hydrochloric acid, chlorine, bromine, sulfuric acid and aerosol. Carbon dioxide emitted during this eruption is a green house gas, sulphur containing gases combined with water in the atmosphere there by causing acid rain, smaller particles of ash emitted during volcanic eruption can accumulate in the troposphere thereby blocking sunlight, Sulphur acid aerosol accumulate in the atmosphere and there by reflect back solar radiation back into space.(Hu *et al.*,2022)

2. **CHANGE IN THE EARTH ORBIT**

The change in the earth orbit is also known as the Milankovitch cycles and this changes can either be looked as in change in the earth's orbit, Tilt shift and Wobble circle. Changes in solar radiation and temperature are caused by the rotation of the Earth, and changes in seasons are

caused by the tilt of the Earth and this changes can either have warming and cooling effect on the Earth. The change caused by this Milankovitch cycles can cause a change in the climate over a long period of time which can cause rise in Sea level, growing and melting of the ice sheets.

3. TECTONICS PLATES: This has different effects on earth itself such as continental shift, influences ocean currents and can also influence volcanoes and formation of mountains and all these can influence climate change. When tectonics plates moved abruptly, it increases the possibility of volcanic eruption happening and this has made it to be identified as a key driver in climate change until recently.

2. 2.2 ANTHROPOGENIC (HUMAN) CAUSES

1. BURNING OF FOSSIL FUEL: This is the primary anthropogenic driver of global climate change. Literally, most activities on Earth such as transportation, generation of electricity, cooking and industrial activities depends on the use of fossil fuels and lead to the emission of carbon dioxide and nitrogen oxide into the atmosphere which is a major greenhouse gases which traps heat in the atmosphere thereby causing climate change.(Client Earth, 2025). According to IPCC in their 2005 carbon capture and storage report, fossil fuel has been recognized as a leading release of up to 75% on Carbon dioxide into the atmosphere. It is released as a result of burning its derivatives such as crude oil, bio gas and coal. When fossil fuels are burnt, the releases Carbon dioxide faster than it took for it to be formed as fossil. Soots usually settles on snow increases absorption of light since they do not reflect light which can lead to the rapid melting of ice caps.
2. DEFORESTATION: In 2023, global loss of tropical forests totaled 3.7 million hectares(Goldman *et al.*,2025) Deforestation contribute greatly to a change in the climate. Forest are known as a major carbon sink as trees stores excess carbon in their roots and

stems. Both the decay and burning of trees releases carbon into the atmosphere. When these trees are cut or burn down, carbon dioxide is released into the atmosphere rapidly at a rate higher than it took the trees to store this carbon. This can also reduce the number of trees available to absorb Carbon dioxide which is needed by trees for respiration.

3. **AGRICULTURE:** According to FAO, Livestock account for 14.5% of human caused green house gases emissions. Different activities from the agricultural sector can cause the release of greenhouse gasses which causes climate change. They include the use of nitrogen based fertilizers, Ruminants animals are also responsible for green house gases emission. When they digest their food, they make a burp sound which emits methane.(Douglas,2023) Storage of manure can also lead to the release of methane. Also during agriculture, trees are fell to cultivate on the soil which can cause climate change. The tilling of the soil, use of tractors and even food waste produced can cause greenhouse gasses emissions which can drive climate change.
4. **INDUSTRIAL PROCESSES:** Greenhouse gases are released from a variety of Industrial activity. Industrialisation drives climate change both directly or indirectly. Industrial activities such as mining, construction as well as manufacturing causes climate change. Indirectly such that fossil are burnt during transportation to the industry, clearing of lands to erect this structures and also using electricity generated from fossil fuels. Some of these fossil fuels may not be burnt, they can be used in making products. Chemical reaction during industrial processes may release carbon dioxide into the atmosphere. Various industries process such as the manufacturing of steel and iron, production of electronic, manufacturing of cement and also mining releases CO₂ into the atmosphere.

2.3 GLOBAL IMPACTS OF CLIMATE CHANGE

2.3.1 ENVIRONMENTAL IMPACT

1. **MELTING SEA ICE:** Melting of Sea Ice reduces sunlight reflection. Sea ice helps reflect solar radiation back to the sun. The faster the seas ice melts, the higher the solar radiation reaching the earth surface which can also accelerate the ice melting and increase the temperature of the earth. This can also leads to rise in Sea level as the ice flows back into the ocean. The Artic is the habitat of some animals such as Penguins, Polar bear. This can cause the extinction of those animals. According to University Corporation for Atmospheric Research (UCAR) Center for Science Education in 2019, this causes the thaw of soils with has been frozen by ice to thaw and carbon dioxide is released during this process.
2. **OCEAN ACIDIFICATION:** Ocean has the capacity to dissolve CO₂ and ocean water reacts with Atmospheric carbon dioxide which inturn produce bi carbonate. (Findlay *et al.*,2021) When increased amount of CO₂ are deposited into the soil, this cause the soil to become acidic which can cause an effect on the marine organisms particularly the shell fish who depends on sea water to make their shell. When there are more hydrogen present in the water due to the increased amount of carbon dioxide present in the sea water, very low bicarbonate ion will be available for this fishes to make their shell and shells can starts dissolving when the pH of the water becomes very low
3. **EXTREME WEATHER EVENTS:** Events such as flood, drought, heat waves and wildfires can affect the ecosystem. Because of the metrological condition that can cause both increased and decreased precipitation leading to flood and drought respectively. Rise in temperature leads to more and increased heat waves reaching the earth. As a result of drier

condition, this set a bedrock for wildfires to occur leading to loss of habitats, disruption ecological process and increased vulnerability to invasive species. Water scarcity occur as a result of climate change leads to reduces precipitation and increased temperature which can decrease the ability of the freshwater to replenish quickly and the recharge of the ground water.

2.3.2 SOCIAL IMPACT

1. **HEALTH RISK:** Between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year. (WHO,2023) Climate change can impact human health either directly or indirectly. Extreme weather condition such as increased temperature as a result of climate change can cause health waves which can cause injuries, heatstroke and fatalities.(Chaudhry, 2018) Wildfires can also cause the spread of respiratory illnesses, vector borne diseases and malnutrition as a result of food scarcity.

2. **FOOD SECURITY:** Although temperatures and CO₂ may be beneficial to plants, on the other hand it can cause increased evapotranspiration which can decrease the water available to crops which can lead to the death of crops. Altered rainfall can also affect agricultural productivity. Climate can also impact food safety as mycotoxins tends to grow on in a certain temperature.

3. **DISPLACEMENT AND MIGRATION:** Climate change is an identified multiplier of human migration. Flooding which is an effect of climate change may displace people from their homes. Extreme weather conditions and environmental degradation associated with climate change may force people to leave their homes thereby increasing poverty and their vulnerability. When agricultural productivity is affected by climate change, this can force the migration of agriculture dependent communities.

2.4 CONCEPT OF WATER SUPPLY

2.4.1. DEFINITION AND OVERVIEW OF WATER SUPPLY

Water supply represents the provision of water by public utilities, commercial organizations, communal or individuals' efforts, usually through a system of pumps and pipes.(Adebayo et. Al.,2021) Water is a very vital part of the ecosystem which support the sustenance of both living organisms and nonliving things in the environment. Water is very important especially when it is available in safe and secure amount. The United Nations (World Water Assessment Programme 2006) recommends access to at least 20 L of safe potable water at the farthest distance of 1 km.The water supply is important not only to maintain the health of the community as it can as well influence industrialisation. Water is a very vital resources in the ecosystem as there is no life without water(Chan and Bouguerra, 2007) Water is so essential to life that 70% of human weight is made of water. Water is a vital resources needed for the sustenance of life (Anake *et al.*, 2013). A water supply system basically contains of an untreated water source, treatment plant

And a distribution network .(Nyende-Byakika et. Al.,2011) Water is also important in balancing the ecosystem as there is no clean environment without water. Water is also a valuable source of energy and it is located in all the region's in the earth. Water is the most widely occurring substance in the world. Over 72% of the earth's surface is covered by water.

2.4.2 HISTORICAL DEVELOPMENT OF WATER SUPPLY SYSTEMS

One of the main factors that influence the human settlements in the early years was water which had been the backbone of all settlement. Human could live 2 to 3 months without food but barely survive 2 days without water. The most famous and expensive water distribution system of ancient times was the Roman Aqueduct. This channel moved water from springs to Rome in the

Anio Valley over 20 miles away.(Wilson,2024) Cast-iron pipe was first installed at Dillenburg Castle in Germany in 1455 and it was constructed to move water in and out of the castle from well sources.(Walski,2006) Water distribution systems have a very long and rich history dated back in time. It is believed that ancient devices for raising water originate from the Assyrians, Babylonians and other ancient nations. The early devices used to raise water from wells are a pulley bucket and windlass. The modern water supply system started with the use of cast iron pipe for distributions in the 18th century Water distribution also include the use of waster treatment plants and AI. In other to ensure the distribution of clean and safe water, organization such as the WHO and EPA was formed in the late 20th Century.

2. 4.3 SOURCES OF WATER SUPPLY

The sources of water supply are usually divided into three classifications which includes Ground Water, Surface water and Rainwater

2. 4.3.1 GROUNDWATER

The ground water supplies include dug, bored, driven and drilled wells, springs and Infiltration galleries. Ground waters are usually free of contaminants .

Groundwater may be defined as the total rainwater which has percolated downward into the soil and rock where it remains, until it finds its way out to the surface. Examples are wells and springs. Groundwater is seen as the major source of water supplies in Urban communities.

2. 4.3.2 SURFACE WATER

This is used to describe water found in land surface. Surface water supplies may be further divided into river, lake, pond and this is considered as traditional water sources. Dams are constructed to create artificial storage for this water. The quality and quantity of the surface

sources are characterized by the surface of the water and the area to which it flows and they are usually susceptible to contamination.

