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and Energy Sciences
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AND ENERGY SCIENCES (including CLIMATE CHANGE)**

Master Dissertation

Submitted in partial fulfillment of the requirements for the Master's
degree in

WATER POLICY

Presented by

Oscar Weah TOGBA

**POTABLE WATER ACCESSIBILITY AND ITS
IMPLICATIONS ON THE SOCIO-ECONOMIC WELL-
BEING OF THE PEOPLE OF BUSHROD ISLAND, LIBERIA**

Defended on 23/04/2024 Before the Following Committee:

Chair	Belarbi Fadila	Dr.	Abou Bakr Belkaid University of Tlemcen
Supervisor	Kennedy A. Alatinga	Prof.	S.D. Dombo University of Business and Integrated Development Studies
External Examiner	Bernhard Tischbein	Dr.	University of Bonn
Internal Examiner	Habi Mohammed	Prof.	Abou Bakr Belkaid University of Tlemcen

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By

Oscar Weah TOGBA

April, 2024

DEDICATION

This work is dedicated to my mother, Agnes Jah. I appreciate the nourishment she gives me.

DECLARATION

I **Oscar Weah Togba**, declare that this thesis was entirely written by me. Information from other sources that is within this work has been cited properly. This research thesis has never been submitted to any institution or authority for the award of a degree, diploma, or certificate.

Oscar Weah Togba

Student's Name

A rectangular box containing a handwritten signature in blue ink, which appears to be 'Oscar Weah Togba'.

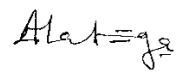
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APPROVAL

This is to clarify that this research work entitled “Potable Water Accessibility and its Implications on the Socio-economic Well-being of the people of Bushrod Island, Liberia”, was conducted by Oscar Weah Togba and supervised by Prof. Kennedy A. Alatinga.

Prof. Kennedy A. Alatinga

Supervisor’s Name



Signature

BIOGRAPHICAL SKETCH

Oscar Weah Togba is a Liberian; born in Harper City, Maryland County. His parents are Agnes Jah and Albert Togba. As a kid, Oscar started his primary studies at Our Lady of Fatima High School, located in Harper, Liberia; he studied continuously at this school and obtained his high school qualifications (High School Diploma and significant certificates). A few months after he graduated from high school in 2016, he applied, received admission from William V.S. Tubman University, and enrolled in 2017. At William V.S. Tubman University, he earned a BSc Degree in Environmental Science and obtained other certificates.

Oscar served as a teacher at the Deck & Kids Kindergarten and Elementary School. He also worked as an intern and volunteer at the Maryland County Health Team, Ministry of Health and Social Welfare, Liberia. He is a candidate for the MSc. Water Policy Track, at the Pan African University of Water and Energy Sciences, including Climate Change (PAUWES). He is enthusiastic about sustainable development; with regards to social, environmental, and economic well-being.

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Notwithstanding, I express my humble gratitude to my mother, family members, and friends who motivated me to get this work completed.

ABBREVIATIONS AND ACRONYMS

IUWM	Integrated Urban Water Management
LEC	Liberia Electricity Corporation
LPRC	Liberia Petroleum Refinery Company
LWSC	Liberia Water and Sewer Corporation
NRWP	National Rural Water Program
NWASHC	National Water Sanitation and Hygiene Commission
MME	Ministry of Mines and Energy
PPP	Private Public Partnership
PAPD	Pro-poor Agenda for Prosperity and Development
SDG	Sustainable Development Goals
TDS	Total Dissolve Solids
WASH	Water, Sanitation, and Hygiene
WSUD	Water Sensitive Urban Design
WTP	Water Treatment Plant

TABLE OF CONTENTS

CONTENTS

TITLE PAGE	ii
DEDICATION	iii
DECLARATION.....	iv
APPROVAL	v
BIOGRAPHICAL SKETCH	vi
ACKNOWLEDGEMENTS	vii
ABBREVIATIONS AND ACRONYMS	viii
TABLE OF CONTENTS	ix
LIST OF TABLES	xii
LIST OF FIGURES	xiii
ABSTRACT.....	xiv
1. INTRODUCTION	1
1.1. Background of the Study	1
1.2. Problem Statement	3
1.3. Research Objectives	5
1.4. Research Questions	5
1.5. Significance of the study	6
1.6. Scope and Limitation of the Study	6
2. LITERATURE REVIEW	7
2.1. Introduction	7
2.2. Global Perspective of Water Access Challenges	7
2.3. The Context of Water Access Challenges in Africa	8
2.4. The Aspect of Access to Potable Water in Liberia	9
2.4.1. Historical Context of Water Supply in Liberia	9

2.4.2.	Overview of the State of Water Infrastructure and Access to Water in Liberia	10
2.4.3.	Factors and Challenges Affecting Access to Potable Water in Liberia.....	11
2.4.4.	Bushrod Island Access to Potable Water Situation	12
2.5.	The Impacts of Inadequate Access to Potable Water on Socio-economic Well-being	14
2.6.	Policy Implications and Interventions for Water Access Improvement	16
2.7.	Conclusion.....	17
3.	METHODOLOGY	18
3.1.	Study Area	18
3.1.1.	Location	18
3.1.2.	Climate.....	19
3.1.3.	Demographics	19
3.2.	Research Design.....	20
3.3.	Sampling Techniques	20
3.4.	Sampling Size.....	21
3.5.	Data Collection.....	22
3.5.1.	Qualitative Data Collection.....	22
3.5.2.	Quantitative Data Collection.....	22
3.6.	Data Analysis.....	22
3.6.1.	Qualitative Data Analysis	22
3.6.2.	Quantitative Data Analysis	23
3.7.	Ethical Consideration	23
4.	RESULTS AND DISCUSSION.....	24
4.1.	Results	24
4.1.1.	Qualitative Results	24
4.1.2.	Quantitative Results	30
4.2.	Discussion	38

5.	CONCLUSION AND RECOMMENDATIONS	42
5.1.	Conclusion.....	42
5.2.	Recommendations	44
6.	REFERENCES	45
7.	APPENDIX.....	52

LIST OF TABLES

Table 2.1. Dates In the Reform of The Water Sector in Liberia.....	10
Table 2.2. Common Categorization of Acute Diseases Linked to Water.....	15
Table 4.1. The Main Source of Drinking Water for Household Members.....	30
Table 4.2. Main Source of Water Used by Households for Other Purposes, such as Cooking and Hand Washing.....	31
Table 4.3. Water Collection Duration for Households.....	31
Table 4.4. Households Water Fetcher.....	32
Table 4.5. Households Drinking Water Treatment.....	32
Table 4.6. Households Pipe Water Connection.....	33
Table 4.7. Average Household Members and Average Daily Water Use.....	33
Table 4.8. Households Daily Water Requirement.....	33
Table 4.9. Households Pipe Water Monthly Payment and Water Purchase from Vendors Daily Payment.....	34
Table 4.10. Water Price Affordability.....	34
Table 4.11. Households Morning Water Collection Time.....	35
Table 4.12. Children Being Late for School.....	35
Table 4.13. Complain about Body Pain.....	36
Table 4.14. Address of the Respondent and Girls Harassment.....	36
Table 4.15. Women’s Workload.....	37
Table 4.16. Females Blocked from Economic Activities.....	37
Table 4.17. Address of the Respondent and Cholera Disease Tracking.....	38

LIST OF FIGURES

Figure 3.1. Political Map of Liberia.....	18
Figure 3.2. Map of Bushrod Island, Liberia.....	19
Figure 7.1. A Water Source in Clara Town, Bushrod Island.....	58
Figure 7.2. Water Collection at a Protected Dug Well in Logan Town, Bushrod Island.....	58
Figure 7.3. Unprotected Dug Well in New Kru Town, Bushrod Island.....	59
Figure 7.4. A Tube Well in Freeport Community, Bushrod Island.....	59
Figure 7.5. Public Standpipes in Vai Town, Bushrod Island.....	60

ABSTRACT

Clean drinking water and sanitation are essential for well-being. There are international agreements that indicate that all people have the right to obtain water in quantities and of a quality that satisfies their fundamental needs, regardless of their social and economic circumstances or developmental stage. Coupled with the management and infrastructure challenges, population growth and urbanization have exacerbated the water accessibility issue in Liberia, despite the country's water resources potential.

An exploratory sequential mixed method (qualitative and quantitative) study design, was employed to collect and analyze data of this study. Through purposeful sampling, participants (water service providers or experts) with a range of perspectives and experiences regarding the problems with Bushrod Island's (Liberia) water supply were selected and interviewed. To guarantee a representative sample of residents from various demographic and socioeconomic groups in Bushrod Island, random sampling was employed. A sample size of 400 was determined for the quantitative survey through the use of the Taro Yamane Formula. For the aspect of the qualitative data, 10 water service providers from several institutions in the water sector of Liberia were selected through purposeful sampling (principle of saturation). These water service providers (experts) were the focus of the in-depth interviews. To get quantitative information on the primary obstacles to water availability in Bushrod Island, a structured survey was conducted. Thematic analysis was used to find repeating patterns and themes in the qualitative data. Descriptive statistics was employed to measure the relationship between variables and find significant statistical data, based on the respondents' (community dwellers) relations and perceptions about access to clean and reliable drinking water and its socio-economic impacts in the study area. Several aspects associated with Bushrod Island's potable water supply challenges, which include damaged and outdated water infrastructure, electricity for water transmission and distribution, chemicals procurement, water theft/ pipes leakages, vehicles breakdown/inadequacy, fuel availability, and customers' refusal to pay water bills, were identified. The 'high cost of water', is one of the impacts of inadequate access to potable water that was indicated by both participants of the study's interview and survey phases. It is recommended that the provision of adequate water sources (supply) can help mitigate the outbreak or spread of cholera disease that affected 4 households of the study (6 months before the study) and improve health and well-being in Bushrod Island.

1. INTRODUCTION

1.1. Background of the Study

Numerous factors contribute to overall well-being. These factors encompass pleasant feelings like joy, contentment, enthusiasm, amazement, and calmness. It also entails having a healthy bodily state and strong fulfilling connections with others. The act of sharing, creating, and maintaining meaningful relationships with people is referred to as social well-being (Sinclair, 2021). This gives you a sense of connection and belonging while also enabling you to feel genuine and appreciated. Economic well-being is defined as having financial security for the present and the future (CSWE, 2016). A person's capacity to continuously satisfy their fundamental needs, such as food, housing, utilities, health care, transportation, education, child care, clothing, and paid taxes, as well as their ability to manage their daily expenses constitute their present financial security. The capacity to withstand financial setbacks, achieve financial objectives, accumulate assets, and sustain a sufficient standard of living throughout a lifetime are all components of future financial stability (CSWE, 2016). The socio-economic well-being of a person is achieved when both the social and economic aspects previously discussed above are aligned.

It is important to note that clean drinking water and sanitation are essential for maintaining life; health and dignity. The United Nations Water Conference in Mar del Plata, Argentina in 1977 created the concept of basic water requirements to support basic human needs. Its Action Plan stated that all people have the right to obtain water in quantities and of a quality that satisfies their fundamental needs, regardless of their social and economic circumstances or developmental stage (UHCHR & WHO, 2010). Target 6.1 of the Sustainable Development Goal (SDG) 6, calls for “universal and equitable access to safe and affordable drinking water for all, by 2030 (United Nations, 2015).

