# Driving Economic Development: The Link between Expanded Water Infrastructure Access and Gross Domestic Product Growth in Nigeria and the Case for Greater Investment in Water Infrastructure

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**Abstract**

There is a strong relationship between water infrastructure development and economic development in Africa. Access to water and sanitation services is crucial to economic development in Africa. According to the United Nations Children's Fund (UNICEF), approximately 418 million Africans lack access to essential drinking water, 779 million people lack access to basic sanitation services (including 208 million who still practice open defecation), and 839 million people still lack essential hygiene services (UNICEF, 2022). This research examines the relationship between increased water infrastructure access and economic development in Nigeria. By combining qualitative and quantitative assessments, this research analyzes available data on access to water and sanitation services in Nigeria and its impact on gross domestic product (GDP). In addition, this research gathers insight on the positive effects of improved water infrastructure on key economic indicators such as agricultural productivity, GDP, health outcomes, and overall human wellbeing. The study also explores policy implications for overcoming challenges and case studies of successful water infrastructure projects in Nigeria. In addition, this study focuses on the importance of prioritizing investment in water infrastructure as a catalyst for long-term sustainable economic development. The preliminary quantitative analysis concluded a strong positive relationship between the increased access to water and sanitation services and economic development in Nigeria. The quantitative analysis is supported by qualitative analysis on the impact water infrastructure projects have had on economic development in Nigeria. The study concludes with policy recommendations and the importance of collaboration among other African countries and regional organizations to promote a coordinated and sustainable approach to addressing water and sanitation challenges in the continent in order to encourage investment in these areas.

Keywords: Economic Development, Gross Domestic Product, Water Infrastructure

## Introduction

According to the United Nations' 17 Sustainable Development Goals, the aim is to provide a sustainable future to people worldwide. The objective of Sustainable Development Goal Six is to provide clean water and sanitation to people worldwide (United Nations, 2023). As the organization puts it, "Water is at the core of sustainable development and is critical for socioeconomic development, healthy ecosystems, and for human survival itself. It is vital for reducing the global burden of disease and improving the health, welfare, and productivity of populations. It is central to the production and preservation of a host of benefits and services for people" (United Nations, 2023, 1).

The preceding quote highlights a relationship between water infrastructure development and economic development in Africa. Access to water and sanitation services is crucial to economic development in Africa. According to the UNICEF, approximately 418 million Africans lack access to basic drinking water, 779 million people lack access to essential sanitation services (including 208 million who still practice open defecation), and 839 million people still lack basic hygiene services. In Nigeria specifically, approximately 48% of the population of 183 million people have access to basic water services and 33% of the population has access to sanitation services (USAID, 2023). This information is essential as it relates to economic development in Nigeria. This paper therefore investigates the relationship between access to water infrastructure and economic development in Nigeria by exploring its impacts, challenges, and potential pathways for sustainable growth.

To understand the current state of water and sanitation services in Nigeria, it is essential to examine the history of water infrastructure in Nigeria. This study contributes to the research on water infrastructure in Nigeria as it relates to its impact on economic development. It is hypothesized in this study that the greater the access to water infrastructure, and safely managed water, sanitation, and handwashing services, the higher the economic development will be in Nigeria. In this study, economic development is measured by per capita gross domestic product (GDP).

## Background

While Europe underwent social reforms to enhance healthy living conditions through improved infrastructure, Nigeria experienced disparities in infrastructure distribution due to segregation across the country. Europeans had to raise money by selling natural resources and taxes from the Nigerian residents to improve infrastructure (Hannemann, 2015). Due to limited budgets from the colonies, limited infrastructure could be built. According to Megan Hannermann, colonial development resulted in more pollution from unimproved sources, thereby increasing the risk of disease for the African population. Europe received backlash from the inadequate distribution of infrastructure, which led to protests around the country (Hannemann, 2015). Like other infrastructure projects in Nigeria, it primarily focused on supporting the colonial powers. Hannerman adds that colonialism significantly influenced the distribution of water and sanitation infrastructure even in present-day Nigeria, leading to persistent inequalities (Hannemann, 2015). The expansion of cities from colonial towns, unequal distribution of infrastructure, neglect of rural areas, post-colonial financial challenges and a growing population have collectively contributed to the inconsistent state of infrastructure across Nigeria (Hannermann, 2015).

Nigeria gained its independence in 1960, and during the post-colonial period, studies have shown that the policies geared toward water infrastructure remained relatively the same from the colonial period. During the post-colonial period, water distribution was geared toward the rich over

the poor and the urban areas over the rural areas (Akpabio, 2012). Some of the present challenges facing Nigerians in achieving the United Nations goals of sustainable water and sanitation services are not only because of lack of neglect in infrastructure that started under the colonial powers that continued under subsequent leadership. According to Adeniran, Daniell and Pittock, Nigeria has always needed to catch up on its commitments to water security. They further add:

> Although access to water has increased from 51 percent in 1990 to 68 percent in 2016, approximately 54 percent of rural and 78 percent of urban inhabitants currently have access… At the local level, Nigeria's Population and high fertility rates mean it will be the third-most populous country in the world by 2050, after China and India. Nigeria's population increase will also mean more water resource development challenges. Only 15 percent of the 3.14 million hectares of potentially irrigable land is irrigated, yet Nigeria spent approximately US$22.5 billion on food imports in 2017 (Adeniran et al., 2021, 1).