2.4.3.3 RAINWATER

Rainwater is a valuable natural resources as it may be considered as the original source of all the water supplied on the earth surface and it is the cleanest form of water. This is usually collected from roof through harvesting into storage tanks.

2.4.4 FACTORS INFLUENCING WATER SUPPLY

2.4.4.1 POPULATION GROWTH: Population affects the availability of water supply to the people. The more people who needs water, the more demand for water supply thereby stressing existing water resources.(Hutton *et al.*, 2017) Increase population growth can lead to scarcity of water supply , especially in urban areas with limited infrastructure.(Bensen,2022)

2.4.4.2 CLIMATE AND SEASONAL VARIATIONS

According to UN Climate Action, Water is at the center of the climate crisis. This influences the rate of rainfall and evaporation. Low rainfall and high temperature leads to reduced rate of water in a location. While high rainfall and decreased temperature leads to abundant water supply in a location. Water availability may also be influenced by melting of ice caps which therefore flows into the ocean. Abundant water supply are common where when precipitation is high with a reduced rate of evaporation. Seasonal phenomena such as ice cap melting also influence water flow patterns and availability.

2.4.4.3 OVER-ABSTRACTION

When water is taken from aquifers, groundwater levels fall. If the amount of water taken is greater than the rate of groundwater recharge. This over use lead to long term water depletion. (Hutton *et al.*, 2017)

2. 4.4.4 POLLUTION

Polluted water limits safe water availability, causes ecological damage, and poses serious health risks including waterborne diseases such as diarrhea, cholera, and hepatitis. Additionally, pollution triggers eutrophication a harmful overgrowth of algae that depletes oxygen and harms aquatic life.

2.4.5 CHALLENGES IN WATER SUPPLY

The major challenges in water supply include:

2.4.5.1 AGING INFRASTRUCTURE

This is one of the issue facing water supply.(TWRI,2019) Many water systems rely on corroded pipes and outdated infrastructure causing leakage and water loss, which reduces water supply and increases contamination risks

2.4.5.2 INCREASING DEMAND AND POPULATION GROWTH:

Rapidly growing populations, urbanization, and higher living standards intensify demand, often surpassing supply capacity, especially in mega cities and developing regions.

2.4.5.3 GROUNDWATER OVERUSE AND SCARCITY:

Over-extraction of groundwater and lower availability in some geological areas contribute to scarcity and ecological damage.

2.4.5.4 ENVIRONMENTAL CHALLENGES:

Drought, desertification, floods, and ecosystem impacts from water infrastructure development affect supply reliability and sustainability.

2.5 DOMESTIC WATER SUPPLY

According to water survey team, industrial water use can be refined as water used in processes designed to convert materials from one form to another that is of greater value and the

development of power by means other than hydroelectric. Domestic water use, according to the World Health Organization (WHO) 2023, refers to the water used within a household for various purposes such as drinking, cooking, sanitation, bathing, and other personal hygiene activities. It is also defined as water used inside or outside residential houses. Safe domestic water are essential part of humans life and we'll being. It is required for a wide range. This can impact health as human health and the quality of life as it is influence by the environment.

WHO is in charge of setting standards to which portable domestic water are characterised by and the are character into both physical, chemical and biological parameters. The physical parameters include turbidity, colour, taste and odor. The chemical parameters such as pH, Total dissolved solid, hardness, presence of nitrate and fluoride. Biological parameters such as the presence of microorganisms which includes E. coli. The Federal Ministry of Water Resources and the Standard Organisation of Nigeria are in charge of setting this water parameters guidelines. They are then monitored by the National Agency for Food and Drug Administration and Control (NAFDAC), Federal Ministry of Water Resources, State Water Boards and Rural Water Supply Agencies

2.5.1. WATER TREATMENT FOR DOMESTIC USE

According to the World Health Organization (WHO), to achieve universal access to safe water for households, the use of household water treatment technologies is necessary where water systems distribution are not feasible and where people rely on water supplies that may be contaminated. Water is treated removed impurities and contaminants that maybe found in the it and may be harmful to humans and make it not suitable for domestic use. There are different type of water treatment method and this include; Household water treatment which involved the use of simple method to make water palatable for domestic use and the Industrial water treatment

which involved the use of sophisticated machinery to make water clean and this is regarded as the safest method of water treatment. Water treatment method may be influenced by water quality, type of contaminants, location, use, cost and social norms.

2.5.2 METHOD OF WATER TREATMENT

2.5.2.1 FILTRATION METHODS

This is regarded as the oldest traditional method of water treatment.(Pakharuddin *et al.*, 2021) Although, the water quality of the filtered water is not guarantee, it makes it more safe for those who practice it. Water filtration is targeted to remove suspended solid particles in the water. There are different water filtration method which include sand filtration; this include the use of land mass of land to filter water. It involve passing water through sand beds which traps large suspended solid.It is effective for removing debris, organic mater and sediments from water and it is cost effective. (Ionexchange, 2024), Activated charcoal which involves the use of large porous charcoal to absorb contaminants like organic compounds, chlorine and taste from water as it passes through it, ceramic filters which uses small pores ceramic to block particles when contaminated water passes through it. (Ionexchange, 2024). Other method of filtration include ultra filtration, Nano filtration and Reverse Osmosis filtration.

2.5.2.2 DISINFECTION TECHNIQUES

This is an important method as it ensures that water is free from pathogens causing water borne diseases. This involves the killing, removal and deactivation of microorganisms in water. These different method of water disinfection and this include which involves the use chlorine to remove all pathogenic microorganisms. This is not to be used boiling in water suitable for household use as it is a lethal gas(Saqib *et al.*, 2017). UV treatment; This used ultraviolet light t kill

bacteria, viruses present in water. This works by disrupting the DNA of the water (Nainwal, 2024). The use of UV treatment is an expensive method of water treatment.

2.5.2.3 SOFTENING AND CONDITIONING:

This is the process of removing excess mineral content from water source. According to Halo Water system 2025, Water softening aims to remove chemicals such as magnesium and chlorine from the water to avoid build up while water conditioning aims to improve the qualities of the water without necessarily removing the chemicals. This ensures the chemicals so they do not corrode pipe by altering their molecular structure. This is usually practiced by people who believe that using of water softening may also remove essential Chemicals from the water.

2.5.3 WATER SUPPLY SYSTEMS

Water supply system is the use of infrastructures such as pipes, to collect, transport and distribute water to household and industries. (Nathanson, 2025) Water supply system may be described as consisting of three basic components: the source of supply, the processing or treatment of the water, and the distribution of water to the users. This water supply system rely on both ground water and surface water for its distribution. There are different type of the water supply system and this include;

2.5.3.1 CENTRALIZED SYSTEMS

This is also known as the conventional treatment is the most common municipal water system supply. This uses treatment process such as coagulation, flocculation, sedimentation, filtration, and disinfection to treat water in a central location and then distributes it via distribution network. The treatment process begins with coagulation, where chemicals are added to the raw water to destabilise minute suspended particles which then clump together to form larger aggregates called flocs during flocculation. The flocs settle at the bottom of sedimentation

tanks due to gravity, thereby removing a portion of impurities from the water. The water is then filtered with the use layers of sand, gravel, or other media to remove smaller particles that were not settled out. The final step is disinfection, usually carried out using chlorine, chloramine, or ultraviolet light, to eliminate any remaining harmful microorganisms and ensure the water is safe for consumption. This method treats large volume of water at a high rate. This method can be cost effective which makes it suitable for large population in urban areas , and it allows for large monitoring of water quality process. There are disadvantages to this system which includes leakage, contamination within the distribution network and it also requires setting up infrastructures which may be too expensive.

2.5.3.2 DECENTRALIZED SYSTEM

This is form of community based water supply infrastructure. This water supply system treats smaller amount of water as opposed to the centralized system therefore, it is not feasible for a larger population. It is common in developing countries. This include rural community schemes, boreholes, hand pumps.

. This focus on addressing local water quality.(Gabel, 2025) This employs various techniques to tackles this issues such as filtration to remove sediments, disinfection techniques to eliminate pathogens and also constructed wet lands and bio sand filters to leverage the natural purification processes. This reduces risk of re contamination and also cost effective.

2.5.4 WATER DISTRIBUTION SYSTEMS

Water distribution systems are aimed at distributing water from reservoirs or aqueducts to the end users. (Feo,2011) Water distribution systems depend on the type of water source used, on the topography, and on the provided supply service level. A domestic water distribution system ensures the continuous supply of water to homes and residential places. Domestic water

distribution system uses pipelines, valves, storage tanks, Household plumbing arrangements and other infrastructure. (Purani,2025)

2.5.4.1 PIPED NETWORKS

A water supply system with a pump is a modern method of domestic water distribution. It is an essential system that ensure the supply of water to households. Pumps are submerged which is used to extract water from underground layers which draws groundwater which it is reliant on and then, it is supplied to residences through pipes. This network consist of interconnected pipes to draw underground water,pump, valves and control mechanisms. This is a cost-efficient system and it is easy to maintain, it eliminates the need for large storage systems and can be connected to multiple water sources.the down side of this system is that it requires high energy consumption, reliance on electricity and high initial installation cost.

2.5.4.2 STORAGE FACILITIES

This is a system whereby water are stored on overhead tanks this are usually elevated above residential house and it distributes water into home. This is easier to maintain as it does not rely on electricity the overhead water tank relies on underground reservoirs which is dig and it contains a submerged pipe which carries water from the underground aquifers. This relies on electricity to pump water into the overhead tank. This method ensures that water is always available to buildings.

2.5.4.3 HOUSEHOLD PLUMBING ARRANGEMENTS

Households Plumbing is a system of pipes and fixtures installed in a building for the distribution and use of potable (drinkable) water and the removal of waterborne wastes., connection points, fixtures, pressure regulation. (Hossain,2021) This classified into two system which is: the water

supply system which delivers fresh water into the household and the drainage waste system which removes Gray and Black water from the household.