The percentage of people who consume safely managed drinking water globally increased from 62% in 2000 to 74% in 2020 (World Health Organization et al., 2022). Notwithstanding these advancements, 2 billion people still lack access to safely managed drinking water, and significant regional differences exist. The UNICEF and WHO reported that in 2020, 39% of Africans used drinking water that was safely managed, 27% used sanitation that was properly managed, and 37% practiced basic hygiene (Akrash, 2020). Africa was estimated to have 1.3 billion people as of 2020, up from 800 million in 2000. 500 million people have access to clean drinking water, and 290 million people have access

to basic sanitary facilities in Africa (Akrash, 2020). The above scenario suggests that the objective of having access to clean water for everyone has not yet been completely accomplished. Poverty, inequality, and unequal power dynamics are the main causes of the current water and sanitation problem, which are made worse by social and environmental issues such as growing urbanization, climate change, rising pollution, and the depletion of water sources (UHCHR & WHO, 2010).

Liberia has considerable challenges in supplying reliable potable water. The situation is particularly evident on Bushrod Island. The issue was made worse by the aftermath of the civil war (1989–2003), which led to gaps in access to water, sanitation, and hygiene (WASH) and damaged water infrastructure. Insufficient water infrastructure forces locals to turn to unsafe sources, creating an economic scarcity of water and affecting the environment and socio-economic activities, including public health. Infections like COVID-19, cholera, and Ebola persist in the country because of ongoing WASH challenges, even after decades of civil stability (Amoak et al., 2023). The World Health Organization et al., (2022) indicated that 75.6% of Liberia's population have access to at least a basic drinking water service level, 10% of the population have limited water access service level, i.e. round trip water collection time of more than 30 minutes, 9.8% of the people in Liberia directly use surface water, and 4.6% of Liberians rely on unimproved water sources.

While existing literature has emphasized the importance of water accessibility, there is still a concern to be addressed in the water sector of Liberia. As the population increases, it adds pressure on the limited water supply systems in Liberia. Citizens' demand for water keeps rising as the existing water infrastructures deteriorate. The water resources management structure in Liberia is still in a fragmentation state; the sharing of roles and service delivery stand out to be challenging. Studying the challenges associated with water accessibility and how it is impacting the socio-economic well-being of Liberians, particularly the people of Bushrod Island, will contribute to existing knowledge that ought to find solutions to the problem of access to potable water, which is vital to survival.

1.2. Problem Statement

Water is a basic and essential necessity for life. One in four individuals lacks access to clean drinking water globally. Less than one-third of the population in the poorest nations, mostly in Sub-Saharan Africa, has access to clean water (WHO/UNICEF, 2020).

Despite Liberia's vast potential for water resources, access to potable water supply is a challenge in the country. Several institutions, including the Liberia Water and Sewer Corporation (LWSC), Ministry of Mines and Energy (MME), and the National Water Sanitation and Hygiene Commission (NWSHC) among others, are charged with the responsibility of water resources management in Liberia. Hence, the sharing of roles and effectiveness of these institutions appear to be a great challenge. The majority of water infrastructures that are being used to supply and deliver water to the people of Liberia are outdated. Coupled with the management and infrastructure challenges, population growth and urbanization have exacerbated the water accessibility issue in the country. Many Liberians migrated from rural to urban settings during and after the fourteen-year civil crisis. Before the Civil War, Monrovia had a population of 500,000 residents and the Liberia Water and Sewer Corporation (LWSC) supplied them with 16 million gallons of water per day from the White Plain Treatment Plant. Monrovia and its environs had a population growth after the 14-year Civil War, reaching 1,500,000; doubling the pre-war population and creating water scarcity in the city (Aslanova, et al., 2022).

The water accessibility situation in Bushrod Island, like other parts of the country, is being affected by poor management structures, inadequate or outdated infrastructures, population growth, and urbanization. A report from (World Bank, 2022) revealed that effective development in Liberia's WASH sector is significantly hampered by institutional and governance constraints. In Bushrod Island, public stand taps, hand-dug wells, boreholes handpumps/tube wells, and the LWSC pipe water connection system are the main water sources, among others. It is observed that the pipe water supply is unreliable in Bushrod Island (Cities Alliance, 2020). Residents have to gather as many gallons of water and store them when water is supplied by the LWSC once, twice, or a few days a week. Many of the residents who are not connected to the pipe water system walk long distances to public stand taps, private wells/pumps, and other water sources, then stay in queues for water collection. Women and children are usually seen collecting water for various households. The water collection task has caused some children to be late or absent from school. There are claims, though not scientifically evident, that some residents of Bushrod Island have

been blocked from some economic activities due to the time they spend on water collection. In Bushrod Island, children are sometimes seen carrying heavy water loads that have the propensity to cause their bodies to ache and affect their health. In some instances, people experience sleepless nights to go to nearby or distant water sources in search of water. On some occasions, people from houses with sanitary facilities resolve to defecate in plastics and throw their feces in the open environment due to a lack of water to flush toilets.

Because of oil spillage from the Liberia Petroleum Refinery Company (LPRC) and other oil companies located on Bushrod Island, dwellers of the Freeport Community and other parts of Bushrod Island can not access safe groundwater. As a result, people located in that affected environment are facing severe water scarcity. People affected by the oil spillage and other residents who are not connected to the LWSC pipe water system resolved to purchase water from vendors; including private wells/pumps, trucks, and tanker owners. The water prices vary among vendors and increase during the dry season. On some occasions water price increases due to fuel (for tanker-truck) limitation/price increase. In another scenario, there are claims made by some residents that some local water vendors incite others to increase water price. Many residents of Bushrod Island tend to spend more money on water they purchase from vendors. The expenditure will not be the same if those people are connected to the pipe water system or have access to adequate water sources.

There is a need to increase funds and investments in the water sector of Liberia. To achieve SDG 6, the government of Liberia has to negotiate with non-governmental (developmental) organizations and private investors for effective management and construction of new infrastructures to enhance the services of access to water and sanitation in the country. This study looked into the challenges associated with access to potable water supply in the study area to provide important insights into enhancing water accessibility and resolving water-related issues in the country. It establishes the groundwork for well-informed policy suggestions and actions to improve the infrastructure supporting water delivery and the country's overall water access condition.

1.3. Research Objectives

The **General Objective** is to examine potable water accessibility and its implications on the socio-economic well-being of the people of Bushrod Island, Liberia.

The Specific Objectives are to:

- i. Assess the challenges associated with potable water supply and service delivery in Bushrod Island;
- ii. Determine the community dwellers' relations and perceptions about water access in Bushrod Island;
- iii. Examine the socio-economic impacts of inadequate access to potable water supply in Bushrod Island.

1.4. Research Questions

- i. What are the challenges associated with potable water supply and service delivery in Bushrod Island?
- ii. What are the community dwellers' relations and perceptions about water access in Bushrod Island?
- iii. What are the socio-economic impacts of inadequate access to potable water supply in Bushrod Island?

1.5. Significance of the study

One of the most important aspects of maintaining health and preventing waterborne illnesses is having access to clean and safe drinking water, which is also a fundamental human right. The study is significant because it directly relates to sustainable development; SDG 6 (Target 1), public health, and the general well-being of Liberia's population, especially in the designated Bushrod Island territory. By concentrating on the challenges encountered in providing and accessing drinkable water on Bushrod Island, this study seeks to identify particular barriers and shortcomings in the system related to water provision and provide necessary recommendations to enhance the situation.

The findings of the research may help non-governmental organizations, governmental authorities or legislators of Liberia, and other stakeholders make decisions regarding the short- and long-term solutions required to deal with these water challenges. Moreover, the study will advance knowledge of the complex issues surrounding the availability of water in developing countries, potentially having global significance.

1.6. Scope and Limitation of the Study

The study was conducted for a duration of four (4) months (December 2023 – March 2024). The residents of Bushrod Island's various communities including community leaders, local authorities, and service providers (experts) in the water sector of Liberia were surveyed and interviewed to gather the study's primary data. The secondary data was collected from literature and the necessary institutions concerned with water management and other aspects related to the study.

Access to precise and current information on Liberia's water infrastructure and other necessary data, particularly at low levels like Bushrod Island, was difficult. This can make comprehensive research and preparation more challenging. Frequent electricity (power) outages from my residence hindered the proper utilization of tools (laptop) used during the research. The national election, inauguration and transitional activities, and the creation of a niche to avoid criminals from various locations on Bushrod Island, also influenced the research and required additional time and effort to deal with.

2. LITERATURE REVIEW

2.1. Introduction

This chapter addresses written works that relate to the objectives of the research. It comprises global, regional, and national documents (articles and reports) concerning access to water, the socio-economic impacts of inadequate access to potable water, and some improvement interventions and policy implications in the water sector.

2.2. Global Perspective of Water Access Challenges

Water is essential for maintaining health, producing food, managing the environment, and creating jobs. It is at the center of economic and social growth. Despite the significance of water, 2 billion people lack access to safe drinking water, and 3.6 billion people lack access to good sanitation (World Bank, 2022). Numerous international treaties and declarations have recognized access to clean water and proper sanitation as a human right. However, the goal of having access to clean water for everyone has not yet been completely accomplished. Worldwide, illnesses associated with water continue to be the leading cause of mortality for children under five; rural regions of developing nations are where these issues are most evident (Grady et al., 2014).

The world's limited freshwater supplies have been further pressured by climate change, severe droughts, population growth, rising demand, and inadequate management in recent decades, leading to severe water shortages in many areas (Salehi, 2022). A report by (UN Water, 2022) indicated that in 2018, 18.4% of all accessible renewable freshwater resources were being depleted globally. Despite its apparent safety, this figure hides significant regional, national, and subnational variances. Three of the seven regions, including two subregions with high water stress (Central and Southern Asia) and one with critical water stress (Northern Africa), had water stress ratings above 25% in 2018. Water stress is considerable in Western Asia and low in Eastern Asia. The other regions and subregions, which together account for about 31% of the world's population, continued to be at the "no stress" level; but, when water stress levels are examined at the national or major basin levels, significant variations become evident (UN Water, 2022).

Due to growing crop irrigation, population growth, high water demand in larger cities, and rising water demand in arid and semiarid regions, groundwater usage has increased globally in recent decades (Wada et al., 2010). Global water consumption is still dominated by the production of food through agriculture. Currently, agriculture uses about 70 percent of the

water that is extracted globally. It is anticipated that the agricultural sector's need for water will rise in correlation with the population's growing food needs (ICA, 2012). One-sixth of the world's population, or 1.2 billion people, reside in severely water-constrained agricultural areas of the 3.2 billion people who live in agricultural areas with high to extremely high water deficits or scarcity (FAO, 2020).

Urbanization, industrialization, and agricultural production all affect the availability of water. Issues with multiple access are also related to climate change, which is a growing factor. Approaches required to meet the worldwide demand for potable water are influenced by acute and chronic diseases caused by contaminated water, as seen from a health perspective (Grady et al., 2014). Water quality can be adversely affected by industrial processes like the manufacturing of pharmaceuticals, the refining of petroleum, the production of paper, the fabrication of textiles, and different mining operations. There are numerous instances where industrial processes and declining water quality are correlated.

2.3. The Context of Water Access Challenges in Africa

The water issue continues to be the risk of most concern after weapons of mass destruction, ranking above other threats including climate change, harsh weather, food crises, and societal instability. Water scarcity in general is not the main problem. Concerns regarding the distribution and use of water resources, water pollution, inadequate institutions, ineffective governance, and a lack of political will to solve the region's growing water shortage are on the rise in sub-Saharan Africa (World Economic Forum, 2017).

(Armah et al., 2018) conducted a study over 25 years in 15 sub-Saharan countries and mentioned that the issue of access to water and sanitation in sub-Saharan Africa is not just scientific and technical but also linked with the region's environment, culture, economy, and behavior. In a study that examined the proliferation of private water supply, its challenges, and socio-economic implications in the Obio /Akpor local government area in Nigeria, (Brown et al., 2020) identified that the socio-economic effects of private water supply management include excessive water consumption, the establishment of water vendors' livelihoods, and increased susceptibility to diseases like typhoid because the study area lacks a minimum standard for borehole drilling and distance.