The aforementioned observation highlights the significant importance of water infrastructure development in Nigeria. This quote means a future of water infrastructure and the potential for food insecurities will impact millions of lives in Africa's most populous country. While significant progress has been made in terms of water access from 1990 to 2016, much work still needs to be done. Data from Our World in Data (in Ritchie et al., 2023) were compiled to understand how water infrastructure has improved. Figure 1 shows the number of people with access to safely managed drinking water, which means an improved water source located on-premises, available when needed, and free from contamination (Eilertsen et al., 2020) in Nigeria. This increased from 16.78 million (13.72% of the population) in 2000 to 44.67million (21.67% of the population) in 2020 (Ritchie et al., 2021).

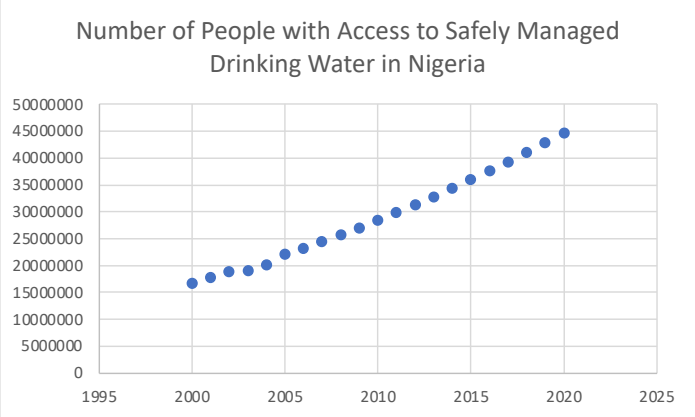


Figure 1: Number of People with Access to Safely Managed Drinking Water in Nigeria (2000-2020)
Source: Self-generated by the Author Using Data from Ritchie et al. (2021)

In terms of the number of people with access to safely managed sanitation (i.e. improved facilities that are not shared with other households and where excreta are safely disposed in situ or transported and treated off-site), the number of people in Nigeria who had access increased from 26.05 million people in 2000 to 62.89 million people in 2020 (Ritchie et al., 2021). Figure 2 graphically displays this increase. This information shows that progress has been made with safely managed sanitation, thereby suggesting progress in sanitation infrastructure development and efforts

to ensure safe and hygienic waste disposal practices in Nigeria during this period.


Figure 2: Number of People with Access to Safely Managed Sanitation
Source: Self-generated by the Author Using Data from Ritchie et al. (2021)

Regarding the number of people with basic handwashing facilities (i.e. the availability of a handwashing facility on premises with soap and water) in Nigeria, data were unavailable from 2000 to 2010. Nonetheless, data were available from 2011 to 2020. The number of people with basic handwashing facilities in Nigeria increased from 52.10 million (32%) in 2011 to 68.43 million (33.20%) of the population in 2020 (Ritchie et al., 2021). This result suggests that there is progress in promoting hygienic practices and infrastructure development during this period when the importance of handwashing gained significant attention due to global health concerns, which may be the result of this increase.


Figure 3: Number of People with Basic Handwashing Facilities in Nigeria (2011-2020)
Source: Self-generated by the Author Using Data from Ritchie et al. (2021)

## Problem Statement

Despite the recognized importance of access to clean water and sanitation services for economic development in Africa, a large portion of the continent's population still needs these necessities. Nigeria, the most populous country in Africa, faces substantial challenges in ensuring universal access to safe water and sanitation. The scarcity of clean water sources and inadequate sanitation facilities remain persistent issues, negatively impacting its citizens' economic development and

wellbeing.

This research seeks to address the problem by examining the relationship between access to water infrastructure and economic development in Nigeria. The substantial disparities in access to clean water and sanitation services within the country underscore the need for this study. Despite global efforts, policies and regional initiatives to improve these essential services, substantial portions of the population still grapple with inadequate access, leading to health consequences, reduced agricultural productivity, and limited opportunities for economic growth.

As indicated by preliminary quantitative analyses, there is a strong and positive correlation between an increase in access to water and sanitation services and economic development in Nigeria. This finding highlights the potential economic benefits of improving water infrastructure across the country.

Case studies provide qualitative insights into understanding the impact of access to water infrastructure projects on economic development in Nigeria. These insights are critical for delivering effective policies to address this issue and promote sustainable economic development.

## Theoretical Framework

The theoretical framework that undergirds this study is Human Capital Theory. As Sean Ross says, "The theory of human capital is relatively new in finance and economics. It states that companies have an incentive to seek productive human capital and to add to the human capital of their existing employees…In the 1960s, economists Gary Becker and Theodore Schultz pointed out that education and training were investments that could add to productivity" (Ross, 2023, 1).

In the context of Nigeria and its workforce, the more Nigeria pours into its employees in terms of education, training, and health, the more robust, educated, and productive the workforce becomes. This is important as it relates to water infrastructure in Nigeria in that providing access to adequate water and sanitation services will eradicate and prevent the spread of waterborne diseases and increase labor productivity, which will lead to an increase in economic development. Accordingly, it makes sense to briefly explore alternate theoretical perspectives for potential explanations as done in the ensuing subsection.

### Alternate Theoretical Perspectives

While this paper utilized Human Capital Theory as the theoretical framework, other theoretical perspectives were examined to understand how they interpret investment in water infrastructure, thereby increasing access to water infrastructure and its impact on economic development in Nigeria. Neoclassical Economic Growth Theory argues that economic development is driven by capital accumulation and technological progress. According to Carole Banton, Neoclassical Economic Growth Theory is about how "Short-term equilibrium results from varying amounts of labor and capital in the production function. The theory also argues that technological change has a major influence on an economy, and economic growth cannot continue without technological advances (2023, 1) Banton further states that

> This growth theory posits that capital accumulation within an economy and how people use that capital is essential for economic growth. Further, the relationship between the capital and labor of an economy determines its output. Finally, technology is thought to augment labor productivity and increase the output capabilities of labor…Therefore, the production function of neoclassical growth

theory measures an economy's growth and equilibrium. That function is Y = AF (K, L).