2.5.5 SUSTAINABLE DOMESTIC WATER SUPPLY PRACTICES

This involves the efficient method of using water responsibly and efficiently to ensure that they are availability for future use. This include practices like Water conservation, Rainwater harvesting and grey water reuse for gardening and flushing

2.5.5.1 WATER CONSERVATION AT HOUSEHOLD AND COMMUNITY LEVEL

Adaption of water conservation is essential to save water(Florke *et al.*,2013). Water conservation makes it possible to avoid water scarcity. This involves the efficient use of water in homes and offices. This include the installation of water efficient alliances and faucet contribute to water efficiency there reducing wastewater flow, regularly checking for leakage in water distribution system, taking shorter showed , reusing water and public awareness at the community level, installation of water recycling systems and water pricing can also go a long way in minimizing water usage.

2.5.5.2 RAINWATER HARVESTING TECHNIQUES

Rainwater harvesting (RWH) is an economical effective methods that has the potential to supply safe water with least disturbance to the environment. (Ishaku *et al.*, 2011) Rainwater harvesting (RWH) could be the most sustainable solution to be included in the urban water management system as it could mitigate the water crisis problem and also reduce the burden on traditional water sources.(Rahman *et al.*, 2014) There are different method of rainwater harvesting techniques and this include roof top harvesting, this involves the method whereby water is collected from rooftops using gutters and downpipes which is the stored in tanks or used for artificial ground water recharge, Surface water harvesting is the process whereby water is

collected from Roads, packs and drainage system and then they are stored for ground water recharge. Other methods involves the use of Rain barrels, gardens and swales.

2.5.5.3 GREYWATER REUSE

This is the process whereby water from sinks, laundry are channeled into use like gardening and toilet flushing.

2.6. FACTORS INFLUENCING DOMESTIC WATER CONSUMPTION

2.6.1 CLIMATIC CONDITIONS

2.6.1.1 Temperature: This is a key factor influencing water consumption. How much water is used depends on the hotness or coldness of the temperature as more water is spent on bathing due g hot temperature. In a research conducted by Bergel & Młyńska (2021) to analyze how air temperatures impact on household water consumption by checking the water meter readings of people in the rural community, it was tested that the growth of the air temperature by 1°C caused an increase of the water consumption per capita depending on the household and regions which was studied. Among various determinants of household water consumption, climate variables such as temperature show a generally high impact, commonly increasing water use during hotter periods for purposes like hygiene and cooling.(Cominola *et al.*, 2023) Household water consumption increases with ambient temperature, particularly in adapting to warmer climate conditions.

2.6.1.2 RAINFALL AND WATER DEMAND

A research conducted by Sadiq & Karney, decrease in rainfall by 10% causes an increase in the average water demand by 0.6%, while decrease in rainfall by 30% caused an increase the average demand by 0.8%. Amount of rainfall is inversely proportional to water demand that is, the greater the rainfall the smaller the consumption of water, or the smaller the rainfall the

greater the consumption of water.(Messakh *et al.*, 2018) In gardening, increased variability of precipitation would generally lead to an increased irrigation water demand.

2.6.1.3 EVAPORATION AND HUMIDITY

High evaporation rates, especially during the dry season, can lead to increased water usage as people compensate for water lost to the atmosphere. High humidity can reduce evaporation rates and potentially decrease water demand. During dry season especially in tropic regions like Nigeria , there is an increased temperature and reduced rainfall leading to increased evaporation rate.

2.6.2 SOCIO-ECONOMIC FACTOR

2.6.2.1 HOUSEHOLD INCOME AND WATER AFFORDABILITY

Household income and domestic water usage are interlinked. Higher income households often have access to more appliances like washing machine, dish washer, more than one cars that requires washing and potentially swimming pool that uses water, larger properties with gardens, and lifestyles that can influence water usage. In low-income households, the financial reasons motivate the need for saving water. When the cost of water is less, household tend to use water without conserving it. When water affordability are high, house holds especially low income earners tends to cut down on their water usage and this will make them prioritize water use. Household income and water affordability directly impact water usage. When the cost of water is low, household tends to increase water consumption while increased cost of water reduces water usage and make them seek alternative sources of water. Most studies agree that an increase in household income is usually accompanied by an increase in water consumption (Hussein *et al.* 2016; Basu *et al.* 2017)

2.6.2.2 OCCUPATION AND LIFESTYLE PATTERNS

Occupation may impact our water usage in the following way, a construction worker or a farmer tends to use more water in his workplace for setting bricks and also for irrigation and fish farming, whereas a driver may consume little or water while working. According to World Economic Forum, An estimated three out of four jobs globally are dependent on water and half the world's workers are employed in industries heavily dependent on water, most of them in farming, fisheries and forestry. The life style of people may impact their water usage, while some people tends to take longer or shorter bath, household chores, cooking and washing habit may also impact water usage. The way

2.6.2.3 ACCESS TO ALTERNATIVE WATER SOURCES

Access to alternative water sources can impact water demand by providing household with alternative options beyond the known main public supply system. This can lead to a decrease in demand for the main water supply and increased water usage especially when alternative sources especially when its water quality is more better. Access to alternative sources can also lead to increased overall water consumption if it is a readily available resource and use more water than they would have. Households who have access to reliable alternative sources like private wells, rainwater harvesting, may choose to use these instead of solely relying on the main public supply.

2.6.3 POPULATION SIZE AND HOUSEHOLD STRUCTURE

2.6.3.1 HOUSEHOLD SIZE AND PER CAPITA WATER USE

Household size is a significant determinant of household water consumption and the link between them is positive. An increase in household size caused a similar Increase in domestic water consumption, while per capita water demand decreases with an increase in household size

(Crouch et al. 2021). The household size impact water usually that water consumed is much, But in comparison with the members of the household living alone, they then to use more water while living alone compared to living differently since the activities and water usage is shared.

2.6.3.2 URBAN VS RURAL POPULATION DENSITY

The demand for water from an increasing population is one of the main factors at play. The higher the population density, the higher the water demand. Increasing population densities can lead to competition for limited water resources among different sectors. Rural areas, with lower population densities, typically have lower total water demand. In both urban and rural settings, a growing population density directly translates to increased water demand, making careful planning and sustainable water management essential.

2.6.3.3 AGE DISTRIBUTION AND SPECIAL WATER NEEDS

The young people use water more because they prioritise personal hygiene while elderly ones exhibit less. (Nahar et al.,2022) During adolescence, bodily changes such as increased sweat and oily skin require more frequent washing of the body, hair, and teeth to manage body odor and acne. Teenagers are encouraged to shower or bathe at least once a day using soap or shower gel, wash their underarms and feet thoroughly and practice menstrual hygiene for girls, which also increases water use.(Popkin.,2011) These personal hygiene practices shows the heightened water needs of younger people. Elderly individuals exhibit reduced thirst and drink less water. Children also have special water needs related to hydration as they may be more susceptible to heat stress and require adequate water intake to prevent dehydration. Their hydration needs differ from those of healthy adults and vary with age, gender, and activity levels.

2.6.4 TECHNOLOGICAL FACTORS

2.6.4.1 WATER-EFFICIENT HOUSEHOLD APPLIANCES

Water-efficient household appliances are designed to use less water than other models while maintaining enough efficiency. These appliances, which include dishwashers, washing machines, toilets, shower heads, and faucets. They can significantly reduce water use for a activity thereby promoting water consumption while delivering it performance efficiently.

2.6.4.2 PLUMBING SYSTEM QUALITY AND MAINTENANCE

A very good plumbing fixtures and maintenance reduces water usage by preventing leakage, maintaining water pressure, and ensuring efficient operation appliances. This also minimizes water loss from leakages and corrosion, avoids blockages that cause inefficient flow, and preserves water quality, which can reduce unnecessary flushing or overuse. Regular inspection, timely repairs, and upkeep extend the lifespan of plumbing components, reduce water waste, and improve overall water delivery efficiency, ultimately lowering water consumption and associated costs

2.6.4.3 RAINWATER HARVESTING AND RECYCLING TECHNOLOGIES

Rainwater harvesting and recycling technologies significantly influence water usage by providing an alternative, sustainable water source that reduces reliance on conventional freshwater supplies. These technologies capture and store rainwater from surfaces like roofs for various uses, including irrigation, toilet flushing, cooling, and even potable uses with treatment. This reduces demand on municipal or groundwater sources, mitigates drought impact, controls flooding, and lowers water bills.

Rainwater harvesting systems vary in complexity from simple setups that is collecting rainwater in tanks to advanced, automated systems. They improve groundwater recharge, decrease erosion runoff. They are cost-effective and are applicable in urban and rural areas, supporting sustainability and reduced pressure on existing water infrastructures.(Rahman *et al.*,2014) Recycling technologies also contribute to this by treating and reusing grey water or other wastewater streams, therefore conserving potable water resources. The integration of harvesting and recycling improves water use efficiency, essential in areas facing water scarcity, climate change impacts, or population growth.