Poor access to water supply and management of potable water in Africa is partly caused by corruption and bad governance in the water sector. (Cyprian Eneh & Ngozi Eneh, 2014) pointed out that up to 50% of water is lost in several African nations as a result of illegal

connections and leaks in pipes and canals. Of Africans, two-fifths lack access to better water supplies, 62% have improved sources of drinking water, and 36% have improved sanitary facilities. Barely 1.6% of people can get better sources of drinking water each year, whereas 1% can access better sanitary facilities (Cyprian Eneh & Ngozi Eneh, 2014).

2.4. The Aspect of Access to Potable Water in Liberia

2.4.1. Historical Context of Water Supply in Liberia

Before 1948, the only sources of water for the citizens of Monrovia were private wells and cisterns, most of which were quite unclean. Three wells were subsequently built in Point Four (Bushrod Island) in 1948, providing water to Monrovia. The demand surpassed these wells' producing capacity as the population and economy expanded quickly (MME, 2009). In New Kru Town (Bushrod Island), infiltration galleries and a pumping station were built in 1952. Since then, the water supply system has been gradually expanded, and by 1980, the White Plains Water Treatment Plant's capacity had been raised to 60.5 million m³ per day. This improvement took place between 1948 and 1980 (MME, 2009).

Liberia experienced a severe recession in the middle of the 1970s, which was followed by a bloody coup (in April 1980), which contributed to the country's political instability. Despite the challenging circumstances, Liberia Water and Sewer Corporation (LWSC) was nevertheless able to provide water service to 75% of the Monrovia region utilizing 17,900 individual connections, of which 45% were metered (Wilson, 2003). People without access to the water system relied on numerous private shallow wells and a small number of public taps. Water production was ensured by the White Plains treatment plant, which is situated on the Saint Paul River 15 kilometers northeast of the capital. Its daily production averaged 61,000 m³ per day (Wilson, 2003).

Records from 1974 indicate the start of a structured rural water program. The National Rural Water Program (NRWP), as it was known, started as a US Peace Corps Volunteer program under the former Ministry of Local Government, Rural Development, and Urban Reconstruction. The development of spring catchment systems, shallow hand-dug wells with Consallen and Aweiller hand pumps, and micro-hydroelectric dams, like the one built in Yandohun, Lofa County, were among the main undertakings (MME, 2009).

In Liberia, the management of water resources is dispersed among multiple entities, with minimal interagency collaboration. One of the main causes of the serious water problems that are emerging is the lack of a strong framework for the management of water resources

(Liberia EPA, 2007). Table 2.1. shows the key dates in the reform of the water sector in Liberia.

Table 2.1.
Dates In the Reform of The Water Sector in Liberia

Year	Event
1956	Public Health Law enacted.
1975	Act Establishing the New Public Health Law of Liberia Chapter 24 had key objective of protecting Liberia's water resources.
1980	National Water Resources Board formed, with Ministry of Lands, Mines and Energy served as Chair and Hydrological Services as Secretariat.
1986	National Public Health Committee established to coordinate water and sanitation affairs in the absence of the National Water Resources and Sanitation Board.
1989	Beginning of civil war.
1992	Water and Sanitation (WatSan) Coordinating Committee established and tasked with coordination of the activities of the water sector institutions.
2002	Environment Protection and Management Law approved, with the key objective of ensuring the sound management of environmental and natural resources.
2008	Liberia PRS (2008–11) includes water and sanitation as part of Pillar IV, infrastructure and service delivery and sets targets for water and sanitation.
2008	Approval of Integrated Water Resources Management Policy.
2009	Approval of National Water and Sanitation Policy.

Source: (Finance, 2015) An AMCOW Country Status Overview

2.4.2. Overview of the State of Water Infrastructure and Access to Water in Liberia

In ten (10) major locations, mostly county capitals, pipe-borne water supply systems were set up and put into service between 1970 and 1985. These systems were all severely damaged during the war, and none have been repaired to their pre-conflict state (MME, 2009). Nine of the outstations were built particularly for the Liberia Water and Sewer Corporation (LWSC), while the tenth plant was acquired from the Liberia Mining Company in Tubmanburg after the Bomi Iron Mine closed in 1977. Except for Tubmanburg, Harper, and Greenville, seven of the Outstations were built between 1978 and 1985 for a total of \$17.34 million that the West German government (KFW) granted as a soft loan (MME, 2009).

White Plains Water Treatment Plant (WTP), which delivers water through a north-southerly transmission mains and distribution network, is Monrovia's primary source of potable water supply. The Plant's capacity was slated to rise to 16 MGD in 2015 after it would have

undergone a complete rehabilitation. Despite all odds, LWSC has kept the facility operating, albeit at a small portion of its full design capacity (Corporation et al., 2016). The supply is supplemented by two Paynesville LWSC-controlled deep wells and numerous manually operated shallow wells that are typically handled by the local community where they are situated. Private wells, boreholes, and rainwater are other sources.

Seven national WASH targets are listed in Liberia's Pro-poor Agenda for Prosperity and Development (PAPD). It was anticipated that by 2023 Liberia would have 85% of people having access to basic services for safe drinking water, an increase of 9% from the present 76%. At the national level, only 4% of the population has access to a supply of drinking water that is safely regulated, and only 1% of the population in rural areas has this access. The Liberian government wishes to increase nationwide coverage for urban and rural areas by 15% each (SWA, 2022). The (World Health Organization et al., 2022) report indicated that 75.6% of Liberia's population have access to at least a basic drinking water service level, 10% of the population have limited water access service level, i.e. round trip water collection time more than 30 minutes, 9.8% of the people in Liberia directly use surface water, and 4.6% of Liberians rely on unimproved water sources.

2.4.3. Factors and Challenges Affecting Access to Potable Water in Liberia

Although Liberia is endowed with an abundance of water resources, careful management and planning are still essential to achieving the country's priorities and goals and minimizing conflicts between competing uses. Administrative, technical, and political issues, particularly the weak status of Liberia's economy following 14 years of civil unrest, further exacerbate this issue (Liberia EPA, 2007). A study by (Gökçekuş et al., 2022) indicated that existing studies showed that the quality of freshwater in Liberia had been mostly impacted by faecal indicator bacteria, heavy metal contamination, and Coliform bacteria during the past few years, and as a result, it is not at an optimal level. The authors further explained that the rapidly growing agro-industrial sector, mining operations, inadequate sanitation systems, and flooding are largely responsible for these contaminations.

Research conducted by (Kumpel et al., 2016) on 204 water sources in Monrovia indicated that a significant percentage of samples tested positive for fecal contamination. 19% of the samples (N = 204) exhibited concentrations of E. coli > 100 MPN/100 mL, while 57% of the samples had ≥ 1 MPN/100 mL. Furthermore, 22% of the samples (N = 204) had nitrate

levels above the 40 mg/L Liberian threshold. The limit for fluoride levels was not surpassed by any sample, and the majority of samples (97%, N =204) had low Total Dissolve Solids (TDS) concentrations (< 500 mg/L). In 80 percent of the samples, the pH was below 6.5. (Kumpel et al., 2016) further explained that in terms of E. coli contamination, drilled boreholes had the lowest level (44%, N = 18), followed by protected hand-dug wells (52%, N = 147) and kiosks (71%, N = 14). There was detected E. coli in all open wells (100%, N = 18), with concentrations considerably greater than in any other source ($P \leq 0.01$, pairwise Wilcoxon rank sum). The median nitrate concentrations in shallow groundwater sources (open wells, 37 mg/L, and protected hand-dug wells with hand pumps, 21 mg/L) were higher than those in boreholes, which access deeper groundwater (median: 8 mg/L), and piped water (median: < 1 mg/L).

According to (ECOWAS, 2013), due to changes in temperature and precipitation, the St. Paul River Basin's runoff is expected to reduce by 0.7-95% by the 2020s. This will affect Monrovia's water supply and the Mount Coffee plant's capacity to produce hydropower. The vulnerability of people who depend on surface water supplies for daily activities may increase due to decreased availability and impaired quality of these sources. However, storms that are severe and occur more frequently might result in stormwater flows, which increases the risk of contaminating shallow wells and surface water sources (USAID, 2017).

In another study, (Amoak et al., 2023) found that in Liberia, drinking water supplies and sanitary facilities were linked to socioeconomic, geographic, and demographic characteristics. In terms of socioeconomic characteristics, households with no education, secondary education, and elementary education were all less likely than those with higher education to have better access to clean water sources and sanitary facilities. The study revealed a substantial correlation between family wealth and the availability of drinking water and sanitation facilities. Specifically, the findings indicated that impoverished families were less likely than their wealthier counterparts to have access to improved sources of drinking water and sanitation facilities.

2.4.4. Bushrod Island Access to Potable Water Situation

Water production was guaranteed by the White Plains treatment plant in Bushrod Island, which is situated on the Saint Paul River 15 kilometers northeast of the capital. On average, it produced 61,000 m³/day each day (Wilson, 2003). Large-scale water supply

rehabilitation was planned following the overthrow of Taylor's administration in August 2003. According to (Smith and Kpakolo, 2004), following a fuel shortage in 2003, White Plains' production further decreased, reaching a little over 3,500 m³/day. After nearly 15 years of interruption, the situation reversed in the middle of 2006 when the newly elected administration repaired the transmission line extensively, increasing water production significantly and enabling water to reach Central Monrovia. At first, GTZ, the ICRC, MSF-Belgium, and UNICEF worked together to fix the water supply infrastructure. In Monrovia, community-based initiatives to stop cholera epidemics were also implemented by UNICEF, Concern, the ACF, Oxfam, and the ICRC.

Oxfam's project in Clara Town, a densely populated low-income region of Bushrod Island, required special attention since it dealt with illegal water vendors. These vendors were frequently under the authority of criminal groups, making it difficult for a foreign NGO to operate there. Up to 60% of the Liberia Water and Sewer Corporation (LWSC) drinking water treatment plant (White Plains) water supply was thought to be unaccounted for in 2004 due to water theft through a leaking pipe of LWSC (Smith and Kpakolo, 2004). Cities Alliance recently delivered twenty new multipurpose water kiosks to the towns of Blamo Town on Bushrod Island and Weh Town in Paynesville, Greater Monrovia. It is estimated that approximately 15,000 people living in informal settlements of the capital city of Liberia benefit from the services (Cities Alliance, 2020). The kiosks, which have a solar lighting system and a storage tank, are made to accommodate small-scale trading, giving the locals access to necessities and assisting in the maintenance of their standard of living.

The management of the Liberia Water and Sewer Corporation (LWSC), through its Communication Director, announced the breakdown of the Corporation's 16" transmission pipeline through Front Page Africa news (Liberia: Another Major Breakdown Hits LWSC – No Water for Bushrod Island Communities). It was stated that the damaged pipeline was a medium of water supply to the communities of Bushrod Island and its adjacent communities, including Virginia, Hotel Africa, Brewerville, Caldwell, and Tweh Farm Community. The LWSC Spokesperson noted at the time the infrastructure was constructed (1967), it was meant to serve about four hundred thousand (400,000) inhabitants and has a lifespan of twenty-five (25) years but unfortunately, the system is currently serving over one million (1m) inhabitants (Front Page Africa, 2021).