- Y denotes an economy's gross domestic product (GDP)
- K represents its share of capital
- L describes the amount of unskilled labor in an economy
- A represents a determinant level of technology (2023, 1).

The equation Y = AF (K, L) shows that an increase in any of the preceding variables will increase an economy's GDP—in this case, Nigeria. Expanding the labor force by increasing the amount of water infrastructure, specifically access to safely managed sanitation services in Nigeria, access to safely managed drinking water, and basic handwashing facilities will help to reduce the number of waterborne diseases transmitted through contaminated water, either by direct ingestion, contact with infected water, or consumption of water-contaminated food. Examples of diseases include Cholera, Typhoid, COVID-2019, and Dysentery, to name some. The reduction of waterborne diseases will increase the number of people that are healthy and can work, which is reflected by L (Labor) in the preceding equation. In addition, it will add more people to the labor force, such as more women and girls who often stay out of the workforce due to inadequate facilities to maintain menstrual care. Also, by adding more women to the workforce is important because women are often the ones who collect water for the household. With adequate water infrastructure, this burden will be lessened for the women and girls of many households.

In addition to Human Capital Theory and Neoclassical Economic Growth Theory, there is also the Endogenous Growth Theory. This theory argues that investment in internal sources such as infrastructure and technology will help to promote greater access to water infrastructure that will lead to economic growth. According to Daniel Liberto, Endogenous Growth Theory "is an economic theory which argues that economic growth is generated from within a system as a direct result of internal processes. More specifically, the theory notes that the enhancement of a nation's human capital will lead to economic growth by means of the development of new forms of technology and efficient and effective means of production" (2023, 1). Endogenous growth theorists argue that the more significant the investment in human capital is, the more productivity increases and the more substantial economic growth and development will be (Liberto, 2023). While this theory emphasizes investment in research and development and knowledge-based sectors such as technology and software, it also emphasizes infrastructure and human capital. Increasing the investment in water infrastructure in Nigeria will therefore benefit from an infrastructure standpoint and human capital in that the citizens of the country will become healthier and more productive. In addition, it will help to promote growth in various industries such as agriculture, construction, health, and education, and a more conducive environment for economic development across diverse sectors.

While the preceding three theories demonstrate the importance of investment in water infrastructure in promoting economic growth and development, the Human Capital Theory emphasizes the importance of developing a country's population. It thus provides a direct link between water infrastructure development and the enhancement of human capital through improved health and hygiene, which can effectively address issues like reduced disease burden and increased educational attainment from better water infrastructure. In addition, the Human Capital Theory also highlights the idea that investment in human capital has long-term positive effects on economic growth. Improved water infrastructure can contribute to sustained long-term growth by reducing waterborne diseases and increasing labor productivity. The other theories look at the importance of labor and its impact on economic growth and development indirectly, whereas the

Human Capital Theory stresses its importance directly. According to the World Health Organization (WHO),

> When water comes from improved and more accessible sources, people spend less time and effort physically collecting it, meaning that they can be productive in other ways. This can also result in greater personal safety and reduce musculoskeletal disorders by reducing the need to make long or risky journeys to collect and carry water. Better water sources also mean less expenditure on health, as people are less likely to fall ill and incur medical costs and are better able to remain economically productive. With children particularly at risk from water-related diseases, access to improved water sources can result in better health and, therefore, better school attendance, with positive longer-term consequences for their lives (2023, 1).

Adequate water and sanitation services are essential worldwide in all aspects of people's lives. In terms of health, clean water and sanitation services help to maintain the health of a nation's citizens. If the citizens of a country are healthy, they can have a healthy and productive workforce. Such a workforce leads to increased output for a country and reduced absenteeism in schools and in workplaces, which in turn lead to more goods and services in the marketplace. More workers mean the production of more goods and services, which leads to more household spending. The spending leads to economic growth, more successful businesses, and more job creation; a country will then have the revenue to acquire more resources such as training and development of its employees and further infrastructure development. Also, infrastructure development will attract more investors who would want to do business in Nigeria in various areas of investment. This investment, combined with the nation's health, leads to the nation's wealth that in turn impacts the quality of life of the country's citizens.

## Research Methodology

This study employed a mixed-methods research design, combining quantitative and qualitative research approaches to comprehensively analyze the relationship between water infrastructure access and economic development in Nigeria. Secondary data sources from official development organizations and journal articles related to water infrastructure access and development from 2000 to 2020 were utilized.

### Quantitative Data Collection

Secondary statistical data were gathered on access to water infrastructure, specifically access to safely managed sanitation services, access to safely managed drinking water, number of people with basic handwashing facilities, and economic indicators (e.g., GDP) on water infrastructure access in Nigeria. Data were gleaned from reliable sources such as the World Bank, Our World in Data (in Ritchie et al., 2021), national government reports, and international organizations covering from 2000 to 2020.

### Qualitative Data Collection

Case studies of successful water infrastructure projects concerning access to safely managed sanitation services, access to safely managed drinking water, and number of people with basic

handwashing facilities in Nigeria were gathered to determine their impact on economic development in Nigeria. The case studies selected are from 2000 to 2020.