2.6.5 AVAILABILITY AND ACCESSIBILITY OF WATER SUPPLY

2.6.5.1 SOURCE PROXIMITY AND EASE OF COLLECTION

The closeness to a water source and the ease with which water can be collected significantly influence domestic water consumption (Oyerinde *et al.*,2021). Households with closer and easier access to water tend to consume more water, as there are no time spent on collecting water compared to when water sources are far away or difficult to access, people tends to conserve water in their homes due to the increased burden and stress of collecting water. A research conducted found that closeness to the water source was the most important factor influencing daily household water consumption Households trekking less than 30 minutes to water sources tend to use more water than those farther away.(Ogunbode *et al.*, 2023)Ease of collection affects not only total volume used but also the timing and distribution of water use throughout the day. Households with closer sources may engage in water-intensive activities at home more readily than those dependent on distant or irregular sources

2.6.5.2 RELIABILITY OF SUPPLY SYSTEMS

When water supply is continuously available, households tend to consume more water. Non availability lead to reduced consumption because people cannot depend on a steady source and may limit water use to critical needs only. Unreliable supplies tend to reduce consumption and prompt costlier and time-consuming coping measures especially among poorer households

2.6.5.3 PRICING AND BILLING METHODS

Water price varies and increasing prices can reduce water consumption, especially in the domestic sector. Moderate changes in price may not drastically reduce consumption but still influence usage patterns. Different pricing schemes such as uniform volumetric rates, increasing block rates (where price increases with more consumption), and flat fees have distinct impacts on consumption. Water prices must balance conservation goals with equitable access. Low-income households are more sensitive to price increases and may reduce consumption to levels inadequate for health and hygiene if tariffs are too high. Subsidies or initial low-price blocks that cover basic water needs are recommended to ensure minimum consumption is preserved while encouraging conservation beyond that threshold.

2.7 STRATEGIES FOR ACHIEVING SUSTAINABLE WATER CONSUMPTION

2.7.1 WATER-EFFICIENT FIXTURES AND APPLIANCES

Low-Flow Fixtures: The term “low-flow” refers to appliances with low water usage. One of the possible way of conserving water especially in the domestic sector is the use of appliances that conserve water. An example is the low flow shower head and toilet. Traditional fixtures and fittings can use large amounts of water, often unnecessarily, which can contribute to water waste. A study conducted shows that showers are responsible for 17% of household water use and 50% of hot water use, shower usage make use of up to 1.2 trillion gallons of water annually in the

U.S. alone. The average family can save over 2,000 gallons of water a year, though, just by switching to a low-flow showerhead. (Shruthi,2024) Low-flow shower heads are shower heads designed in a way that they use less water than standard shower heads. They are designed in a way that consumers do not go back to using the normal shower head. It comes in two basic forms which are the aerating shower head which mixes air into the water, creating a misty shower spray and laminar-flow shower heads that form individual streams of water. However, these two have the same common purpose which is to conserve water by minimizing its usage. Low-flow faucets work by mixing air into the water-flow. This gives the feel and impression of full water-flow even though the water volume is greatly reduced. The use of low flow toilet which has two buttons are provided for flushing for partial flush and full flush, which will save about 40% of flushing water. Flow restrictors are also recommended for faucets, which do not have the option to install a water conserving model. A research conducted by (Basak *et al.*, 2020) shows that using low-flow appliances will reduce water consumption by 40 to 50%. Water-efficient fixtures and fittings use less water than traditional ones, which can help conserve water resources and using less water also means generating less wastewater, which can help reduce the load on wastewater treatment facilities and the environment.

2.7.2 ENERGY-EFFICIENT APPLIANCES

This is a corner stone in water saving . The Energy Star Label signifies products that meet energy efficiency standards leading to water conservation, energy, and operational costs. Similarly, an ENERGY STAR certified dishwasher uses 12% less energy and 30% less water than a standard model. These efficiencies directly translate into lower utility bills for households and businesses, while simultaneously reducing carbon footprints associated with energy generation and water treatment. All ENERGY STAR certified products undergo rigorous testing and are certified by an

independent third party, ensuring that they perform better than standard model products while performing the same function. This is important because it builds consumer trust and facilitates quick adoption of this mode. This model demonstrates the profound impact a trusted, performance-based standard can have in accelerating the adoption of sustainable technologies across various sectors. A full-sized ENERGY STAR washer, for instance, uses approximately 14 gallons of water per load, a notable reduction compared to the 20 gallons used by a standard machine. This represents a 30-33% decrease in water consumption per load. Modern efficient washing machines incorporate different mechanisms such as advanced top-load models that utilize a “flip or spin” mechanism, moving clothes through a stream of water rather than fully submerging them. This dramatically reduces the water volume required and, consequently, the energy needed to heat the water. High spin speeds during the spin cycle are another key feature, extracting more water from clothes and thereby reducing the energy consumption of the dryer. Front-load washers stand out as the most water and energy efficient which use about 50% less energy and water than traditional top-load agitator washers, While top-load impeller washers offer an Improvement over agitator models, front-load washers remain approximately 25% more energy and water efficient than impeller types. These benefits make the transition to efficient models more appealing, accelerating their market penetration and demonstrating that integrating conservation into product design, rather than solely relying on behavioral change, is a powerful strategy for widespread impact. An ENERGY STAR certified dishwasher costs approximately \$35 per year to run and can save an average of 3,870 gallons of water over its lifetime compared to a standard model. When compared to hand washing, annual water savings can range from 4,000 to 6,000 gallons. Efficiency standards also play a crucial role in lowering peak electricity demand, a factor critical for grid stability and infrastructure investments. The connection

between water savings and energy savings whereby less energy needed to pump, treat, and heat water can create a powerful multiplier effect.

2.7.3 RAINWATER HARVESTING AND GREYWATER RECYCLING

Two of the most effective strategies for achieving sustainable water consumption are rainwater harvesting and grey water recycling. These practices offer an approach to reducing demand on water while promoting water resilience. Rainwater harvesting is the practice of collecting and storing rainwater from rooftops and other surfaces for later use. This rainwater harvesting techniques builds resilience against droughts and water shortages. There are different components of rainwater collection. Practice which are; collection surface: which is usually the roof the first-flush diverter which diver the first few minutes of rain which carries dust and other dirt away from the storage tank, before entering the storage tank, rainwater is typically passed through a pre-filter to remove other solid debris, the storage tanks, pump is required move the water and provide the necessary pressure. Rainwater can be harvested in different scales such as Small-Scale Residential Systems, Medium-Scale Residential Systems and the large-scale commercial and multi-family systems. Rainwater can be used for different purposes depending on the treatment such as outdoor usage and indoor non-potable usage. grey water recycling involves collecting and treating wastewater from household sources other than toilets for reuse in non-potable applications. This is wastewater from showers, bathtubs, bathroom sinks, and washing machines and it has a relatively low level of contamination compared to black water which is wastewater from toilets and, in some jurisdictions, kitchen sinks and dishwashers due to the presence of food particles, grease, and potential pathogens. Grey water can be treated for reuse focusing on the removal of solids. This involves filtration, grease and oil separation, use of

settling tanks, bio filtration and disinfection It can be used for Irrigation, flushing toilets and laundry.

2.8 CHALLENGES TO IMPLEMENTING SUSTAINABLE DOMESTIC WATER CONSUMPTION

2.8.1 ECONOMIC BARRIERS

2.8.1.1 HIGH INITIAL COSTS

High initial costs pose a significant barrier to implementing sustainable domestic water consumption practices. This is because many water-saving technologies and infrastructure upgrades, like rainwater harvesting systems or water-efficient appliances, require substantial investments. These costs can be prohibitive, particularly for low-income households, hindering adoption of sustainable water management. Installing systems for collecting and storing rainwater can involve significant expenses for tanks, filtration systems, and potentially pumps, especially for larger properties(Richards *et al.*,2021). Treating and reusing household wastewater (grey water) for non-potable uses requires specialized equipment and potentially professional installation, adding to the cost. Existing water infrastructure often has a long life, limiting flexibility and delaying the replacement with more sustainable technologies, which intensifies the initial cost burden for upgrades. Initial capital costs may be high, particularly when water prices are subsidized.

2.8.1.2 LACK OF FINANCIAL INCENTIVES

Lack of financial incentives is a significant barrier to implementing sustainable domestic water consumption practices. While water conservation can lead to long-term cost savings, the initial investment in water-efficient technologies and practices can be a deterrent for many individuals

and households. Financial incentive such as discounts or high charges tied directly to water consumption can encourage water-saving behaviors. Without these incentives, consumers may not see the need to conserve water as there is no benefit thereby limiting changes in behavior.(Otaki *et al.*, 2024) Lack of financial incentives reduces the attractiveness of investing in water-saving technologies and sustainable practices, both at household and official levels. (Yogita *et al.*, 2018).

2.8.1.3 SOCIOECONOMIC DISPARITIES

Socioeconomic disparities significantly hinder the implementation of sustainable domestic water consumption. Unequal access to safe and affordable water sources, coupled with varying socioeconomic conditions such as education, wealth and occupation creates challenges in promoting water usage and conservation (Gedamu *et al.*,2025). Poverty, lack of education and infrastructure affect the ability of individuals to inculcate water saving plans. People in rural areas often lack access to affordable water infrastructure making availability to water limit thereby affecting their ability to implement sustainable consumption practices. The lack of infrastructure also limits the effectiveness of water-saving technologies and interventions. Lack of education and awareness programs about sustainable water use affects low-income and marginalized communities. Lack of knowledge about the importance of water conservation and the impact of unsustainable practices can hinder the adoption of water-saving behaviors.

2.8.2 SOCIAL AND CULTURAL RESISTANCE

2.8.2.1 RELUCTANCE TO CHANGE HABITS

One major barrier is the reluctance to change ingrained habits and routines related to water use. Habits such as taking showers for long,unnecessarily flushing of toilets are deeply rooted in comfort, convenience, and cultural norms. Behavioral inertia in collaboration with human

resistance to change means that even when there is water scarcity, people may be too slow to adopt conservation practices like taking shorter showers or practicing “yellow is mellow” (deliberately not flushing toilets after peeing). People often perceive the inconvenience of changing habits as outweighing the benefits as they are already comfortable with their habits. In the societal settings, people may feel pressured to conform to existing behaviors rather than experiment with new ones. These factors combine to create a barrier to behavior change necessary for sustainable water use.