2.5. The Impacts of Inadequate Access to Potable Water on Socio-economic Well-being

Water scarcity is one of the world's problems that more people are impacted by. Women and children suffer more from water scarcity because they are frequently the ones who have to collect water. There is usually less time for school when the water is farther away since it takes longer to collect. Lack of water in schools affects student enrolment, attendance, and performance, especially for girls. Long-distance water carrying is very difficult physically and puts kids in danger of being exploited. According to (UNICEF, 2023), at least one month in the year, four billion people, or about two-thirds of the world's population, suffer from acute water scarcity. More than two billion people live in nations with inadequate water supplies. As early as 2025, half of the world's population may reside in regions with limited access to water. By 2030, severe water scarcity may force 700 million people to be displaced. Approximately 1 in 4 children globally will live in regions with extreme water stress by 2040 (UNICEF, 2023).

Emerging water-related illnesses like chikungunya and dengue fever are resurfacing and affecting the lives of the impoverished; to stop the spread of infectious diseases, poor nations have a pressing need for access to clean water and health care (Ahmed et al., 2020). Millions of people worldwide, particularly children, die every year from acute illnesses linked to water. In addition to causing acute illnesses, drinking contaminated water can lead to several chronic illnesses, including cancer. Worldwide access to potable water is impacted by acute and chronic illnesses caused by contaminated water, and innovative strategies are required to meet the demand for potable water (Grady et al., 2014). Acute water-related illnesses can manifest in a variety of ways and spread to humans via several different routes. The classification system for diseases connected to water is displayed in **Table 2.2**.

Table 2.2.

Common Categorization of Acute Diseases Linked to Water

Classification	Examples	Causes
Waterborne	Cholera Hepatitis Typhoid	Drinking contaminated water
Water washed	Scabies Trachoma	Lack of water for proper hygiene
Water based	Schistosomiasis Guinea worm Threadworm	Swimming or walking in contaminated water (through skin)
Water-related insect vector	Malaria Dengue fever Yellow fever	Bite by infected insects that breed near water

Source: (Wardlaw et al., 2010)

Certain contaminants in drinking water have been connected to chronic diseases, but acute water-related illnesses are a direct threat to health. The global number of people affected with chronic water-related diseases is difficult to estimate. The majority of these illnesses may also result from other exposures, and they may also be underreported, particularly in underdeveloped nations.

In addition to causing health and economic issues, a lack of access to potable water exacerbates poverty. Miscarriages, birth deformities, and new-borns health problems such as methemoglobinemia and dehydration are examples of health challenges linked to lack of clean water (Cyprian Eneh & Ngozi Eneh, 2014). The Water Integrity Network and Transparency International expressed that corruption in the water sector endangered the lives and livelihoods of billions of people and impeded efforts to reduce poverty and promote development (IT and WIN, 2008). More current data show illnesses linked to water kill around 5 million people annually. One billion people do not have access to water within a 15-minute walking distance of their houses on a global scale according to (Eneh, 2011). Africa has a greater scarcity of potable water. The continent is plagued by persistent, endemic water and sanitation crises that limit access to possibilities for education and life, kill and affect vast numbers of people, and endanger the health of the labor force (Alexander, 2008).

2.6. Policy Implications and Interventions for Water Access Improvement

The activities of effective development, in (Adeniran et al., 2021) perspectives, include concentrating on what are variously referred to as "nature-based solutions" and "ecosystem-based adaptation"; rehabilitating existing, failed, and deteriorating dams, and their catchments to support current climate mitigation efforts, supporting indigenous knowledge systems to improve local rainwater harvest and conservation agriculture, and lastly, encouraging more efficient use of existing water and return environmental flows.

Numerous issues, such as growing urbanization caused by population expansion, the effects of climate change, and aging infrastructure that has reached capacity limits, put pressure on the viability of today's urban water systems (Sharma et al., 2020). In recent years, Integrated Water Resources Management has been accepted as a concept and means for equitable, economically sound, and environmentally sustainable management of water resources and the provision of water services (GWP, 2000). Urban water services are currently being developed using methodologies like Water Sensitive Urban Design (WSUD) and Integrated Urban Water Management (IUWM) to address these problems (Sharma et al., 2020). Many water utilities have difficulties meeting the regular water demand due to the rapidly depleting freshwater resources and deteriorating water infrastructure in many urban and rural areas. The water utilities' primary strategies for addressing water scarcity focus on offering alternative water sources such as rainwater harvesting and reuse (Angelakis et al., 2018; Hashim and Sayl, 2021). Water providers should carefully investigate and monitor practices before and during the implementation of alternative practices, such as water blending and intermittent water supply, to prevent contaminating delivered water, even though these practices temporarily address consumers' need for potable water. In addition, water users should be advised of the potential risks involved in using the first flush water supplied following the restoration of the water supply and given the necessary guidance to lessen their exposure to microbiological and chemical contaminants in tap water (Salehi, 2022).

However, (Vyas-doorgapersad, 2023) research claims that budgetary limitations prevent several African governments from funding developments in urban water infrastructure. Private Public Partnerships (PPPs) may be the solution since they allow private partners to supply the funds and technical expertise required for the planning, construction, and/or renovation of urban water infrastructure. PPPs will provide access to clean water, boost industry, create jobs, and strengthen the whole economic cycle. The report suggests that

one of the many approaches to solving the issues with water infrastructure may be the use of PPPs in urban water infrastructure (Vyas-doorgapersad, 2023).

The Dublin-Rio Principle states, "Water development and management should be based on a participatory approach, involving users, planners, and policy-makers at all levels; Women play a central part in the provision, management, and safeguarding of water" (GWP, 2011). (Tseklevs et al., 2022) findings, based on a review of multiple studies, indicate that elevating women into leadership positions in water and sanitation programs and community water management can increase sustainability and improve the efficiency of water projects. It was also stated by (Tseklevs et al., 2022) that while developing and putting into practice WASH technologies and treatments, cultural preferences have to be a major consideration. Hence, intentionality and a longer time frame are necessary for community participation to be effective. Additionally, change agents who are trained and employed in existing culturally rooted leadership structures, such as schoolteachers and religious leaders, should be used.

2.7. Conclusion

Water is a vital resource that is crucial for human survival. On this basis, many organizations and states have advocated for access to water as a human right. Yet, many people across the world still lack access to potable water supply. Several studies have been done to address this pressing issue. There is a need for further studies, including this research, to be carried out and resolve the issue of access to water that people are experiencing globally.

The fourteen (14) years of civil war (1989 – 2003) that was fought in Liberia, coupled with poor water management structures and population growth have made the aspect of access to potable water supply a challenge in the study area (Bushrod Island). This research aimed to examine and contribute to bridging the gap in the water sector of Liberia, especially the challenge of access to potable water supply and its impacts on the people of Bushrod Island's socio-economic well-being.

3. METHODOLOGY

This chapter comprised of information related to the research study area, research design, sampling techniques, sampling size, data collection methods, data analysis, and ethical considerations.

3.1. Study Area

3.1.1. Location



Figure 3.1. Political Map of Liberia

Source: (Worldometer, 2018)

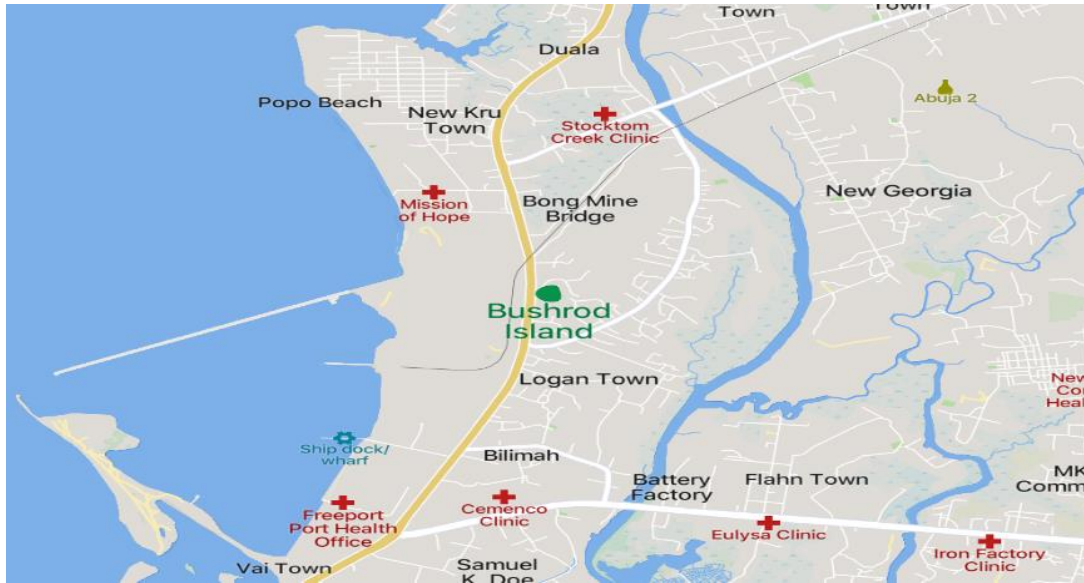


Figure 3.2. Map of Bushrod Island, Liberia

Source: [Bushrod Island Map - Island - Montserrado County, Liberia - Mapcarta](#)

Bushrod Island is located near Monrovia, Liberia, and is encircled by the Saint Paul River, the Mesurado River, and the Stockton Creek. The main national port of Liberia, the Freeport of Monrovia, as well as other enterprises, are located on the island. It also has a lot of residences and government structures. Vai Town, New Kru Town, Logan Town, and Clara Town are the four main towns that make up the island (Mapcarta, 2023).

3.1.2. Climate

Liberia (Bushrod Island) has a tropical climate with considerable rains from May to October and a brief break from mid-July to August. The dry season lasts from November to April; yet during the past 30 years, both seasons have gradually changed. Except for highland regions where air is forced to rise, causing aerographic rains, coastal areas are wetter, and rainfall decreases as atmospheric moisture moves from the coast toward the interior. From 32°C in November to 28°C in June, the temperature varies. The relative humidity ranges from 60% to 90% during the dry season and from 90% to 100% during the wet season (Communication, 2013).

3.1.3. Demographics

The Liberia Institute for Statistics and Geo-Information Services (LISGIS) released the result of the 2022 Census and stated that Liberia has a population of 5.2 (5,248,621) million people. In comparison to the 2008 census, the population grew by 1,772,013 (50%) overall. Given a national sex ratio of 101.5 males for every 100 females; men make up 50.4 percent

of the population overall (2,644,450), while women make up 49.6 percent (2,604,171) of the population. According to this report of LISGIS, Bushrod Island has a current population of 278,766 people (LISGIS OFFICIAL, 2023; UN Liberia, 2023).

3.2. Research Design

This study employed an exploratory sequential mixed methods study design in which the quantitative portion of data collection and analysis comes after the qualitative phase (Fetters et al., 2013). A more thorough grasp of the challenges, perceptions, and socio-economic impacts of Bushrod Island potable water access was obtained when both data types were combined. Through the combination of data from qualitative and quantitative sources, this technique strengthened the validity and reliability of the study and offered a stronger basis for policy suggestions and interventions aimed at resolving Bushrod Island's water access issues.

3.3. Sampling Techniques

Through purposeful sampling, participants (water service providers or experts) with a range of perspectives and experiences regarding the problems with Bushrod Island's (Liberia) water supply were selected and interviewed (recorded). This technique, also known as judgemental sampling, is preferred in situations where a small number of respondents possess the necessary information. This approach entails choosing a sample of respondents who have the best ability to offer the information needed (Nanjundeswaraswamy & Divakar, 2021). The purposive sampling technique used in this research is supported by the principle of saturation in qualitative research; when no new information or themes emerge from the data set, the data set is said to be saturated, meaning that all of its possibilities have been exhausted (Naeem et al., 2024).