### Quantitative Data Analytical Technique

The Microsoft Excel Data Analysis package was used to perform a regression analysis in order to determine the relationships between access to safely managed sanitation services, access to safely managed drinking water, with the number of people with basic handwashing facilities in Nigeria (independent variables) and economic development in Nigeria measured by GDP (dependent variable).

### Qualitative Data Analytical Technique

Case studies were used to analyze the factors contributing to the success of specific water infrastructure projects in Nigeria and their impact on economic development. The case studies specifically examined access to safely managed drinking water, number of people with basic handwashing facilities in Nigeria as the independent variables and the country's GDP as the dependent variable.

The combination of qualitative and quantitative data and analysis was used to formulate policy recommendations for improving water infrastructure investment in Nigeria. It also helped to emphasize the importance of prioritizing water infrastructure investment as a catalyst for sustainable economic development.

## Limitation of the Study and Analyses of the Results

It is important to note that while this paper highlights the relationship between the selected independent and dependent variables, correlation does not mean causation. What this statement means as it relates to access to safely managed sanitation services in Nigeria and GDP is that although there is a strong and positive linear relationship between these two variables, it does not mean that there may not be other external variables that impact the relationship. Additional multivariate statistical examination that encompasses various variables may be needed to understand the impact of access to safely managed sanitation services, safely managed drinking water, and number of people with basic handwashing facilities in Nigeria. For this research, specific case studies are used to assess the findings of the regression testing conducted. This is necessary because according to Shivani Shekhawat, "Establishing causation requires a more rigorous approach, such as experimental research, controlled studies, or advanced statistical techniques that account for potential confounding factors" (2023, 1). This study therefore seeks to determine the relationships between the independent variables identified and their impacts on GDP. Qualitative data are used to further determine these independent variables' impact on GDP.

Based on the results in Table 1, the Multiple R (correlation coefficient) reflects that there is a strong and positive relationship between the independent variable access to water and sanitation services and the dependent variable GDP. A multiple R of 0.70 indicates a moderately strong and positive correlation between the independent variable and the dependent variable. This means that as the level of access to safely managed sanitation services increases, there tends to be an increase in the country's GDP.

Also, an R-squared of 0.495 means that approximately 49.5% of the variation in access to safely managed sanitation services in Nigeria (2000-2020) can be explained by the independent

variable access to safely managed sanitation services. In addition, in terms of the p-value, a small p-value (such as 0.000368) suggests that the model is statistically significant at the 0.05 level, indicating that access to safely managed sanitation services is associated with GDP. In sum, the results show a moderately strong, and positive relationship between access to safely managed sanitation services and GDP in Nigeria from 2000 to 2020.

Table 1: Regression Testing: Access to Safely Managed Sanitation Services in Nigeria (2000-2020)

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.70398755 | | | | | | | |
| R Square | 0.49559848 | | | | | | | |
| Adjusted R Square | 0.46905103 | | | | | | | |
| Standard Error | 564574496 | | | | | | | |
| Observations | 21 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 5.9504E+18 | 5.9504E+18 | 18.6684032 | 0.00036859 | | | |
| Residual | 19 | 6.0561E+18 | 3.1874E+17 | | | | | |
| Total | 20 | 1.2007E+19 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | -102641075 | 469645620 | -0.2185501 | 0.82933092 | -1.086E+09 | 880338506 | -1.086E+09 | 880338506 |
| X Variable 1 | 47.2717646 | 10.9407786 | 4.32069476 | 0.00036859 | 24.3724519 | 70.1710773 | 24.3724519 | 70.1710773 |

Source: Self-generated by the Author Using Data from (Ritchie et al. (2021) and the World Bank (2022)

In light of the results in Table 2, a Multiple R of 0.735 indicates a strong and positive correlation between the independent variable access to safely managed drinking water and the dependent variable GDP. This suggests that as access to safely managed drinking water improves or increases, there is a tendency for GDP to increase from 2000 to 2020.

Table 2 shows that the more the population has access to clean drinking water, the higher the economic growth/development of Nigeria will be. According to the WHO, "Sustainable Development Goal target 6.1 calls for universal and equitable access to safe and affordable drinking water. The target is tracked with the indicator of safely managed drinking water services—drinking water from an improved water source that is located on-premises, available when needed, and free from fecal and priority chemical contamination" (2023, 1). The economic benefits of access to clean drinking water lead to reduced health expenditures, as access to clean water decreases the likelihood of water-related illnesses, allowing individuals to remain productive in the workforce. Particularly beneficial for children, improved water sources contribute to better health, increased school attendance, and positive long-term outcomes for their lives (World Health Organization, 2023).

Table 2: Regression Testing: Access to Safely Managed Drinking Water in Nigeria (2000-2020)

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.73492949 | | | | | | | |
| R Square | 0.54012135 | | | | | | | |
| Adjusted R Square | 0.51591721 | | | | | | | |
| Standard Error | 539081816 | | | | | | | |
| Observations | 21 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 6.485E+18 | 6.485E+18 | 22.3152473 | 0.00014774 | | | |
| Residual | 19 | 5.5216E+18 | 2.9061E+17 | | | | | |
| Total | 20 | 1.2007E+19 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | -42401367 | 418631746 | -0.1012856 | 0.92038497 | -918607682 | 833804948 | -918607682 | 833804948 |
| X Variable 1 | 64.986228 | 13.7568968 | 4.7239017 | 0.00014774 | 36.1927122 | 93.7797438 | 36.1927122 | 93.7797438 |

Source: Self-generated by the Author Using Data from (Ritchie et al. (2021) And the World Bank (2022)

Access to clean drinking water is essential to the survival of any country. Access to clean drinking water leads to improved health in that it prevents the spread of waterborne diseases, reduces the burden on a country's healthcare system, and makes a healthy population. Also, productivity increases because communities can engage in agriculture and other economic activities as it is essential for irrigation, livestock and manufacturing. In terms of education, reliable water sources are needed for children, specifically girls, to attend school regularly; and it also establishes a more productive learning environment. In addition, it reduces the time spent by women and girls to collect water for the households. Investment in water infrastructure reduces the potential conflict that may arise because of scare water supplies. Having access to clean water also attracts investors and tourists, as a lack of adequate water resources is a deterrent for not only investors but also tourists. Proper water infrastructure investment is also needed to maintain the environment. Without proper clean water, it is difficult to maintain crops or environmental sustainability.