2.8.2.2 PERCEPTION OF RECYCLED WATER

The acceptance of recycled water, especially grey water reuse for non-potable applications such as garden irrigation, faces a strong social stigma often referred to as the “yuck factor.” Despite the scientific evidence proving that grey water treated and managed correctly is safe for reuse, many people retain a discomfort with the idea of using recycled wastewater. This reaction is influenced by the cultural and religious associations of wastewater with dirtiness and disease, making it difficult for communities to embrace it. This often persists even when people are educated about the safety and environmental benefits of grey water reuse. Instead, building trust through communication, demonstration projects, and community engagement is essential to reduce the “yuck factor.” Public education that clearly addresses health concerns, practical benefits, and environmental significance, combined with visible examples of safe grey water use, can gradually shift perceptions toward acceptance.

2.8.2.3 LACK OF KNOWLEDGE

People have little or no knowledge about sustainable water technologies and their benefits. Many people do not understand how methods such as rainwater harvesting, grey water recycling, and water-efficient fixtures function or the positive impacts they can have on water sustainability.

This knowledge gap can lead to mistrust or undervaluing of these technologies, inadequate dissemination of information about water conservation benefits, can be a contributing factor. Without targeted awareness campaigns and educational efforts tailored to local contexts, communities remain skeptical or indifferent toward sustainable water initiatives. The absence of community involvement and empowerment in decision-making further deepens this gap

2.8.3 REGULATORY AND POLICY LIMITATIONS

2.8.3.1 OUTDATED BUILDING CODES AND REGULATIONS

This involves the existence of outdated building codes that were developed before the invention and drive towards modern sustainable water technologies. These codes may fail to accommodate innovations like grey water recycling systems, rainwater harvesting installations, and water-efficient plumbing fixtures. When building codes do not explicitly permit sustainable water systems, individuals and organizations cannot easily obtain necessary permits or approvals. This results in discouragement of effective water-saving solutions. Modifying building codes to explicitly allow these technologies is essential to remove legal obstacles and foster widespread adoption.

2.8.3.2 LACK OF COMPREHENSIVE AND CLEAR POLICIES

Many governments lack comprehensive, coherent policies that address water sustainability goals, define minimum efficiency standards, or provide incentives for sustainable water supply adoption. Without clear policies, efforts by stakeholders tend to be abortive. Effective sustainable water policies should establish clear guidelines around technology standards, water use efficiency, reuse protocols, monitoring requirements, and stakeholder responsibilities. They should also incentivize adoption via subsidies, tax credits, and capacity-building support, especially targeting low-income households vulnerable to climate change impacts. In regions

facing water scarcity, the absence of national or local water scarcity adaptation policies undermines long-term sustainability planning. A policy vacuum often leaves water supply systems vulnerable to over-extraction, pollution, and inefficiencies, exacerbating scarcity challenges over time.

2.8.3.3 INADEQUATE ENFORCEMENT AND MONITORING

Even where policies exist, enforcement weaknesses severely limit their impact. Without effective monitoring systems, compliance checks, penalties for violations, and accountability mechanisms, water efficiency standards.

Many developing contexts, institutional capacities for enforcement are stretched thin by resource constraints, lack of skilled personnel, and competing priorities. Political will may also be lacking to prioritize enforcement of water conservation regulations. This results in unchecked illegal water use, sub-standard infrastructure installations, and disregard for sustainable technologies. Strengthening enforcement involves investing in monitoring infrastructure, training regulatory staff, establishing transparent reporting mechanisms, and empowering communities to hold providers accountable. It also requires incentivizing compliance and disciplining non-compliance consistently

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 DESCRIPTION OF STUDY AREA

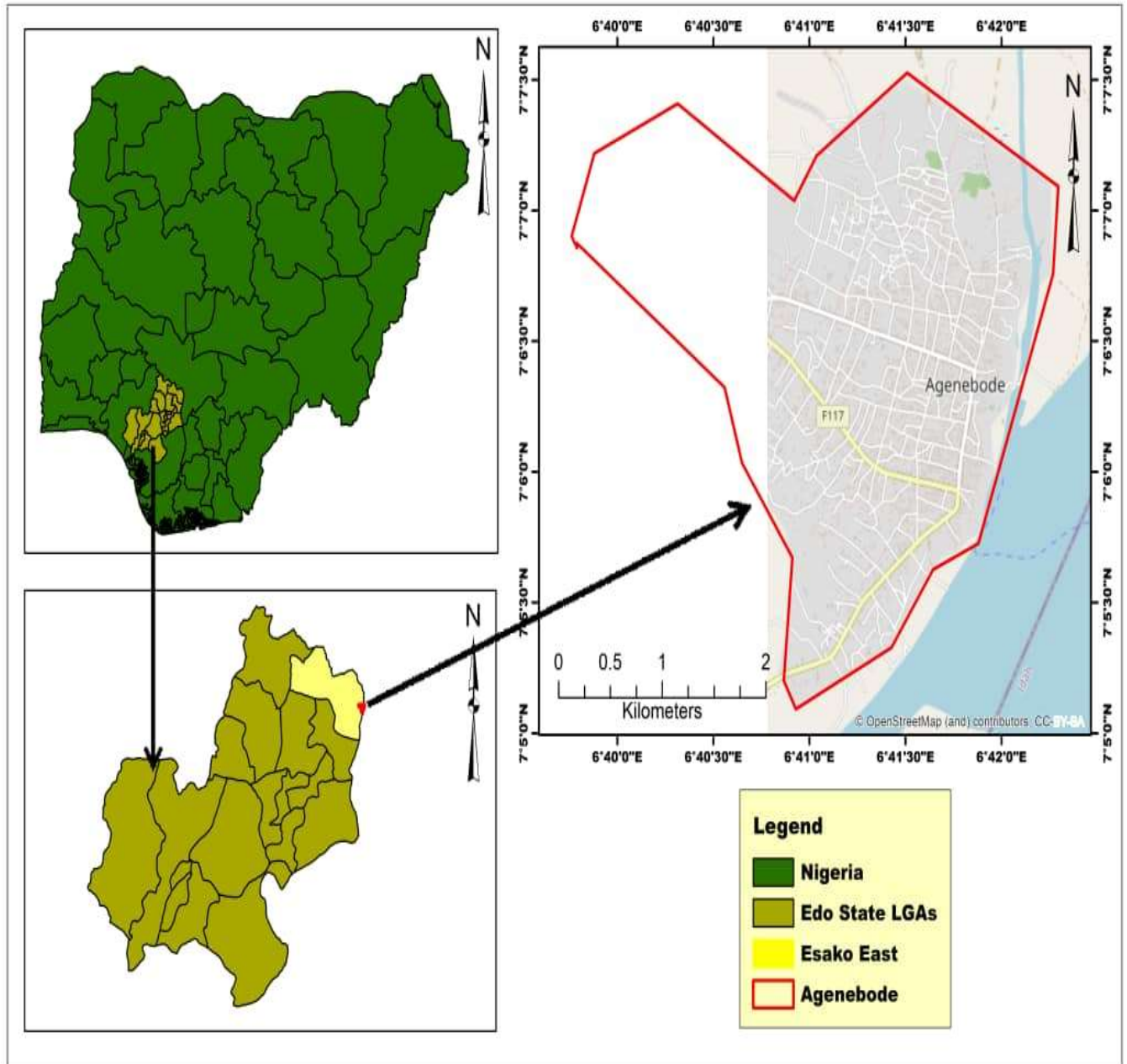
The study area, as shown in Figure 3.1, is Agenebode, located in the northern part of Edo State, Nigeria. It holds a significant importance as the administrative headquarters of Etsako East Local Government Area and also the traditional headquarters of the Weppa Uwanno Kingdom. Its location close to the River Niger has made it a significant trading centre as it was the regional headquarters for the Royal Niger Company, a British mercantile company. Its economic activities including farming and fishing because of its close proximity with the River and approximately 12,000 population size. The lower Niger River at Agenebode is a boundary between Idah in Kogi State and Edo State.(Agbugui *et al.*,2019) and has a land mass of 1,132.82 km².The study area lies between latitudes 7°03'15"N to 07°09'15"N and longitudes 06°39'42"E to 6°45'00"E respectively. It is located on the lower course of the River Niger. The area is generally a lowland area, the highest elevation being a little above 200m(Akpejiori *et al.*, 2017)

3.1.1 CLIMATE CONDITION OF THE STUDY AREA

Agenebode is situated within the Guinean forest-savanna mosaic. It also falls within the broader category of Nigerian lowland forests, which include various forest types like mangroves, swamp forests, and transition forests. It is located at the lower River Niger, typically with an average humid climate and weather 30°C. The area has 2 distinct seasons and the wet season is from April to October and the dry season is from November to March.(Agbugui *et al.*,2019). Agenebode experiences annual rainfall between 1,500 and 2,000 millimeters(Okosodo *et al.*,2024)

3.1.2 VEGETATION AND SOIL OF STUDY AREA

The vegetation consists mainly of scattered cultivation with the presence of light forest and scrubland (Akpejiori *et al.*,2017).The soil is characterized by thick ferralitic soils which is extensive over the major part of the River Niger basin in Nigeria and also Clayey and Sandy soil because of its closeness with the River Niger. Some parts are of the savannas and orchard bushes type of vegetation (Ojha *et al.*,2008). Deforestation has a negative impact as it causes erosion, loss of soil fertility and also increased temperature. The Riverine area are dominated by spatially distributed Mangrove trees



3.2 SOURCE OF DATA

A primary source of data on the implementation of sustainable use of water were obtained from traders, fishermen and also office workers for the purpose of this research. A 5 points Likert-scale questionnaire questionnaire was shared among the habitants of Agenebode town to measure their level of awareness on the sustainable use of domestic water supply

3.2.1 SAMPLING TECHNIQUES

This study centered on randomly selected house hold in Agenebode which . The questionnaire was distributed randomly among various houses in Agenebode making it a total of one hundred and fifty (150) questionnaire which were distributed.