To guarantee a representative sample of residents from various demographic and socioeconomic groups in Bushrod Island, simple random sampling was employed. With this method, each individual in the population has an independent and equal likelihood of being chosen; the experiment's framework enables the researcher to select participants from the entire population, by choosing the number of participants at random (Nanjundeswaraswamy & Divakar, 2021). The research sampling frame (278,766 people) was obtained from the Liberia Institute for Statistics and Geo-Information Services (LISGIS).

3.4. Sampling Size

The quantitative sample size was decided using statistical concept to guarantee that the findings were representative and applicable to the entire population of Bushrod Island. Since the population of Bushrod Island is known as 278,766, (LISGIS, 2023), the Taro Yamane Formula was used to determine the sample size. To find the sample size from a given population, statistician Tara Yamane developed the Taro Yamane technique in 1967 (Nanjundeswaraswamy & Divakar, 2021).

Taro Yamane Formula; $n = N / (1+N (e)^2)$

Where: n means the sample size, N signifies the population under study, and e represents the margin of error (Nanjundeswaraswamy & Divakar, 2021).

The study sample size was determined as follows:

$$n = N / (1+N (e)^2)$$

$$n = 278,766 / (1 + 278,766 (0.05)^2)$$

$$n = 278,766 / (278,767 (0.0025))$$

$$n = 278,766 / 696.9175$$

$$n = 399.99 \text{ or } 400$$

Therefore, 400 is the sample size of the 278,766 population of Bushrod Island, which is the lower number to maintain a 95% confidence interval from the respondents, considering a 5% or 0.05 margin of error for the study's primary quantitative data.

For the aspect of the primary qualitative data, 10 water service providers from several institutions in the water sector of Liberia were selected through purposeful sampling. This number (10) of participants is the number of water service providers (experts) that the researcher judges to be in the best position and possess the needed information that addressed inquiries (questions) of the qualitative component of the study, based on the principle of saturation.

3.5. Data Collection

3.5.1. Qualitative Data Collection

Key informants, such as water service providers (experts) were the focus of the in-depth interviews. Qualitative insights into the challenges and socio-economic impacts related to water availability in Bushrod Island were obtained from these interviews that were recorded. A total of 10 key informants were interviewed. Three employees of the Liberia Water Sewer Corporation (LWSC), including the Manager of Operations, Account Officer for Water, and a staff of the Monitoring and Evaluation (M&E) Unit were interviewed at the corporation's office located at Front Street, Monrovia, Liberia. During field trip encounters, the other 7 key informants representing the T-Five Natural Mineral Water, Bushrod Island Pure Drinking Water Ltd, Natural Rock Water Inc, Zaye and Sons Mineral Water, Ducor Natural Water, Flourish Mineral Water, and Blue Lake Mineral Water were interviewed.

3.5.2. Quantitative Data Collection

To get quantitative information on the primary obstacles to water availability, a structured survey was conducted. A questionnaire was developed and administered to a sample of households, concentrating on respondents' perceptions about activities affecting water access, reliability, cost, and the socio-economic impacts of inadequate access to potable water in the study area.

Through field trips made by the researcher of the study, a total of 400 respondents were surveyed from five major communities of Bushrod Island. These communities include New Kru Town (94 respondents), Logan Town (87 respondents), Clara Town (85 respondents), Vai Town (65), and Freeport (69 respondents) respectively.

3.6. Data Analysis

3.6.1. Qualitative Data Analysis

Thematic analysis was used to find repeating patterns and themes of the qualitative data. Thematic analysis is one of the most essential methods of analysis utilized for qualitative data. Thematic analysis is the method that most researchers prefer to use when analyzing audio or video transcripts (Nicolas, 2021).

Potential factors influencing Bushrod Island water supply were identified with the aid of this investigative technique. Interview recordings were transcribed and underwent a thematic analysis process; coding of phrases and sentences. Like codes were developed into patterns and themes that reflected water service providers' experiences with Bushrod Island water supply challenges and the socio-economic impacts of inadequate access to potable. The themes were then named for proper representation of the data.

3.6.2. Quantitative Data Analysis

Descriptive statistics was employed to measure the relationship between variables and find significant statistical data, based on the respondents' (community dwellers) relations and perceptions about access to clean and reliable drinking water and its socio-economic impacts in the study area. The survey data was subjected to statistical analysis using Statistical Package for Social Science (IBM SPSS Statistics 27). For sophisticated statistical data analysis, a variety of academics use SPSS. The SPSS software package was developed to manage and analyze social science data using statistics. It was first introduced by SPSS Inc. in 1968, and IBM later purchased it in 2009 (Alchemer, 2021).

3.7. Ethical consideration

The necessary authorities and community leaders were consulted for community and institutional entry approvals. The participants' identities, confidentiality, and consents were prioritized and used only for the research (academic) purpose strictly.

4. RESULTS AND DISCUSSION

4.1. Results

4.1.1. Qualitative Results

During the interviews with water service providers (the study key informants), several challenges were listed as the factors of which “potable water supply” is difficult in Bushrod Island, Liberia; whereas, socio-economic impacts of “inadequate access to water” assumed by the study key informants, were highlighted. For the aspect of water supply challenges, the information gathered from the key informants was arranged in patterns and then structured into 7 themes which include: damaged and outdated water infrastructure, electricity for water transmission and distribution, chemicals procurement, water theft/ pipes leakages, vehicles breakdown/inadequacy, fuel availability, and customers’ refusal to pay water bills.

Damaged and Outdated Water Infrastructure: The key informants, especially the staff that were interviewed from the Liberia Water and Sewer Corporation (LWSC) highly emphasized on the current infrastructure that provides water to Bushrod Island (Liberia) as being “damaged or outdated”. They stated that it is a serious challenge to effectively supply water with the water infrastructure that is currently available. One of the staff interviewed from LWSC explained as follows:

“To supply water to many communities in Liberia is difficult because many people have built on water pipes and this has caused problems to the water supply system.” (Interview with LWSC Staff, Researcher’s Fieldwork, 2024).

One of the key informants also mentioned the following:

“The water infrastructure that is currently in use was built long ago and has lived its span. So, it is very challenging to distribute water to customers with the outdated water infrastructure.” (Interview with LWSC Staff, Researcher’s Fieldwork, 2024)

The above points made by the study key informants indicate that one reason why access to potable water is difficult in Bushrod Island (Liberia) is due to the limited (damaged or outdated) infrastructure that is currently serving the population Bushrod Island (Liberia).

Electricity for Water Transmission and Distribution: Many of the water service providers (key informants) interviewed mentioned the inadequacy and unreliability of electricity as a crucial challenge to water transmission and distribution. A participant narrated the aspect of this challenge in the following tone:

“If there could be a reliable flow of electricity, there would be a reliable supply of water.” The corporation needs sufficient power for the transmission and distribution of water to the public” (Interview with LWSC Staff, Researcher’s Fieldwork, 2024)

Another water service provider narrated as follows:

“Sometimes this water company does not supply water to customers for days due to the fluctuation of electricity. When there is no electricity, we don’t have other means to pump water from the ground.” (Interview with T-Five Natural Mineral Water Staff, Researcher’s Fieldwork, 2024)

Electricity availability as emphasized above is one of the many challenges water service providers face in supplying water to communities of Bushrod Island and nationwide.

Chemicals Procurement: The provision of chemicals needed for the treatment of water, appears to be a challenge for service providers in the water sector of Liberia. On many occasions, water could not be supplied to customers due to the lack of chemicals, according to participants interviewed. A staff of the LWSC expressed his opinion about the chemicals’ procurement situation in the following way:

“There is a need to have enough chemicals procured for the treatment of water. Some days we don’t supply water to customers because of the limitation of chemicals. We can not supply water that is not safe to the public, my brother”. (Interview with LWSC Staff, Researcher’s Fieldwork, 2024)

Another water service provider from Bushrod Island Pure Drinking Water Ltd pointed out that chemicals are cardinal for water treatment:

“When water is not treated with the necessary quantity and quality of chemicals, drinking it is of high risk. My company won’t like to see people drink unsafe water”. (Interview with Bushrod Island Pure Drinking Water Ltd Staff, Researcher’s Fieldwork, 2024)

With the scenarios above, it had been understood by the researcher that ‘chemicals’ which are vital to water potability, are a challenge for water service providers in Bushrod Island and Liberia as a nation.

Water Theft/Pipes Leakages: The leaking of water pipes has created an avenue for criminals to collect and sell water. Aside from the collection of water from leaking pipes, it is also realized that some customers are illegally connected to the water supply system. The aspects of leaking pipes and illegal connections have caused inefficiency of water supply and revenue generation; as stated by the majority of the LWSC Staff interviewed. One of the participants narrated about the water theft situation as follows:

“Sometimes water is not supplied to customers for days because there are too many people benefiting the corporation service but are not legally registered to our database. Due to the too much weight on the water network, we are unable to supply everyone with water daily. People have to do proper registration for our water and sewage services”. (Interview with LWSC Staff, Researcher’s Fieldwork, 2024)

Another staff of LWSC raised a point:

“The water pipes in use now are old and deteriorating. Several criminals take advantage of the situation to steal and sell water from the leaking pipes. Because of this water loss issue, we can’t effectively supply water and generate its revenue”. (Interview with LWSC Staff, Researcher’s Fieldwork, 2024)

As indicated above, it is assumed that a certain percentage of water that is lost (non-revenue water) to pipe leakages and illegal connections could serve other customers with an increase in the quantity of water. Therefore, water revenue could be generated and make a meaningful impact on Liberian society.

Vehicles Breakdown/Inadequacy: Many of the participants pointed out that the availability of logistics such as vehicles, is a critical challenge for water service providers in the water sector of Liberia. On many occasions, water services/projects supervisions tend to fail due to the unavailability of vehicles. It becomes very challenging for water service providers to execute certain duties because of limited vehicles. One of the water service providers expressed himself about the situation as follows:

“Sometimes we are not able to go in the field to disconnect people that are doing water theft. If there were cars available for frequent field trips, we could continuously check the network to get rid of the people that are illegally connected”. (Interview with LWSC Staff, Researcher’s Fieldwork, 2024)

In another tone, a participant interviewed explained about the situation associated with vehicles needed for water services:

“We will always try our best to bring water to Bushrod Island communities if there is a car available for distribution trips. The reason why we don’t come to supply water here some days is because of our truck breakdowns”. (Interview with Flourish Mineral Water Staff, Researcher’s Fieldwork, 2024)

The availability of vehicles for water distribution and other services has surfaced to be a challenge that has hindered many water services. From the above scenarios, water service providers certainly struggle to supply water when vehicles break down or are unavailable.

Fuel Availability: All of the participants that were interviewed highlighted the essence of fuel (crude oil and gasoline) availability for the running of vehicles and pumps, among others, for effective supply and distribution of water. Some emphasized the unreliability of power from the Liberia Electricity Corporation (LEC) as a hindering issue to water supply and service delivery. One of the water service providers that was interviewed expressed her concern about the situation as follows:

“Without current, to pump water is almost impossible. LEC current is not stable at all. We have to buy fuel sold for high price, just to get our machines and trucks functional to supply water to customers”. (Interview with Ducor Natural Water Staff, Researcher’s Fieldwork, 2024)

Customers’ Refusal to Pay Water Bills: According to some of the water service providers interviewed during the research, many customers across Bushrod Island, on some occasions refuse to pay tariffs/prices attached to water services. This situation has affected water revenue generation. Some participants stated that the customers' refusal to pay emerges from the aspect of unreliable water supply and delivery services. Whereas, other

participants expressed that some customers deliberately refuse to pay for water services. One of the participants' expressions about this issue is quoted below:

“We expect customers to come to the office for registration and payment of water and sewage services. But many customers deliberately don't bother to do proper payment of the services they received, while others refuse to pay due to the inconsistencies of water supply by the corporation”. (Interview with LWSC Staff, Researcher's Fieldwork, 2024)

On the other hand, 4 themes, which include waterborne diseases, high cost of water, water vendors' livelihood, and limitation of water for domestic activities were identified for the aspect of the 'socio-economic impacts of inadequate access to potable water' in Bushrod Island.