In Table 3, the Multiple R of 0.541 indicates a moderate and positive relationship between basic handwashing services and GDP. This result means that as the number of people with basic handwashing facilities increases, the GDP in Nigeria also tends to increase.

The R-square of 0.293 indicates that the R-squared value is 29.3%, which suggests that a moderate portion of the variability in GDP is accounted for by the variation in access to basic handwashing facilities. The model cannot explain the remaining 70.7% of the variability in GDP. This unexplained variability may be due to other factors not included in the model; for instance, random fluctuations and variables not captured by the linear relationship between the variables.

The Significance F of 0.1056 indicates that the model is not statistically significant because the p-value is greater than 0.05. This suggests that the independent variable (access to basic handwashing facilities) may not significantly impact the dependent variable (GDP) based on this model.

As mentioned earlier, the United Nations established 17 Goals for ensuring sustainable development in 2023, of which clean water and sanitation is number 6 on the list. According to the

United Nations, the goal is based on the belief that "Access to safe water, sanitation, and hygiene is the most basic human need for health and well-being. Billions of people will lack access to these basic services in 2030 unless progress quadruples" (United Nations, 2023, 1). This lack of access is because of competing demands with rapid urbanization, population increases, and needs from the agricultural, industrial, and energy sectors. Thus, according to the United Nations, achieving the goal of universal access to drinking water, hygiene, and sanitation would require development goals to increase fourfold. If the development targets are met, it will result in a savings of 829,000 lives annually (United Nations, 2023).

Table 3: Number of People with Basic Handwashing facilities in Nigeria (2011-2020)

| SUMMARY OUTPUT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| *Regression Statistics* | | | | | | | | |
| Multiple R | 0.54196098 | | | | | | | |
| R Square | 0.2937217 | | | | | | | |
| Adjusted R Square | 0.20543691 | | | | | | | |
| Standard Error | 367759413 | | | | | | | |
| Observations | 10 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | | | |
| Regression | 1 | 4.4996E+17 | 4.4996E+17 | 3.32697973 | 0.10560311 | | | |
| Residual | 8 | 1.082E+18 | 1.3525E+17 | | | | | |
| Total | 9 | 1.5319E+18 | | | | | | |
| | | | | | | | | |
| | *Coefficients* | *Standard Error* | *t Stat* | *P-value* | *Lower 95%* | *Upper 95%* | *Lower 95.0%* | *Upper 95.0%* |
| Intercept | 4866983723 | 1343224998 | 3.62335702 | 0.00674968 | 1769501322 | 7964466124 | 1769501322 | 7964466124 |
| X Variable 1 | -40.663785 | 22.2937295 | -1.824001 | 0.10560311 | -92.073218 | 10.745647 | -92.073218 | 10.745647 |

Source: Self-generated by the Author Using Data from (Ritchie et al. (2021)
And the World Bank (2022)

**Qualitative Analysis**

In terms of assessing existing qualitative research findings, this paper examined community approaches to managing Nigeria's water and infrastructure challenges. The first case study is the Obudu Plateau, which is one of the two mountain ecosystems in Nigeria. Obudu Plateau is also home to the Becheve agricultural communities and Fulani pastoralists (United Nations, 2006). The development of the Obudu Plateau Ranch Resort was established in 1999 and resulted in substantial deforestation, increased environmental strain, and a reduction of water supply for the local community (United Nations, 2024).

The new development brought in income. Nonetheless, conflicts arose due to the limited

water supply impacting the health and wellbeing of the Becheve women. They emphasized the challenges arising from competing demands on the region's water resources, including low-income family health, time spent collecting water, and the poor water quality (United Nations, 2006). The response of the Nigerian Conservation Foundation' (NCF) to the worsening water situation was to initiate the Watershed Management Project, through which gender concerns were integrated into organizational policies. The adoption of participatory approaches allowed for women's involvement at every stage, including the project's design, implementation, and monitoring. The committee, which included elected women representatives, conducted workshops to address environmental challenges, sensitize communities on gender biases, and educate the community about participatory watershed management (United Nations, 2006).

As a result, in the first stage (2000-2001), a survey mapped the watershed and watercourses that focused on drinking water points. The second stage (2002-2003) produced a manual on watershed ecology, with training provided to women and youth on preserving ecology and the dangers of unsustainable practices. Conservation clubs were established for environmental education, emphasizing the active participation of women in the predominantly male management committee. In the third stage (2003-2004), discussions with the local health clinic addressed water-related health issues, leading to the construction of two reservoirs to improve water supply and combat diarrhea. Throughout the project, the NCF aimed to empower women, enhance environmental awareness, and promote sustainable watershed management practices (United Nations, 2006).

This project led to women's voices being heard and participation in the decision-making process of the Watershed Management Project. Women were not only able to participate in the meetings but also to engage in the management committee's construction and maintenance of the reservoir, reducing the time needed for women to collect water for their households and instead provided more time in income-generating activities, farming, and marketing. The benefits in terms of women's healthcare and gender desensitization were increased by 45%. Girls and women could go to school, and men could see the importance of women's participation in the community (United Nations, 2006).