3.3 METHOD OF DATA COLLECTION

The researcher went to the randomly selected households in Agenebode to distribute questionnaires. The researcher gave the questionnaires to Traders, fishermen as well as Office workers staying in Agenebode. The respondents filled the questionnaires on the spot and they were retrieved from them immediately. This was done to enable the researcher to obtain information regarding implementation of sustainable domestic water supply. The questions focused on the vulnerability of water supply infrastructure to climate change, behaviours household implement to cope with climate change, role of water efficient appliances and fixtures in reducing domestic water consumption, socioeconomic and cultural factors that influence domestic water consumption and challenges encountered while practising sustainable water management practices.

3.4 METHOD OF DATA ANALYSIS

The mean, standard deviation and Pearson correlation coefficient were obtained using the formulae below:

$$\text{Mean } (\bar{x}) = \frac{\sum x_i}{N} \dots \dots \dots \text{eq 1}$$

Where,

$\sum x_i$ = Summation of all individual item

x_i = Mean of the x -variable in a sample

n = Total number of entries

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{\Sigma(x_i - \bar{x})}{n}} \dots \dots \dots \text{eq2}$$

Where,

$\Sigma(x_i - \bar{x})$ = Summation of all the individual items

x_i = Mean of the x -variable in a sample

\bar{x} = Mean of the values of the x -variable

n = Total number of entries

$$\text{Pearson correlation coefficient } (r) = \frac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\Sigma(x_i - \bar{x})^2 (y_i - \bar{y})^2}} \dots \dots \dots \text{eq3}$$

Where,

Σ = Summation

r = Correlation coefficient

x_i = Mean of the x -variable in a sample

\bar{x} = Mean of the values of the x -variable

y_i = Values of the y -variable in a sample

\bar{y} = mean of the values of the y -variable

However, Statistical analysis software like Statistical Package for Social Scientists (SPSS) was used for speed and accuracy in analyzing the data collected through questionnaires.

CHAPTER FOUR

RESULTS

The reliability of the instrument used for this study is 0.663 as shown in table 4.1

Table 4.1: Reliability Statistics

Cronbach's Alpha	N of Items
0.663	25

4.1 DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

The gender, age, marital status and educational level of the respondents are shown in Table 4.2. There were 42.1% male and 57.9% female which means that most of the respondents were female. In terms of age, 6.4% were less than 20 years, 61.4% were between 21-30 years, 31.4% were between 31-40 years and 0.7% were over 40 years. This showed that most of the respondents were in their economically productive age. This is crucial because young people could have higher tendencies to engage in carbon emitting activities and for a longtime thereby contributing to climate change. Consumption of water will equally be higher at this age range. As shown in the table, 75.0% were married and 23.6% were single, indicating that the respondents were mostly married. The result also revealed that 3.6% had only primary school education, 64.3% had secondary education and 32.1% had tertiary education signifying that most of the respondents were literate. Being mostly literate connotes that accepting innovations that could help in achieving sustainable water consumption would not be a much problem in the study area.

TABLE 4.2: DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS

Characteristics	Components	Frequency	Percentage (%)
Gender	Male	59	42.1
	Female	81	57.9
	Total	140	100.0
Age	20 or less	09	6.4
	21-30	86	61.4
	31-40	44	31.4
	41 and above	01	0.7
	Total	140	100.0
Marital Status	Married	105	75.0
	Single	33	23.6
	Widow/Widower	01	0.7
	Divorced	01	0.7
	Total	140	100.0
Educational Level	Primary	05	3.6
	Secondary	90	64.3
	Tertiary	45	32.1
	Total	140	100.0
Religion	Christianity	68	48.6
	Islam	71	50.7
	Others	01	0.7

Source: Researcher's computation, 2025

4.2 VULNERABILITY OF WATER SUPPLY INFRASTRUCTURE TO CLIMATE EVENTS IN THE STUDY AREA

Table 4.3 reveals agreement by most respondents that the water supply in the study area has been disrupted due to extreme weather events such as flooding, drought over the past years. However, majority disagree that water supply structures such as boreholes, wells have been damaged due to flooding and irregular rainfall pattern. They also disagree that the quality of domestic water has deteriorated as a result of climate events and that current water infrastructure capacity has been able to meet the population demand of the habitants of Agenebode. As such, there is minimal vulnerability of water supply infrastructure to climate events in Agenebode.

Table 4.3 Vulnerability of Water Supply Infrastructure To Climate events In The Study Area.

ITEMS	SA Freq (%)	A Freq (%)	UD Freq (%)	D Freq (%)	SD Freq (%)	Mean	STD	Remark
The primary source of domestic water supply has been reliable in meeting the daily needs.	24(17.1)	107(76.4)	02(1.4)	07(5.0)		1.94	0.62	Moderate vulnerability
Water supply structures	06(4.3)	87(62.1)	44(31.4)	03(2.1)		2.31	0.58	Low

such as boreholes, wells have been damaged due to flooding and irregular rainfall pattern.)				9	vulnerability
The quality of domestic water has deteriorated as a result of climate events	09(6.4)	112(80.0)	17(12.1)	02(1.4)		2.09	0.48	Low vulnerability
The current water infrastructure capacity has been able to meet the population demand of the habitants of Agenebode.	09(6.4)	110(78.6)	06(4.3)	14(10.0)	01(0.7)	2.20	0.73	Low vulnerability
The water supply has been disrupted due to extreme weather events such as flooding, drought over the past years.	69(49.3)	67(47.9)	07(0.7)	2(1.4)	01(0.7)	1.56	0.65	High vulnerability

Strongly Agreed (SA) = 1; Agreed (A) = 2; Undecided (UD) = 3; Disagreed (D) = 4; and

Strongly Disagreed (SD) = 5. **Weighted Average (WA) = 1.93**

4.3 HOUSEHOLD WATER USE BEHAVIORS TO COPE WITH THE IMPACTS OF CLIMATE CHANGE

Table 4.4 reveals most of the respondents are of the opinion that their households have made a significant investment in water supply technology such as rainwater harvesting, boreholes. They

also agree that prioritization is placed on essential use during water scarcity. On the other hands majority are not of the opinion that their households have adjusted the water usage due to water availability concern and that they rely on alternative water supply during water scarcity. They also disagree that challenges have been experienced in an attempt to reduce overall water consumption. Therefore, it can be deduced that the people do not behave in a way to cope with the impact climate change on water

TABLE 4.4 HOUSEHOLD WATER USE BEHAVIORS TO COPE WITH THE IMPACTS OF CLIMATE CHANGE.

ITEMS	SA Freq (%)	A Freq (%)	UD Freq (%)	D Freq (%)	SD Freq (%)	Mea n	STD	Remark
My household has adjusted the water usage due to water availability concern.	103(73.6)	37(26.4)				1.26	0.443	Low behavioral change
My household rely alternative water supply during water scarcity.	102(72.9)	37(26.4)	01(0.7)			1.28	0.466	Low behavioral change
Challenges have been experienced in an attempt to reduce overall water consumption.	97(69.3)	41(29.3)	01(0.7)	01(0.7)		1.33	0.529	Low behavioral change

My household has made a significant investment in water supply technology such as rainwater harvesting, boreholes.	46(32.9)	94(67.1)				1.67	0.471	High behavioral change
Prioritization is placed on essential use during water scarcity.	42(30.0)	96(68.6)	02(1.4)			1.71	0.484	high behavioral change

Strongly Agreed (SA) = 1; Agreed (A) = 2; Undecided (UD) = 3; Disagreed (D) = 4; and

Strongly Disagreed (SD) = 5. **Weighted Average (WA) = 1.45**

4.4 ROLE WATER-EFFICIENT APPLIANCES AND FIXTURES CAN PLAY IN REDUCING DOMESTIC WATER CONSUMPTION

As seen in table 4.5, majority of the respondents are in agreement that water consumption rate has changed due to installation of water efficient appliances and that there is less dependency in local water supply. However most people disagree that importance is placed on water efficiency while purchasing new water dependent appliances and that water efficient appliances are effective in reducing cost associated with water consumption. They also disagree that water efficient appliances are significant in reducing their household's daily water consumption. It can be inferred that water-efficient appliances and fixtures play minimal role in reducing domestic water consumption in the study area.

**TABLE 4.5 ROLE WATER-EFFICIENT APPLIANCES AND FIXTURES CAN PLAY IN
REDUCING DOMESTIC WATER CONSUMPTION**

ITEMS	SA Freq (%)	A Freq (%)	UD Freq (%)	D Freq (%)	SD Freq (%)	Mea n	STD	Remark
Importance is placed on water efficiency while purchasing new water dependent appliances.	30(21.4)	104(74.3)	04(2.9)	02(1.4)		1.84	0.527	Low role
Water efficient appliances are effective in reducing cost associated with water consumption.	18(12.9)	114(81.4)	04(2.9)	04(2.9)		1.96	0.521	Low role
Water consumption rate has changed due to installation of water efficient appliances.	21(15.0)	65(46.4)	52(37.1)	02(1.4)		2.25	0.721	high role
There is less dependency in local water supply.	07(5.0)	85(60.7)	06(4.3)	42(30.0)		2.59	0.974	high role
Water efficient appliances are significant in reducing my household's daily	06(4.3)	117(83.6)	14(10.0)	03(2.1)		2.10	0.469	Low role

water consumption.								
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Strongly Agreed (SA) = 1; Agreed (A) = 2; Undecided (UD) = 3; Disagreed (D) = 4; and

Strongly Disagreed (SD) = 5. **Weighted Average (WA) = 2.15**

4.5 INFLUENCE OF DIVERS SOCIOECONOMIC AND CULTURAL FACTORS ON DOMESTIC WATER CONSUMPTION PATTERNS AND SUSTAINABILITY

Table 4.6 Shows that majority of the people are not with all the items which indicate that socioeconomic and cultural factors have less influence domestic water consumption patterns and sustainability in the study area.