Water Borne Diseases: The majority of the participants that were interviewed first mentioned the outbreak of waterborne diseases as an impact of inadequate access to potable water. It was sensed by the participants of the research interview phase, that public health is directly at risk and can be greatly affected through the consumption of unsafe water. Many of the participants emphasized that people turn to unsafe water sources when they don't have access to adequate and safe sources of water. The following narrative of a water service provider gives a hint about the situation:

“We are all humans that need water and other basic life supports to survive. When there is not enough safe water to drink or use, people go to unsafe water sources to help themselves out. This practice of drinking unsafe water exposes our body to health risks, i.e. bacteria and other micro-organisms that can cause waterborne diseases and impact our lives negatively”. (Interview with LWSC Staff, Researcher's Fieldwork, 2024)

Another participant stated:

“Water is life. If we don't have sufficient water to drink, it affects the body system and causes us to be sick”. (Interview with Zaye and Sons Mineral Water Staff, Researcher's Fieldwork, 2024)

High Cost of Water: It was assumed by most of the participants that when water access is limited, the demand for it becomes high with competing forces. Hence, the public (customers) is at the point of disadvantage. Water vendors use inadequate access to water as an opportunity to exploit water buyers; the price of water increases beyond affordability.

This situation gets worse in Bushrod Island and other parts of Liberia during the Dry Season. A water service provider gave his opinion about the issue as follows:

“Everyone can not be connected to the LWSC system because of the water infrastructure challenge. It hurts to see that people are suffering to get water to even drink. And because of the situation, other people who are selling water are taking advantage of customers by selling water at high prices”. (Interview with LWSC Staff, Researcher’s Fieldwork, 2024)

Water Vendors Livelihood: Some of the water service providers that were interviewed, mentioned that the inadequacy of access to potable water affects the livelihood of people who depend on water sales to earn income and survive. In their various opinions, it was sensed that water vendors that rely on tanker-trucks for water supply before selling water by jerrycans/buckets to others, sometimes do not have water available to be sold, due to limited water supply from the tanker-trucks services. It was also emphasized that sometimes sachet/bottled water retailers go out of stock (water) when the water supply companies struggle to process sufficient water for distribution. The quote below is in regards to the situation:

“Many water sellers do not receive water from this company when our wells run low. We prioritize big sales during this time. Some local water retailers that we don’t supply during these moments do not sell water for the days we won’t supply them. And this situation can disturb their hustles”. (Interview with Natural Rock Water Inc. Staff, Researcher’s Fieldwork, 2024)

Limitation of Water for Domestic Activities: It was highlighted by many of the participants during the study interviews that another impact of inadequate access to potable water is the limitation of water for domestic activities. The participants mentioned that water for cooking, washing, and other domestic works become unavailable in some households due to the limitation of access to water. This situation greatly affects households’ effectiveness and growth. In an interview, a participant expressed his thoughts as follows:

“Houses without sufficient water struggle to engage with their daily domestic activities. When there is enough water, domestic tasks such as cooking flow smoothly. The pace of people and their homes' growth also rely on water being available for proper functioning”. (Interview with Blue Lake Mineral Water Staff, Researcher’s Fieldwork, 2024)

The above mentions as indicated by the study participants of the interview phase, are perceptions of the various challenges faced with Bushrod Island water supply and its assumed socio-economic impacts attached.

4.1.2. Quantitative Results

Respondents’ Statistical (Descriptive) Characteristics: The survey questionnaire comprised 28 items. In the study survey, 86 of the respondents constituting 21.5% were males and 314 of the respondents constituting 78.5% were females. Two hundred and one (50.2%) of the respondents were single, 135 (33.8%) married, 20 (5%) divorced/separated, and 44 (11%) widowed. One hundred and twenty-seven (31.8%) of the respondents surveyed did not acquire any level of education, 67 (16.8%) obtained primary education, 182 (45.5%) earned high school education (diploma), 23 (5.8%) had undergraduate education (bachelor degree), and 1(.3) acquired post-graduate education (master degree). The respondents of the study survey from Clara Town were 85 (21.3%), Freeport 69 (17.3), Logan Town 87 (21.8), New Kru Town 94 (23.5), and Vai Town 65 (16.3).

Relations and Perceptions About Water Access: The study survey, as presented in **Table 4.1.** showed that 52.3% of the respondents’ main source of drinking water is bottled/sachet water; followed by tube well/pump which is 32%. For the main source of water used by households for other purposes such as cooking and hand washing, protected dug well constituted 30.8%, unprotected dug well 25.8%, tanker-truck 12%, tube well/pump 14.2%, public tap/standpipe 1.8%, other (specify); i.e. surface water/runoff and rainwater 1.5%, and piped water located in house/yard 14%; see **Table 4.2.**

Table 4.1. Main Drinking Water Source

What is the main source of drinking water for your household members?

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Piped water located in house/yard	3	.8	.8	.8
Public tap/Standpipe	37	9.3	9.3	10.0
Tube well/Pump	130	32.5	32.5	42.5
Protected dug well	2	.5	.5	43.0
Bottled/Sachet water	209	52.3	52.3	95.3
Tanker-truck	19	4.8	4.8	100.0
Total	400	100.0	100.0	

Source: Author’s Fieldwork, 2024

Table 4.2. Main Source of Water Used by Households for other Purposes, such as Cooking and Hand Washing

What is the main source of water used by your household for other purposes, such as cooking and hand washing?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Piped water located in house/yard	56	14.0	14.0	14.0
	Public tap/Standpipe	7	1.8	1.8	15.8
	Tube well/Pump	57	14.2	14.2	30.0
	Protected dug well	123	30.8	30.8	60.8
	Unprotected dug well	103	25.8	25.8	86.5
	Tanker-truck	48	12.0	12.0	98.5
	Other (specify)	6	1.5	1.5	100.0
	Total	400	100.0	100.0	

Source: Author’s Fieldwork, 2024

Table 4.3. shows that 38.8% of the survey respondents indicated they spend more than 30 minutes for round-trip water collection, including queuing. While 25% of the respondents don’t know the actual time they spend on round-trip water collection, 20.5% indicated that they use less than 30 minutes for round-trip water collection, including queuing, and 15.8% stated that they don’t go to distant places for water because they have water located on their premises (house/yard). The water collection task in various households of the study was indicated by the surveyed respondents and ranked in percentage as follows: adult woman 14.2%, adult man 1.8%, female child 29.8%, male child 32.5%, and households where water collection task is not specified for household members constituted 21.8%; see **Table 4.4.**

Table 4.3. Water Collection Duration for Households

How long does it take you to go to the water source, get water, and come back?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 30 minutes	82	20.5	20.5	20.5
	More than 30 minutes	155	38.8	38.8	59.3

Water located on premise	63	15.8	15.8	75.0
Don't know	100	25.0	25.0	100.0
Total	400	100.0	100.0	

Source: Author's Fieldwork, 2024

Table 4.4. Households Water Fetcher

Who usually goes to this source to fetch the water for your household?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Adult Woman	57	14.2	14.2	14.2
	Adult Man	7	1.8	1.8	16.0
	Female child	119	29.8	29.8	45.8
	Male child	130	32.5	32.5	78.3
	No one specific	87	21.8	21.8	100.0
	Total	400	100.0	100.0	

Source: Author's Fieldwork, 2024

For the aspect of water treatment, 23.3% of the study respondents indicated that water is treated in their households before drinking, 60.3% admitted that they drink water directly from the source without treatment in their households, while 16.5% stated that they don't know if water is treated in their households before drinking; see **Table 4.5**. 55 respondents, constituting 13.8% of the study surveyed 400 respondents, stated that their households are connected to a piped water system; see **Table 4.6**.

Table 4.5. Households Drinking Water Treatment

Does your household treat water in any way to make it safer to drink?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	93	23.3	23.3	23.3
	No	241	60.3	60.3	83.5
	Don't know	66	16.5	16.5	100.0
	Total	400	100.0	100.0	

Source: Author's Fieldwork, 2024

Table 4.6. Households Pipe Water Connection

Is your household connected to a piped water system?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	55	13.8	13.8	13.8
	No	345	86.3	86.3	100.0
	Total	400	100.0	100.0	

Source: Author’s Fieldwork, 2024

The average number of household members of the 400 respondents as shown in **Table 4.7.** was 6.35; and the average number of jerrycans (5 gallons/20 liters) of water used daily as indicated by the respondents was 3.68 (4) jerrycans (20 gallons/80 liters). Meanwhile, 47.3% of the study survey respondents indicated that the water they use daily is ‘not sufficient’ for their desired daily water needs; 25.8% stated that the water supplied to them daily is sufficient for their daily desire, while 26.5% of the respondents mentioned that they ‘don’t know’ if the water their households use per day is ‘sufficient’ for their daily water desire. See details in **Table 4.8.**

Table 4.7. Average Household Members and Average Daily Water Use

Descriptive Statistics

	Mean	Std. Deviation	N
How many people are in your household?	6.35	2.259	400
How many jerrycans (5 gallons/20 liters) of water on average does your household use per day?	3.68	1.603	400

Source: Author’s Fieldwork, 2024

Table 4.8. Households Daily Water Requirement

Can the water supplied or fetched daily, sufficiently meet your household requirements?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		2	.5	.5	.5
	Yes	103	25.8	25.8	26.3
	No	189	47.3	47.3	73.5
	Don't know	106	26.5	26.5	100.0

Total	400	100.0	100.0
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Source: Author’s Fieldwork, 2024

Social-economic Impacts of Inadequate Access to Potable Water: The ‘mean’ of the average monthly payment of the study households connected to a piped water system is 2,060 Liberian Dollars (LD), equivalent to 11 United States Dollars (USD). Whereas, the ‘mean’ of the average daily payment of the study households that purchase water from vendors is 155 LD, equivalent to 0.8 USD; see **Table 4.9**. However, 61% of the study respondents indicated that the water price in their communities is ‘not affordable’, 20.8% think the water price is ‘affordable’, and 18.2% stated that they ‘don’t know’ if the water price is affordable in their communities; see **Table 4.10**.

Table 4.9. Pipe Water Monthly Payment and Water Purchase from Vendors Daily Payment

Descriptive Statistics			
	Mean	Std. Deviation	N
If your household is connected to the pipe water system, how much on the average do you pay monthly?	2060.1818	746.20147	55
How much do you pay for the average amount of water your household uses per day when you purchase water from vendors (tankers, trucks, or private wells)?	155.3250	94.47928	400

Source: Author’s Fieldwork, 2024

Table 4.10. Water Price Affordability

Do you think the water price in your community is affordable?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	83	20.8	20.8	20.8
	No	244	61.0	61.0	81.8
	Don't know	73	18.3	18.3	100.0
	Total	400	100.0	100.0	

Source: Author’s Fieldwork, 2024

In terms of the hour of the day (morning) that residents of Bushrod Island engage in water collection, 38% of the study respondents indicated that their households fetch water by 6 A.M, 16.8% stated that they fetch water by 5 A.M, 9.8% mentioned that they fetch water by 7 A.M, .5% indicated that they do water collection by 4 A.M, while others, accounting for 35%, specified that their households collect water from the water sources during afternoon and evening hours when students return from school; see **Table 4.11**. As shown in **Table 4.12**, 38% of the study respondents surveyed, stated that children in their households ‘do not get late’ for school due to water collection tasks, and 47% mentioned that they ‘don’t know’ if their children get late for school due to the time spent collecting water. On the other hand, 10.5% indicated that their children get late for school ‘once a week’ because of the time spent fetching water, 3.3% mentioned ‘twice a week’, 0.5% stated ‘thrice a week’, while others (.8%) specified that their children ‘do not relate’ to them about how often they get late for school due to water collection tasks.