The project impacted the quality and access of water for the Obudu Plateau housing. It demonstrated the transformative impact of integrating gender perspectives into environmental initiatives, fostering community development, gender equity, and improved water management practices. Investing in water infrastructure is essential to the success of projects such as the Watershed Management Project because infrastructure investment provides the necessary resources for community outreach, training, and awareness campaigns, thereby fostering a sense of responsibility for water conservation. The implementation of watershed management projects requires collaboration among government, non-governmental organizations, and local stakeholders. Thus, increased water infrastructure investment is crucial for fostering these collaborations and the success of these projects to ensure that they are well-planned, well-executed, and sustainable for long-term development. At the conclusion of the Watershed Management Project resulted in a 45% reduction is diarrhea cases in 2004 (United Nations, 2006). Preventing diseases like diarrhea eliminates the need for expensive medical treatments, hospitalizations, and medications. This results into overall cost-savings for both individuals and healthcare systems. In addition, a healthy person has an overall better quality of life. Healthy individuals are more likely to engage in economic activities, become a part of the labor force, and engage in social interactions and community development, all of which are essential aspects of economic growth and development.

The second case study concerns the Daily Group Handwashing (DGHW) concept pertaining to primary school pupils. This case study looked at the importance of educating children

in primary school on adequate handwashing procedures so that they learn about proper handwashing procedures early on. The case study also focused on the potential ripple effect on families and communities. It highlights global concerns, such as iron deficiency anemia in school children due to worm infestations. This case study further discussed the effectiveness of handwashing with soap to reduce absenteeism in schools, the risk of diarrhea and respiratory infections, and the spread of further diseases related to improper handwashing procedures (Federal Government of Nigeria and UNICEF, 2017).

This case study looked at four elements of establishing proper handwashing procedures in primary schools: (1) health, (2) learning, (3) childhood, and (4) community. First, in terms of health, according to the UNICEF, 37% of children under the age of five in Nigeria have stunted growth because of malnutrition. This malnutrition is caused by worm infestation and anemia due to improper handwashing procedures. According to the UNICEF, data available from WHO shows that "53% of school-age children in developing countries suffer from IDA (Iron Deficiency Anemia), which is beyond the 43% threshold. According to NDHS (2013) in Nigeria, 37 % of children below 5 years are stunted, 18% wasted, and 29% underweight" (Federal Government of Nigeria and UNICEF, 2017, 20).

Second, regarding the community dimension, the UNICEF discussed the importance of teachers playing a significant role in assisting students with proper handwashing procedures because of their respect by students and people in the community. It was also added that these practices are extended into the community in the homes of students. More is needed to have a healthy school environment; a healthy community environment is also necessary to prevent the spread of infections. For instance, a student infected by a family member can force that student to miss several days of school. It is added that schools are a primary and influential source for spreading the importance of proper sanitation procedures not only in schools but also in the community (UNICEF, 2017).

Third, the malleability of children is a great way to change and influence students' behavior about proper handwashing procedures that will follow them throughout life. Nigeria has over 62,000 primary public schools with over a million students. The case study shows that by sheer numbers of students, they will be influential in instituting change in the communities and have the power to change handwashing procedures within the country (UNICEF, 2017).

Fourth, there is a valuable learning aspect in the endeavor. This feature is explained by the UNICEF as follows:

> It is a known fact that a healthy child (physically, emotionally, and mentally fit) is expected to do better in learning than a sick child. Stunted children are generally admitted to school late and are less likely to complete their schooling. Test results have shown that stunted children are less intelligent than their peers who are better nourished. Recent studies have also shown that not only diet but also the adverse impact of poor sanitation and hygiene contributes to stunting (2017, 1).

The foregoing aspect is essential for evaluating the productivity of a labor force in a country like Nigeria. Proper sanitation procedures such as handwashing are essential in influencing all aspects of a student's life. The inability to attend school is caused by illnesses such as worm infections resulting from improper handwashing procedures. Lack of education means a lack of an educated workforce. A lack of an educated workforce in turn means less productivity and the likelihood that a person will be unable to contribute to the economic growth and development of a country. At the heart of practicing proper sanitation procedures is having greater access to proper

facilities through water infrastructure investment. The four aspects discussed earlier highlight the importance of not only establishing proper handwashing procedures in instituting a healthy population and establishing a generation of people who are healthy, educated, and productive members of the population, but also it stresses the need for investment in water infrastructure to allow for the institution of proper resources.

In terms of the third case study for the DGHW concept, it was initially introduced in 18 schools in Chickun Local Government Area (LGA) of Kaduna State by employing Tippy-Tap technology in commemoration of the 2015 Global Hand Washing Day. According to the UNICEF,

> Tippy-Tap is a low-cost appropriate technology for hand washing that could be used at the household level or institutional level such as schools. It is a hands-free way to wash hands under running water where there are no taps, especially appropriate in rural areas where there is no running water. It is operated by a foot lever, which reduces the chances of bacterial contamination as the users touch only the soap and not the water container (2017, 22).