TABLE 4.6 INFLUENCE OF DIVERS SOCIOECONOMIC AND CULTURAL FACTORS ON DOMESTIC WATER CONSUMPTION PATTERNS AND SUSTAINABILITY

ITEMS	SA Freq (%)	A Freq (%)	UD Freq (%)	D Freq (%)	SD Freq (%)	Me an	STD	Remark
The number of people residing in my household directly impacts my water management efforts.	56(40)	50(35.7)	20(14.3)	14(10.0)		1.94	0.973	Low influence
My religion and culture influences my water consumption habit.	06(4.3)	125(89.3)	08(5.7)	01(0.7)		2.03	0.359	Low influence
The community norms and peer pressure influences	05(3.6)	116(82.9)	11(7.9)	08(5.7)		2.16	0.566	Low influence

efforts made to manage water consumption.								
My occupation impacts my water usage.	03(2.1))	110(78.6))	10(7.1)	17(12.1))		2.2 9	0.70 5	Low influence
My cultural belief and tradition is solely dependent on clean and sufficient water.	06(4.3))	84(60.0)	06(4.3)	43(30.7))	01(0.7))	2.6 4	0.99 1	Low influence

Strongly Agreed (SA) = 1; Agreed (A) = 2; Undecided (UD) = 3; Disagreed (D) = 4; and Strongly Disagreed (SD) = 5. **Weighted Average (WA) = 2.74**

4.6 CHALLENGES HOUSEHOLDS FACE IN IMPLEMENTING SUSTAINABLE WATER MANAGEMENT PRACTICES TO ENSURE LONG-TERM WATER SECURITY

Table 4.7 reveals that majority of the respondents are of the view that government policies support their household efforts in sustainable water management and that information has been accessible on effectively implementing sustainable water management practices in my household. However, they disagree that indigenes of the community are unaware of the importance of water conservation and that financial barriers have been a considering factor in an attempt to adopt sustainable water management practices. They also disagree that the existing level of community engagement and collaboration effectively promotes sustainable water management in my neighborhood. The outcome indicates that there is little challenge in implementing sustainable water management practices in the study area.

**TABLE 4.7 CHALLENGES HOUSEHOLDS FACE IN IMPLEMENTING
SUSTAINABLE WATER MANAGEMENT PRACTICES TO ENSURE LONG-TERM
WATER SECURITY**

ITEMS	SA Freq (%)	A Freq (%)	UD Freq (%)	D Freq (%)	SD Fre q (%)	Mean	STD	Remark
Indigenes of the community are unaware of the importance of water conservation.	65(46.4))	15(10.7))	06(4.3))	54(38.6))		2.35	1.39 3	low challenge
Financial barriers have been a considering factor in an attempt to adopt sustainable water management practices.	50(35.7))	33(23.6))	03(2.1))	54(38.6))		2.44	1.32 1	low challenge
Government policies support my household efforts in sustainable water management.	06(4.3))	27(19.3))	06(4.3))	101(72.1))		3.44	0.94 7	High challenge
Information has been accessible on effectively	02(1.4))	79(56.4))	06(4.3))	53(37.9))		2.79	0.98 0	High challenge

implementing sustainable water management practices in my household.								
The existing level of community engagement and collaboration effectively promotes sustainable water management in my neighborhood.	50(35.7)	51(36.4)	07(5.0)	32(22.9)		2.15	1.14 4	Low challenge

Strongly Agreed (SA) = 1; Agreed (A) = 2; Undecided (UD) = 3; Disagreed (D) = 4; and Strongly Disagreed (SD) = 5. **Weighted Average (WA) = 2.63**

4.7 RELATIONSHIP BETWEEN LEVEL OF EDUCATION AND HOUSEHOLD WATER USE BEHAVIORS TO COPE WITH THE IMPACTS OF CLIMATE CHANGE

Table 4.8 reveals strong positive relationship between level of education and household water use behaviors to cope with the impacts of climate change which is not statistically significant ($r = 0.96$, $p = 0.260 > 0.05$). As such H_0 is rejected and H_1 (there is no statistically significant relationship between level of education and household water use behaviors to cope with the impacts of climate change)It can be inferred that level of education of the respondents has nothing to do with the behaviour of the people in terms of water use to cope with the impact of climate change.

Table 4.8: Correlation between level of education and household water use behaviors to cope with the impacts of climate change

			Level of education	water use behaviors
Pearson Correlation (r)	Level of education	Correlation Coefficient	1	0.96
		Sig. (2-tailed)	.	0.260
		N	140	140
	water use behaviors	Correlation Coefficient	0.96	1

4.8 RELATIONSHIP BETWEEN LEVEL OF EDUCATION AND CHALLENGES HOUSEHOLDS FACE IN IMPLEMENTING SUSTAINABLE WATER MANAGEMENT PRACTICES TO ENSURE LONG-TERM WATER SECURITY

Table 4.9 reveals very weak positive relationship between level of education and challenges households face in implementing sustainable water management practices to ensure long-term water security which is not statistically significant ($r = -0.006$, $p = 0.948 > 0.05$). As such H_0 is rejected and H_1 (there is no statistically significant relationship between level of education and household water use behaviors to cope with the impacts of climate change) is accepted. This indicates that level of education of the respondents has nothing to do with challenges households could face in implementing sustainable water management practices.

TABLE 4.9: CORRELATION BETWEEN CHALLENGES HOUSEHOLDS FACE IN IMPLEMENTING SUSTAINABLE WATER MANAGEMENT PRACTICES TO ENSURE LONG-TERM WATER SECURITY

			Level of education	challenges
Pearson Correlation (r)	Level of education	Correlation Coefficient	1	-0.006
		Sig. (2-tailed)	.	0.948
		N	140	140
	challenges	Correlation Coefficient	0.96	1

CHAPTER FIVE

5.1 VULNERABILITY OF WATER SUPPLY INFRASTRUCTURE TO CLIMATE EVENTS IN THE STUDY AREA

This study shows that there is minimal vulnerability of water supply infrastructure to climate events in Agenebode. Borzi, 2023, showed that although climate change can increase the susceptibility of water infrastructures to damages but this vulnerability has been changed by using durable pipe material such as steel, reducing reliance on one water sources and pipeline route planning. As such, the people of Agenebode may have developed various strategies in reducing the vulnerability of water infrastructure to climate change. The people are known to be involved in rain water harvesting which can reduce their reliance on only one water supply, The water infrastructures as agreed by most respondent are not laid in areas prone to damage due to flooding caused as a result of climate change impacts. During borehole drilling in Agenebode, wells are constructed deeper into the ground to access groundwater reserves.(Abanyie *et al.*, 2023) This is particularly important in times of drought, when irregular rainfall causes groundwater depletion, as deeper boreholes ensure continued water availability under such conditions. The holes drilled are also covered with bentonite clay to prevent it collapse because of the soil structure.

5.2 HOUSEHOLD WATER USE BEHAVIORS TO COPE WITH THE IMPACTS OF CLIMATE CHANGE

People do not behave in a way to cope with the impact of climate change on water in the study area. There are various strategies that can help cope with the impact of climate change in water water crisis such as drought and irregular rainfall pattern which needs various strategies to

manage such concern, people in the study area do not adapt this strategies to cope with climate variability and this could be as a result of lack of awareness, psychologist barriers especially when faced with climate related stress and anxiety, weak policies and enforcement, limited resources while they can also rely on alternative water supply during water scarcity (Muttarak, 2022; Padhy *et al.*,2022). Adaptation strategies have gained recognition to manage climate change and the impacts that it will have on local communities (Baker *et al.* 2012). The adaptation of water supply systems to new climate realities is core to sustainability and resilience (Levine *et al.* 2016). This strategies to adapt to the impact of climate change include; wetlands restoration, preserving natural flood-plains in watercourses, treatment of waste water, modelling, using of efficient water fixtures.(UN, 2019; Bartlett *et al.*, 2022)

5.3 ROLE WATER-EFFICIENT APPLIANCES AND FIXTURES CAN PLAY IN REDUCING DOMESTIC WATER CONSUMPTION

Water-efficient appliances and fixtures play minimal role in reducing domestic water consumption in the study area. Water efficient appliances and fixtures have been designed to play an important role in the management of water usage. According to a research conducted by Basak *et al.*, 2020, Water efficient fixture has been found to save about 48 to 60% annually without hampering user's comfort. The water efficient appliances works by measuring the amount of water required for a particular purpose and this reduces water consumption rate. In the study area, less importance is placed on water efficiency when purchasing new water dependent appliances. This could be as a result of lack of awareness or the cost of purchasing these appliances as most of the residents are low income earners so priority is not accorded to purchasing these appliances despite its long term benefits. According to the result of the questionnaire, the residents disagree that water efficient appliances play a role in minimizing

household water consumption and this amplifies their level of awareness concerning these water-conserving appliances. Agenebode is a rural community where household chores which rely heavily on water such as laundry, dishwashing, cleaning and toilet flushing rely on the traditional method and adopting to the modern method takes a lot of public awareness.

5.4 INFLUENCE OF DIVERSE SOCIOECONOMIC AND CULTURAL FACTORS ON DOMESTIC WATER CONSUMPTION PATTERNS AND SUSTAINABILITY

Socioeconomic and cultural factors have less influence on domestic water consumption patterns and sustainability in Agenebode. This contrasts with research conducted where socio-economic variables such as household income and water price have an impact on daily water consumption within a household. (Gondo *et al.*, 2020). In Agenebode, its close proximity to the river means most households consume more or less water based on factors such as availability and access. It influences various aspects of daily life, including water access and usage patterns. Most of the people use water not because of their cultural practices, income or social status but they just have to manage the little water they can get. Most times, getting that water requires the stress of trekking from a street to another to get it, which increases the stress level for women and children who are burdened with getting this water; this can cause illnesses such as body pains and headaches. To avoid such, households who are not really close to water supply will diversify a way of managing the water they can get either from rainwater harvesting which is collected and stored in containers. The people seem to have similar habits when it comes to water consumption which could be as a result of the similar challenges they face when acquiring this water rather than because of their socioeconomic and cultural statuses.