Table 4.11. Households Morning Water Collection Time

Which hour of the morning do members of your household fetch water?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4 A.M.	2	.5	.5	.5
	5 A.M.	67	16.8	16.8	17.3
	6 A.M.	152	38.0	38.0	55.3
	7 A.M.	39	9.8	9.8	65.0
	Other (specify)	140	35.0	35.0	100.0
	Total	400	100.0	100.0	

Source: Author’s Fieldwork, 2024

Table 4.12. Children Being Late for School

How often do children of your household get late for school due to water collection tasks?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Once a week	42	10.5	10.5	10.5
	Twice a week	13	3.3	3.3	13.8
	Thrice a week	2	.5	.5	14.2
	Don't know	188	47.0	47.0	61.3
	None	152	38.0	38.0	99.3
	Other (specify)	3	.8	.8	100.0

Total	400	100.0	100.0
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Source: Author’s Fieldwork, 2024

It was captured from the study survey respondents that 40.3% of the study households’ members ‘complain about body pain’ due to water loads they carry; 32.8% indicated that their households’ members ‘do not complain’ about body pain, and 26.8% of the respondents mentioned that they ‘don’t know’ if their households’ members complain about body pain due to water loads they carry; see **Table 4.13**.

Table 4.13. Complain about Body Pain

Do members of your household complain about body pain due to the water loads they carry?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	161	40.3	40.4	40.4
	No	131	32.8	32.8	73.2
	Don't know	107	26.8	26.8	100.0
	Total	399	99.8	100.0	
Missing	System	1	.3		
Total		400	100.0		

Source: Author’s Fieldwork, 2024

The study survey also revealed that 6 of the 400 respondents, among which 3 from Logan Town, 2 from Clara Town, and 1 from New Kru Town indicated that in their households ‘girls complained about being harassed’ during water collection period; see **Table 4.14**. Meanwhile, 75.5% of the respondents stated water collection ‘adds a very heavy task’ to women’s workloads; 21% indicated that they ‘don’t know’ if water collection adds a very heavy task to women’s workloads, while 3.3% of the respondents mentioned that water collection task ‘does not add’ a very heavy task on women’s workloads; see **Table 4.15**.

Table 4.14. Address of the Respondent and Girls Harassment

Address of the Respondent * Do girls of your household complain about being harassed during the period of water collection? Crosstabulation

Count

	Do girls of your household complain about being harassed during the period of water collection?			Total
	Yes	No	Don't know	
Clara Town	2	61	22	85

Address of the Respondent	Freeport	0	48	21	69
	Logan Town	3	59	25	87
	New Kru Town	1	69	24	94
	Vai Town	0	47	18	65
Total		6	284	110	400

Source: Author's Fieldwork, 2024

Table 4.15. Women's Workload

Do you think water collection adds a very heavy task to women's workload?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	302	75.5	75.7	75.7
	No	13	3.3	3.3	78.9
	Don't know	84	21.0	21.1	100.0
	Total	399	99.8	100.0	
Missing	System	1	.3		
Total		400	100.0		

Source: Author's Fieldwork, 2024

Nonetheless, 8 of the respondents, constituting 2%, of the study survey stated that 1 female from each of their households had been 'blocked from doing economic (business) activities' due to the time they spent on water collection. Whereas, 1 respondent (.3%) mentioned that 2 females from their household had been blocked, and 368 respondents (92%) indicated that 'no member of their households' had been blocked from doing economic (business) activities due to the time they spent on water collection; see **Table 4.16**.

Table 4.16. Females Blocked from Economic Activities

How many adult females in your household have been blocked from doing economic (business) activities due to the time they spent on water collection?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	368	92.0	92.0	92.0
	One	8	2.0	2.0	94.0
	Two	1	.3	.3	94.3
	Other (specify)	23	5.8	5.8	100.0
	Total	400	100.0	100.0	

Source: Author's Fieldwork, 2024

As shown in **Table 4.17**, it was revealed by the study surveyed respondents that 2 of the study households' members from Clara Town, 1 from New Kru Town, and another 1 from Logan Town were affected by cholera disease during the last 6 months before the start of the study (December 2023).

Table 4.17. Address of the Respondent and Cholera Disease Tracking

Address of the Respondent * During the last six (6) months, did any member of your household get cholera disease? Crosstabulation

Count

				During the last six (6) months, did any member of your household get cholera disease?			Total
				Yes	No	Don't know	
Address of the Respondent	Clara Town		2	66	17	85	
	Freeport		0	55	14	69	
	Logan Town		1	66	20	87	
	New Kru Town		1	79	14	94	
	Vai Town		0	54	11	65	
Total		4	320	76	400		

Source: Researcher's Fieldwork, 2024

4.2. Discussion

Challenges Associated with Potable Water Supply and Service Delivery: The challenges associated with potable water supply in Bushrod Island as indicated by the water service providers interviewed during the study, include damaged and outdated water infrastructure, electricity for water transmission and distribution, chemicals procurement, water theft/pipes leakages, vehicles breakdown/inadequacy, fuel availability, and customers' refusal to pay water bills.

The finding of 'damaged and outdated water infrastructure' as a key challenge to effectively supply water is supported by previous literature. Due to rising water demands and limited supplies, drinking water utilities confront major challenges in providing a consistent and safe supply of water. Water leaks are a common consequence of aging supply and distribution networks, which exacerbates the problem even more, especially in urban areas (Picazo et al., 2024). Electricity for water transmission and distribution as a finding of this study, appears to be significant and is consistent with existing literature. Energy is used in a water supply system for the extraction, transmission, treatment, and distribution of source water. The production and distribution of drinking water use between 7% and 8% of the

energy produced globally (Sharif et al., 2019). Chemicals are vital to water treatment; the finding of ‘chemicals procurement’ as an associated challenge to water supply is in line with previous studies. One of the most significant developments in public health of the 20th century has been the disinfection of drinking water to lower the risk of water-borne infectious diseases. Water can contain organisms such as bacteria, viruses, and parasites. Public water systems add disinfectants, including chlorine and chloramine, ozone, and UV light, to their drinking water to eliminate or neutralize microbiological pollutants (U.S. EPA, 2004; CDC, 2009).

Relations and Perceptions About Water Access: In terms of the main source of drinking water, the survey study revealed that bottled/sachet water, constituting 52.3% of the study households, was consumed the highest by the study households; followed by water consumed from tube well/pump which constituted 32%. Many of the community dwellers in Bushrod Island resolve to drink sachet water because it is the most accessible source of drinking water. Many people are not connected to a piped water system. It was also made known that as of the study 400 respondents (households), 55 households were the recorded number of households that have access to piped water in their house/yard; 11 of the 55 households' main drinking water source is piped water. A recent report from the Liberia Water and Sewer Corporation indicated that Bushrod Island has a total of 3,597 drinking water customers connected to their network. It was specified that of the 3,597 connected customers, Clara Town accounted for 230, Logan Town 541, New Kru Town 170, Vai Town 219, and Freeport 302 (LWSC, 2024). During the study, 38.8% of the survey respondents indicated that they spent more than 30 minutes for round-trip water collection, including queuing. And 25% of the respondents don't know how long it takes them to do round-trip water collection. Many dwellers of Bushrod Island go to far distances and spend longer time (30 minutes or more) because of limited water sources or inadequacy of water access. This finding is in line with previous literature. In nations where access to on-premises drinking water supplies is uncommon, a significant amount of time is spent fetching water. In 2015, 26.3% of people in the entire world lacked such access. As a result, it's common to have to go to a water source, maybe wait in line, fill up containers, and then carry them home (Cassivi et al., 2018).

The average number of household members in the survey study was 6; 4 jerrycans (20 gallons/80 liters) was the average amount of water they used daily. This amount is said to be ‘insufficient’ by 47% of the study's households because it is low in quantity to satisfy

the daily water requirements of the study households' members. This finding is supported by previous literature. Expert advice and experience indicate that, in most cases, 20 L/person/day (basic access), should be enough for drinking and cooking as well as food hygiene, hand and face washing, but not for additional hygiene routines (Howard et al., 2020). Therefore, it is realized that each household in the study lacks 2 jerrycans (10 gallons/40 liters) of water needed for the minimum individual daily water consumption.

Social-economic Impacts of Inadequate Access to Potable Water: 'High cost of water', is one of the impacts highlighted by the study participants (water service providers) that were interviewed. This suggestion aligns with the study surveyed respondents' perceptions. Households of the study that purchase water from vendors tend to spend more money on water for their various water use requirements as compared to households that are connected to a piped water system. The households of the survey study that are connected to the piped water system spent 2,060 Liberian Dollars (LD), equivalent to 11 United States Dollars (USD) on average, monthly. Whereas, households that purchase water from vendors spend 155 LD daily, which is equivalent to 0.8 USD; it was estimated by the researcher that these households spend 4,650 LD (24 USD) on average, monthly. This happens because the households that purchase water from vendors have limited access to water sources. This finding is consistent with previous studies. A study done by Alfonso et al., (2022) indicated that due to the study participants' socio-economic standing, which includes land ownership, over 30% of the impoverished were forced to buy water from vendors since they did not have access to piped water.

As indicated by the participants of the study interview phase, another impact of inadequate access to potable water is the 'limitation of water for domestic activities.' This is also supported by the result of the survey phase of the study. The limitation of access to potable water in Bushrod Island has caused many of the study surveyed respondents' household members (38%) to wake up early, go to water sources, and collect water as soon as possible before most of the water sources (wells and pumps) run dry as usual, during later hours of the day. This routine period of water collection has influenced the time students go to school; causing 10.5% of students of the study households to 'get late' once a week for school, 3.3% twice a week, and .3% thrice a week. On the other hand, 40.3% of the study households' members 'complained about body pain' due to the water loads they carry. This impact on their social well-being (health) can be reduced when there are water sources located on their premises (house/yard). Furthermore, as 'water borne diseases' was

mentioned as one of the impacts of inadequate access to potable water, the provision of adequate water sources (supply) can help mitigate the outbreak or spread of cholera disease that affected 4 households of the study (6 months before the study), and improve health and well-being in Bushrod Island. However, a report from the National Public Health Institute of Liberia (NPHIL) indicated that over the past 3 years (2021-2023), Bushrod Island had a total of 13 cholera disease cases (NPHIL, 2024). This simply means many Bushrod Island dwellers' lives (socio-economic well-being) are at risk, as the challenges of water access persist.

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study aimed at examining potable water accessibility and its implications on the socio-economic well-being of the people of Bushrod Island, Liberia. It targeted the assessment of the challenges associated with potable water supply and service delivery in Bushrod Island, the determination of the community dwellers' relations and perceptions about water access in Bushrod Island, and the examination of the socio-economic impacts of inadequate access to potable water supply in Bushrod Island. An exploratory sequential mixed method (qualitative and quantitative) study design, was employed to collect primary data that were analyzed and discussed.