Teachers were trained on the benefits of DGHW, emphasizing soap hand washing before children's lunch under teacher supervision. The State Universal Basic Education Board's School Health Desk Officer participated in lending credibility. The Tippy-Tap technology and its operation were explained, and it was agreed that students would bring water bottles for hand washing. The LGA WASH Team supervised the construction of handwashing stations in pilot schools, where group handwashing demonstrations took place. This led to its implementation in over 2,000 schools across 50 LGAs in 11 States (UNICEF, 2017). The community impact appears to be significant in that it led to healthier communities and healthier students who will then transfer this knowledge and practices into their home environments and communities. In addition, other communities may see this as a success and adopt the Tippy-Tap technology. This will lead to a reduction in the spread of diseases, which will in turn limit the impact on healthcare costs, a reduction in absenteeism in schools and workplaces, and a more educated workforce.

Nonetheless, there are challenges with the Tippy-Tap technology such as vandalism, issues with the quality of the thin plastic bottles, insufficient water bottles, water supply challenges, soap replenishment challenges, and lack of funding in some schools. These issues are currently being addressed by promoting community involvement and the development of mobile handwashing stations that provide a more sturdy, mobile, and maintainable solution for promoting handwashing, thereby addressing the needs of school environments; and the hope is that if this solution is effective, it will be implemented in other states throughout the country (UNICEF, 2017). Also, as the UNICEF points out,

> The overall savings from various interventions put together has increased from US$ 157,927 in August 2014 to US$ 380,213 in July 2015 and US$ $ 538,141 in June 2016. Besides reducing the unit costs of various interventions, the strategy motivated the government to invest more in the sector. Apart from cost savings, a greater number of people gained access to WASH Services with the same amount of investment compared to previous periods (Federal Government of Nigeria and UNICEF, 2017, 62).

Moreover, a study was conducted in Nigeria to assess whether the efforts made for water and sanitation in Nigeria received a "Value for Money" (VFM). The factors examined in determining

value were economy, efficiency, effectiveness, and equity. VFM is assessed at the inputs stage, focused on the cost-effectiveness of purchasing inputs such as supplies, training, and transport in water, sanitation, and hygiene (WASH) interventions. This involves calculating unit costs for supplies, contracts, staff, and training to ensure competitive pricing and economic efficiency in implementing WASH activities (Federal Government of Nigeria and UNICEF, 2017).

Efficiency refers to the impact of a specific and its conversion to an output. In the case of WASH activities in Nigeria, efficiency is determined by the percentage of the outputs achieved for a specific input, such as the construction or installation of a water point or the ability of a community-led total sanitation (CLTS) to stimulate a realization of the health risks associated with poor sanitation and open defecation. This is measured by the percentage of the communities that still practice open defecation post-engagement of the CLITS (Federal Government of Nigeria and UNICEF, 2017). CLTS "is an innovative methodology for mobilizing communities to stop open defecation and achieve total sanitation. The CLTS approach was piloted in Nigeria in 2004…Scaling up CLTS began in 2008 in most states" (Institute for Development Studies, 2017, viii). According to the Institute for Development Studies, CLTS has led to over 1,600 communities that are open defecation free, more than a million people using sanitary latrines, practicing improved hygiene practices, and having access to reliable water sources (Institute for Development Studies, 2017).

Effectiveness is when the implementer does not exercise influence or control over the outcomes of a particular input and whether they can be sustained. Effectiveness is expressed as follows (Federal Government of Nigeria and UNICEF, 2017, 63):

$$E = \frac{\text{Actual Beneficiaries}}{\text{Targeted Beneficiaries}} \times 100$$

The equation represents the number of individuals who have benefited from the WASH interventions by the intended target beneficiaries, providing the percentage of output converted to outcomes (Federal Government of Nigeria and UNICEF, 2017).

Finally, equity addresses the disparities in service distribution between the rural and urban areas, between the different states within Nigeria, within the local government areas (LGAS) within the state, and amongst the different communities and gender inequality (Federal Government of Nigeria and UNICEF, 2017) Furthermore, according to the UNICEF, the savings from the WASH interventions in six states increased by US $380,2.0014 from US$157,927.00 in August of 2014 to US$538,141.00 in June of 2016 ((Federal Government of Nigeria and UNICEF, 2017). The savings were because of several factors, such as realistic budgeting, use of local resources, adherence to procurement practices, and renegotiated rates that decreased unit costs for hand pump boreholes and latrines compared to previous benchmarks (Federal Government of Nigeria and UNICEF, 2017).

In terms of the economic impact, WASH achieved economic savings estimated at US$ 139,395 by negotiating daily subsistence allowances (DSAs) directly with basic WASH staff in the states of Jigawa, Kaduna, and Zamfara. This approach involved direct payments to the trainees instead of routing payments through the government (Federal Government of Nigeria and UNICEF, 2017).

The three case studies are essential in highlighting the community-based initiatives that are taking place within Nigeria to overcome water infrastructure challenges. The Tippy-Tap example is an excellent model to build upon in various communities in Nigeria and all over Africa. These case studies are vital in highlighting the involvement in the community in changing water and sanitation practices in the country. The emphasis on promoting hygiene in schools not only contributes to

improved health but also the emphasis on the interconnectedness of water, sanitation, and education. Healthy students are better positioned to excel in school, thereby emphasizing the holistic impact of water infrastructure on various aspects of community life. While there are noted challenges in each case study, the challenges and solutions presented, such as addressing issues with water bottle durability and soap replenishment, highlight the need for resource-efficiency, collaboration, government intervention, private sector coordination, further community engagement, and involvement of regional organizations and the adoption of sustainable approaches are needed in the development of water infrastructure in Nigeria.