5.5 CHALLENGES HOUSEHOLDS FACE IN IMPLEMENTING SUSTAINABLE WATER MANAGEMENT PRACTICES TO ENSURE LONG-TERM WATER SECURITY

There is little challenge in implementing sustainable water management practices in the study area. There are different challenges which could be encountered during the implementation of sustainable water practices and this include population growth, climate change and water scarcity of mismanagement of water management funds. However , this challenges can be overcome. This could be because of the adaption by the residents by adopting water saving practices such as rainwater harvesting, and increased awareness through policy regulations and community sensitization. These challenges can be addressed by improving infrastructure, enforcing strong policies and regulations, providing incentives for water management goals, fostering community involvement, and promoting integrated water resource management. In the study area, this milestone has been achieved by residents through government policies that support household water management as well as local initiatives aimed at promoting water-use efficiency, sustainability, and climate resilience. In addition, cultural attitudes and socioeconomic conditions, such as income, household size which affect water conservation behaviors in other regions, seem to play a less significant role in Agenebode due to relatively stable community climate resilient structure which has helped them tackle challenges household face while implementing sustainable water practices.

5.6 CONCLUSION

The study assessed the impacts of climate change on domestic water supply in Agenebode, Edo State, and to identify strategies for enhancing its sustainability using questionnaire designed in Likert-scale to get information from respondents around Agenebode. The questionnaire assessed

vulnerability of water supply infrastructure, behavioral adaptation to cope with the impacts of climate change, role water efficient appliances can play in reducing domestic water consumption, factor influencing domestic water consumption as well as various challenges household face while implementing water management practices. The results revealed that in Agenebode, there is minimal vulnerability of water supply infrastructure to climate events therefore the people do not behave in a way to cope with the impact climate change on water resulting in water-efficient appliances and fixtures play minimal role in reducing domestic water consumption as well as socioeconomic and cultural factors have less influence domestic water consumption patterns and sustainability leading to little challenge in implementing sustainable water management practices.

5.7 RECOMMENDATIONS

1. Residents should be continually educated on the impacts of climate change on water resources and the importance of adopting sustainable water practices.
2. Government and NGOs can enlighten the residents on the adoption of water-efficient appliances and fixtures through public campaigns, subsidies, or incentives to reduce household water consumption.
3. The use of climate resilient infrastructure that can withstand flooding and droughts should be encouraged
4. Households should be encouraged install rainwater collection systems as an alternative water source, especially during dry seasons or flooding when the available water supply sources becomes contaminated. And various ways this rainwater can be purified so that it can be consumed.

5. Local government should provide climate data and future projections in water resource planning to help residents plan before a disaster occurs.
6. Provide technical and financial support to help households implement sustainable water management practices.
7. Incentive such as food, housing should be provided to residents during water related climatic disaster since most of them rely on water as their means of income.

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APPENDIX

SECTION A: DEMOGRAPHIC INFORMATION

1. Sex: a) Male [] b) Female []
2. Age: a) ≤ 20 [] b) 21 – 30 [] c) 31 – 40 d) ≥ 40
3. Marital Status: a) Single [] b) Married [] c) Divorced [] d) Widow/Widower []
4. Religion a) Christianity [] b) Islam [] c) Others []
5. Educational Level a) Primary [] b) Secondary c) Tertiary [] d) No Formal Education []

SECTION B: DEVELOPMENT OF REASERCH QUESTIONS

Kindly tick {√} the column that best indicate your opinion using the following keys:

Strongly Agreed (SA) = 1; Agreed (A) = 2; Undecided (UD) = 3; Disagreed (D) = 4; and Strongly Disagreed (SD) = 5.

S/N	ITEMS	SA	A	UD	D	SD
		1	2	3	4	5
I.	Vulnerability Of Water Supply Infrastructure To Climate Change In The Study Area.					
1.	The primary source of domestic water supply has been reliable in meeting the daily needs.					
2.	Water supply structures such as boreholes, wells have been damaged due to flooding and irregular rainfall pattern.					

3.	The quality of domestic water has deteriorated as a result of climate events					
4.	The current water infrastructure capacity has been able to meet the population demand of the habitants of Agenebode.					
5.	The water supply has been disrupted due to extreme weather events such as flooding, drought over the past years.					
II.	Household Water Use Behaviors To Cope With The Impacts Of Climate Change.					
6.	My household has adjusted the water usage due to water availability concern.					
7.	My household rely alternative water supply during water scarcity.					
8.	Challenges have been experienced in an attempt to reduce overall water consumption.					
9.	My household has made a significant investment in water supply technology such as rainwater harvesting, boreholes.					
10.	Prioritization is placed on essential use during water scarcity.					
III.	Role Water-efficient Appliances And Fixtures Can Play In Reducing Domestic Water Consumption.					
11.	Importance is placed on water efficiency while purchasing new water dependent appliances.					

12.	Water efficient appliances are effective in reducing cost associated with water consumption.					
13.	Water consumption rate has changed due to installation of water efficient appliances.					
14.	There is less dependency in local water supply.					
15.	Water efficient appliances are significant in reducing my household's daily water consumption.					
IV.	Influence Of Divers Socioeconomic And Cultural Factors On Domestic Water Consumption Patterns And Sustainability					
16.	The number of people residing in my household directly impacts my water management efforts.					
17.	My religion and culture influences my water consumption habit.					
18.	The community norms and peer pressure influences efforts made to manage water consumption.					
19.	My occupation impacts my water usage.					
20.	My cultural belief and tradition is solely dependent on clean and sufficient water.					
V.	Challenges Households Face In Implementing Sustainable Water Management Practices To Ensure Long-term Water Security					
21.	Indigenes of the community are unaware of the importance					

	of water conservation.					
22.	Financial barriers have been a considering factor in an attempt to adopt sustainable water management practices.					
23.	Government policies support my household efforts in sustainable water management.					
24.	Information has been accessible on effectively implementing sustainable water management practices in my household.					
25.	The existing level of community engagement and collaboration effectively promotes sustainable water management in my neighborhood.					

-

APPENDIX 2

Statistics

		The primary source of domestic water supply has been reliable in meeting the daily needs.	Water supply structures such as boreholes, wells have been damaged due to flooding and irregular rainfall pattern.	The quality of domestic water has deteriorated as a result of climate events	The current water infrastructure capacity has been able to meet the population demand of the habitants of Agenebode.	The water supply has been disrupted due to extreme weather events such as flooding, drought over the past years.
N	Valid	140	140	140	140	140
	Missing	0	0	0	0	0
	Mean	1.94	2.31	2.09	2.20	1.56
	Std. Deviation	.621	.589	.487	.732	.659

Household Water Use Behaviors To Cope With The Impacts Of Climate Change.

Statistics

		My household has adjusted the water usage due to water availability concern.	My household rely alternative water supply during water scarcity.	Challenges have been experienced in an attempt to reduce overall water consumption.	My household has made a significant investment in water supply technology such as rainwater harvesting, boreholes.	Prioritization is placed on essential use during water scarcity.
N	Valid	140	140	140	140	140
	Missing	0	0	0	0	0
Mean		1.26	1.28	1.33	1.67	1.71
Std. Deviation		.443	.466	.529	.471	.484

Role Water-efficient Appliances And Fixtures Can Play In Reducing Domestic Water Consumption

Statistics

		Importance is placed on water efficiency while purchasing new water dependent appliances.	Water efficient appliances are effective in reducing cost associated with water consumption.	Water consumption rate has changed due to installation of water efficient appliances.	There is less dependency in local water supply.	Water efficient appliances are significant in reducing my household's daily water consumption.
N	Valid	140	140	140	140	140
	Missing	0	0	0	0	0
Mean		1.84	1.96	2.25	2.59	2.10
Std. Deviation		.527	.521	.721	.974	.469

Influence of Divers Socioeconomic And Cultural Factors On Domestic Water Consumption Patterns And Sustainability

Statistics

		The number of people residing in my household directly impacts my water management efforts.	My religion and culture influences my water consumption habit.	The community norms and peer pressure influences efforts made to manage water consumption.	My occupation impacts my water usage.	My cultural belief and tradition is solely dependent on clean and sufficient water.
N	Valid	140	140	140	140	140
	Missing	0	0	0	0	0
	Mean	1.94	2.03	2.16	2.29	2.64
	Std. Deviation	.973	.359	.566	.705	.991

Challenges Households Face In Implementing Sustainable Water Management Practices To Ensure Long-term Water Security

Statistics

		Indigenes of the community are unaware of the importance of water conservation.	Financial barriers have been a considering factor in an attempt to adopt sustainable water management practices.	Government policies support my household efforts in sustainable water management.	Information has been accessible on effectively implementing sustainable water management practices in my household.	The existing level of community engagement and collaboration effectively promotes sustainable water management in my neighborhood.
N	Valid	140	140	140	140	140
	Missing	0	0	0	0	0
Mean		2.35	2.44	3.44	2.79	2.15
Std. Deviation		1.393	1.321	.947	.980	1.144

Relationship between Level of Education and Household Water Use Behaviors to Cope With The Impacts of Climate Change

Correlations

		Bahavi our	E
Bahavi our	Pearson Correlation	1	.096
	Sig. (2-tailed)		.260
	N	140	140
E	Pearson Correlation	.096	1
	Sig. (2-tailed)	.260	
	N	140	140

Relationship between Level of Education and Challenges Households Face In Implementing Sustainable Water Management Practices To Ensure Long-term Water Security

Correlations

		E	challen ge
E	Pearson Correlation	1	-.006
	Sig. (2-tailed)		.948

	N	140	140
Challen ge	Pearson	-.006	1
	Correlation		
	Sig. (2-tailed)	.948	
	N	140	140

RELIABILITY TEST

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded ^a	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.