Several aspects associated with Bushrod Island's potable water supply challenges were identified by the water service providers (key informants) interviewed during the study. These aspects include the findings of damaged and outdated water infrastructure, electricity for water transmission and distribution, chemicals procurement, water theft/ pipes leakages, vehicles breakdown/inadequacy, fuel availability, and customers' refusal to pay water bills. One factor that makes access to potable water difficult in Bushrod Island (Liberia), as emphasized by water service providers during the study, is the 'limitation of water infrastructure' (damaged or outdated) currently serving the population. Many of the water service providers (key informants) also mentioned the inadequacy and unreliability of electricity as a crucial challenge to water transmission and distribution. The provision of chemicals needed for the treatment of water also appears to be a challenge for service providers in the water sector of Liberia, as was highlighted during the study's interview phase. It was also realized that the aspects of leaking pipes and illegal connections have caused inefficiency of water supply and revenue generation; as stated by the majority of the LWSC Staff interviewed. It becomes very challenging for water service providers to execute certain duties because of limited vehicles or other necessary logistics. All of the participants that were interviewed highlighted the essence of fuel (crude oil and gasoline) availability, for the running of vehicles and pumps, among others, for effective supply and distribution of water. According to some of the water service providers interviewed during the research, many customers across Bushrod Island, on some occasions refuse to pay tariffs/prices attached to water services; it has affected the supply of water over the past years.

In terms of the community dwellers' relations and perceptions about water access, several findings emerged. The study survey showed that 52.3% of the respondents' main source of drinking water is bottled/sachet water; followed by tube well/pump which is 32%. However, 55 households (13.8% of the study's households), were recorded to have piped water in their house/yard. For the main source of water used by the study's households for other purposes such as cooking and hand washing, 'protected dug well' constituted 30.8%, as the highest frequency among the options of water sources. The survey phase of the study also revealed that the average number of household members of the 400 respondents was 6.35 (6), and the average jerrycan (5 gallons/20 liters) of water used daily as indicated by the respondents was 3.68 (4) jerrycans (20 gallons/80 liters). Meanwhile, 47.3% of the study survey respondents indicated that the water they use per day is 'not sufficient' for their desired daily water needs.

Both the interview and survey data complimented each other on some aspects considered as the socio-economic impacts of inadequate access to potable water in Bushrod Island, even though some additional points were highlighted by the quantitative data. The 'high cost of water', is one of the impacts of inadequate access to potable water, as indicated by both participants of the study's interview and survey phases. It was made known that households of the study that purchase water from vendors tend to spend more money, i.e. 2 times or more, than the amount that households that are connected to a piped water system spend on water for their various water use requirements. The 'limitation of water for domestic activities' is another finding that emerges from both the qualitative and quantitative data, as an impact of inadequate access to potable water. The limitation of access to potable water in Bushrod Island has caused many of the study surveyed respondents (38%) to wake up early, go to water sources, and collect water as soon as possible before most of the water sources (wells and pumps) run dry as usual, during later hours of the day. As 'water borne diseases' was mentioned as one of the impacts of inadequate access to potable water, the provision of adequate water sources (supply) can help mitigate the outbreak or spread of cholera disease that affected 4 households of the study (6 months before the study), and improve health and well-being in Bushrod Island. The findings of this research may help non-governmental organizations, governmental authorities and legislators, and other stakeholders make decisions regarding the short- and long-term solutions required to deal with these water challenges.

5.2. Recommendations

Based on the findings of the study, the researcher sees it necessary to take into consideration the following recommendations which address the water accessibility issues in Bushrod Island and how the community dwellers' socio-economic activities are affected due to inadequate water access.

- The government of Liberia and its collaborating partners in the water sector should invest in the renovation of damaged or outdated water infrastructure and construct new standardized infrastructure.
- The Liberia Electricity Corporation (LEC) and other energy service providers need to prioritize and supply reliable electricity to the Liberia Water and Sewer Corporation (LWSC) and other water service providers for proper and effective collection, treatment, transmission, and distribution of water.
- There is a need for the government of Liberia to get the water sector involved in public-private partnership (PPP) since the provision of chemicals and other logistics including vehicles, the reliability of water supply, and the maintenance of water projects appear to be huge challenges that persist for the sole water utility, LWSC.
- The government of Liberia needs to fully implement the Integrated Water Resources Management (IWRM) Policy in a national (local) context, with standards, in the water sector. This aspect will straighten the sharing of roles among the various institutions of the sector.
- Investors should take pleasure in water businesses and construct stand-alone water supply systems (kiosks and tanks) at strategic points in the various communities of Bushrod Island, to aid in water access; this will reduce the distance and time the communities' dwellers covered during water collection.
- Further research and innovations in Bushrod Island need to be undertaken by members of research institutions, universities, and other intellectual bodies. Activities of such will create awareness, educate, and enhance access to water and community dwellers' livelihoods.

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7. APPENDIX

Appendix 1: Questionnaire for Water Service Providers (Experts)

Pan African University of Water and Energy Sciences, including Climate Change (PAUWES)

Program: MSc. Water Policy

Dear Respondent,

This research exercise is being conducted in partial fulfillment of the requirement of a Master of Science Degree in Water Policy at the Pan African University of Water and Energy Sciences, including Climate Change (PAUWES). The research aims to examine “Potable Water Accessibility and Its Implications on the Socio-economic Well-being of People in Bushrod Island, Liberia”.

In this regard, the researcher assures that the information you provide will be used strictly for academic purposes and kept confidential. This exercise is expected to last about 30 minutes. Thanks in advance for your participation and cooperation.

Section 1: Respondent’s Details

This section is about the respondent’s data. It aims to display key information about the various individuals participating in this research exercise.

1. Date: _____
2. Research ID Number: _____
3. Institution: _____
4. Sex of the respondent: 1) Male 2) Female
5. Age of the respondent: _____
6. Marital status of the respondent: 1) Single 2) Married 3) Divorced/Separated 4) Widowed
7. Highest level of education obtained: 0) No formal Education 1) High School Diploma 2) Bachelor Degree 3) Master Degree 4) Doctorate Degree
8. What is your position in your company/institution? _____

Section 2: Challenges Associated with Potable Water Supply and Service Delivery

This section is to assess the respondent's knowledge about water supply and service delivery associated challenges in Bushrod Island (Liberia). It aims to address objective 1 of the research.

9. What are the key challenges facing the water supply system in Bushrod Island or Liberia as a whole?

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10. Which strategy does your institution have in place for reliable operation and maintenance of water supply and delivery services?

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11. What are the problems your institution faces with water revenue collection?

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Section 3: Social-economic Effects of Inadequate Access to Potable Water

This section aims at gathering the respondent's perceptions about how inadequate access to potable water is affecting both the social and economic well-being of people in Bushrod Island (Liberia). It addresses objective 3 of the research.

12. How well do think the problem of water shortage affects domestic and economic activities?

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13. What do you think can be done to aid in reducing the amount of time that the people of Bushrod Island (Liberians) spend in search of water from far sources?

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14. What do you think are the effects of inadequate access to potable water on public health?

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15. Which recommendation can you make to tackle the water supply and delivery problems in Bushrod Island or Liberia at large?

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Thanks for your participation.

Appendix 2: Survey Questionnaire for Water Consumers (Household Heads) in the Study Area (Bushrod Island)

Pan African University of Water and Energy Sciences, including Climate Change (PAUWES)

Program: MSc. Water Policy

Dear Respondent,

This research exercise is being conducted in partial fulfillment of the requirement of a Master of Science Degree in Water Policy at the Pan African University of Water and Energy Sciences, including Climate Change (PAUWES). The research aims to examine “Potable Water Accessibility and Its Implications on the Socio-economic Well-being of People in Bushrod Island, Liberia”.

In this regard, the researcher assures that the information you provide will be used strictly for academic purposes and kept confidential. This exercise is expected to last about 20 minutes. Thanks in advance for your participation and cooperation.

Section 1: Respondent’s Details

This section is about the respondent’s data. It aims to display key information about the various individuals participating in this research exercise.

1. Date: _____
2. Research ID Number: _____
3. Address: _____
4. Sex of the respondent: 1) Male 2) Female
5. Age of the respondent: _____
6. Marital status of the respondent: 1) Single 2) Married 3) Divorced/Separated 4) Widowed
7. Highest level of education obtained: 0) No formal education 1) Primary education 2) High School Diploma 3) Bachelor Degree 4) Master Degree 5) Doctorate Degree
8. What is your occupation? _____
9. How many people are in your household? _____

Section 2: Relations and Perceptions About Water Access Activities

This section seeks to address objective 2 of the research. It takes into consideration, the respondent's relation and perception of water accessibility, reliability, and safety in the study area.

10. What is the main source of drinking water for your household members? 1) Piped water located in house/yard 2) Public tap/standpipe 3) Tube well/Pump 4) Protected dug well 5) Unprotected dug well 6) Bottled/Sachet water 7) Tanker-truck 8) Other (specify)

11. What is the main source of water used by your household for other purposes, such as cooking and hand washing? 1) Piped water located in house/yard 2) Public tap/standpipe 3) Tube well/Pump 4) Protected dug well 5) Unprotected dug well 6) Bottled/Sachet water 7) Tanker-truck 8) Other (specify)

12. How long does it take you to go to the water source, get water, and come back? 1) Less than 30 minutes 2) More than 30 minutes 3) Water located on premise 4) Don't know

13. Who usually goes to this source to fetch the water for your household? 1) Adult woman 2) Adult man 3) Female child 4) Male child 5) Don't know 6) No one specific

14. Does your household treat water in any way to make it safer to drink? 1) Yes 2) No 3) Don't know

15. Is your household connected to a piped water system? 1) Yes 2) No

16. If the previous response is "Yes", how many days in the week are you supplied with water? _____

17. How many jerrycans (5 gallons/20 liters) of water on average does your household use per day? _____

18. Can the water supplied or fetched daily, sufficiently meet your household requirements? 1) Yes 2) No 3) Don't know

Section 3: Social-economic Impacts of Inadequate Access to Potable Water

This section aims at gathering the respondent's perceptions about how inadequate access to potable water is affecting both their social and economic well-being. It addresses objective 3 of the research.

19. If your household is connected to the pipe water system, how much on average do you pay monthly? _____
20. How much do you pay for the average amount of water your household uses daily when you purchase water from vendors (tankers, trucks, or private wells)?

21. Do you think the water price in your community is affordable? 1) Yes 2) No 3) Don't know
22. How often do children of your household get late for school due to water collection tasks? 1) Once a week 2) Twice a week 3) Thrice a week 4) Don't know 5) None 6) (Specify) Other
23. Which hour of the morning do members of your household fetch water? 1) 3 A.M. 2) 4 A.M. 3) 5 A.M. 4) 6 A.M 5) 7 A.M. 6) Other (Specify)
24. Do members of your household complain about body pain due to the water loads they carry? 1) Yes 2) No 3) Don't know
25. Do girls in your household complain about being harassed during the period of water collection? 1) Yes 2) No 3) Don't know
26. Do you think water collection adds a very heavy task to women's workload? 1) Yes 2) No 3) Don't know
27. How many adult females in your household have been blocked from doing economic (business) activities due to the time they spent on water collection? 0) None 1) One 2) Two 3) Three 4) Other (Specify)
28. During the last six (6) months, did any member of your household get cholera disease? 1) Yes 2) No 3) Don't know

Thanks for your participation.



Figure 7.1. A Water Source in Clara Town, Bushrod Island

Source: Author's Fieldwork, 2024



Figure 7.2. Water Collection at a Protected Dug Well in Logan Town, Bushrod Island

Source: Author's Fieldwork, 2024



Figure 7.3. Unprotected Dug Well in New Kru Town, Bushrod Island

Source: Author's Fieldwork, 2024



Figure 7.4. A Tube Well in Freeport Community, Bushrod Island

Source: Author's Fieldwork, 2024



Figure 7.5. Public Standpipes in Vai Town, Bushrod Island

Source: Author's Fieldwork, 2024