## Conclusions and Policy Recommendations

From the findings of this research, it can be noted that several efforts have been put in place within Nigeria to improve the water and sanitation services and handwashing practices from 2000 to 2020. There is still some work that needs to be done to ensure that everyone has access to sustainable water and sanitation services, which is a critical climate change mitigation strategy for the years ahead. According to Sylvia Wakiuru Maina and Toni Sittoni, "Nigeria loses NGN 455 billion annually or US$ 3 billion due to poor sanitation…this works out to US$ 20 per capita/year and constitutes 1.3% of Nigeria's GDP" (2012, 1). According to the same authors, "open defecation alone costs Nigeria over US$ 1 billion a year" (Maina and Sittoni, 2012, 1).

Accordingly, first, all levels of government in Nigeria must work together to attract investments for water and sanitation infrastructure and pay special attention to the rural and underserved areas in the country. Expanding efforts to underserved communities will ensure that more communities will have access to adequate water and sanitation services.

Second, all levels of government should work together to provide marketing support to the CLTS and also give the support needed through water infrastructure investment. Based on the research, there have been some challenges in the communities, but they have also successfully reduced open defecation practices. The CLTS must therefore understand the local cultural practices and dynamics to know the needs of a community, how to successfully approach sanitation solutions, and how to tailor their messages to fit local community needs. Support in water infrastructure development, distribution of materials, consistent monitoring practices, and other resources and endorsement of all levels of government in their policies related to the CLTS will provide adequate backing and financial assistance. In addition, all levels of government should regularly monitor the support of the CLTS to understand their importance in the communities. This will also provide all levels of government the ability to refine their support, investment and policies based on the feedback from the CLTS.

Third, it is recommended that all levels of government work together to establish partnerships with hand sanitation companies to prevent the spread of diseases and germs. While there may be challenges with receiving funding for water and sanitation infrastructure, it will be essential to establish relationships with hand sanitation companies to minimize the spread of germs and diseases and promote basic handwashing sanitation. In rural areas where essential hygiene products are inaccessible, it is crucial to advocate for donations of hand sanitizers and Clorox wipes as a short-term solution to managing limited resources for basic handwashing practices. In addition, these companies can also help with marketing development because they have experience with outreach and educational programs. Collaborating with these companies can aid in providing effective awareness campaigns and educating the population on proper hand hygienic practices. Working with these companies in terms of innovation will also be beneficial in providing solutions for water purification and hand sanitation. It will in addition be necessary for all levels of

government in Nigeria to work with these private companies to develop long-term engagement for ongoing support and product availability. Just as discussed earlier regarding the importance of cultural sensitivity, all levels of government will need to work with the private companies to tailor messages based on the local customs and culture of these private-public partnerships and investment in water infrastructure, and the support of the CLTS will prove to be beneficial to the citizens of Nigeria.

Finally, it is vital to establish cross-sector collaboration. For example, WASH sector can collaborates with the healthcare sector to develop policies that prevent the spread of waterborne diseases, health-related issues, and sanitation practices as they relate to women and girls with menstruation. The two sectors can also work together to spread the message of understanding how the larger the number of people who have access to water and sanitation services will help to prevent the spread of disease and strengthen the population so that citizens can obtain an education and live healthy and productive lives. Working with the healthcare sector can help WASH to see the importance of working together and establishing marketing campaigns that engage the communities and emphasize the importance of clean water and sanitation. The two organizations can also work together to develop policies highlighting the economic benefit of improved water and sanitation practices to policymakers and stakeholders at all levels of government. The WASH, healthcare and educational sectors can further work together to spread the message of the importance of implementing proper water and sanitation practices in schools. These three sectors together can work to spread the message of the importance of adequate handwashing practices and water and sanitation. These collaborative efforts will contribute to the overall development and prosperity of the country. All these factors cannot be achieved unless there is investment in water infrastructure. Only then will Nigeria be able to see a healthy population that can attend school, obtain an education, and receive jobs that will help to increase the labor force in Nigeria. A healthy population helps to reduce medical care costs due to the reduction in waterborne diseases and leads to a healthy population. These efforts will increase labor and productivity and will aid in promoting sustainable economic development for Nigeria. In addition, it will aid in meeting the United Nations' SDG 6 of water and sanitation for all by 2030.

In terms of the agricultural sector, an adequate water source is critical in maintaining crops. In addition, it will also aid in the productivity of the farmers in that the healthier the crops are, the more harvest the farmers will have, and the more a country becomes food secure. Having an adequate water supply is also essential in managing droughts and other climate-related impacts on agriculture. A food-secure country is in addition a healthy country. Investing in water infrastructure for agriculture is therefore a multifaceted approach that positively impacts food production, economic development, and environmental sustainability.

Apropos making more jobs available, the installation of water pipes and irrigation systems yields jobs for the local population. In addition, there are jobs associated with the engineering and installation of these systems. Based on the information provided in this research, Nigeria will need to coordinate with other African countries and regional organizations. Thus, investment in water infrastructure is pivotal for addressing pressing challenges, promoting sustainable development, and fostering collaboration among African nations. It is an imperative for regional organizations seeking to build resilient, water-secure futures for their populations. Many African countries share rivers and borders. It is therefore important to collaborate in efforts geared toward developing and managing water infrastructure to promote regional integration, strengthen diplomatic ties, and foster shared responsibility for water resources. It is crucial for Nigeria to extend its focus beyond national borders. Its government leaders should collaborate with those of neighboring countries and regional organizations to assess successful and unsuccessful aspects of water infrastructure investment and

development. Sharing resources and knowledge will be instrumental in achieving comprehensive access to clean water, sanitation services, and basic handwashing facilities. This collaborative effort must aim to not only benefit individual countries, but also to allow the continent to glean valuable lessons and recognize the profound impact of water and infrastructure investment on all facets of life.

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