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# Impact of Potable Water Availability on Economic Development of North Benue State

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Abstract

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Abstract

The socioeconomic progress of developing nations, states, and rural communities largely depends on the development and management of their water resources. Rural communities of the North Senatorial District (NSD) of Benue, Nigeria do not have adequate access to potable water. The purpose of this correlational study was to evaluate the statistical relationship between availability of potable water and the economic development of the NSD and Benue state. The primary theoretical framework included Omamegbe's theory of migration and brain drain. A quantitative, cross-sectional design was employed using a modified version of the World Health Organization (WHO) Laboratory Assessment Checklist. Participants consisted of 43 water supply managers and five officials of the Ministry for Water Resources and Environment (MWRE). Data were analyzed using Pearson product-moment correlation coefficient to establish a relationship between the independent variable (potable water supply) and the dependent variable constructs relating to the availability and quality of water supply technologies and resources as well as the presence of documentation for maintenance and improvements. The results indicated all dependent variables had statistically significant relationships to lack of potable water supply and its negative effect on the economic development of the NSD. The implications for social change include developing a state model that would improve water supply to communities of the NSD of Benue state which may no doubt have a positive health, economic, and social impacts for the state and potentially, the country.

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# DEDICATION

This doctoral work is dedicated to my father, Abraham Akange Azande of blessed memory, who even though was not highly educated, knew the inalienable value of education and strove for the skies to be my limit. Dad, I am sure you are proud that your desire and efforts are accomplished. Additionally, I dedicate this project to my mother Theresa Nagbaa Akange who for years has missed the closeness she deserved during my years of academic journey, away from home.

# ACKNOWLEDGMENTS

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In a profound way, I want to say a big thank you to my dynamic Dissertation Committee Chair, Dr. Lori Ann Demeter who right from course work saw "cult member" potentials in me, believed in me, monored and directed every step of my dissertation process to its completion. My sincere thanks go also to my Committee members, Dr. Gloria Billingsley for her collaborative diligent review of my research as well as the University Research Reviewer [URR], Dr. Mai Moua who all worked hard to see me to the finished line.

I express my thanks to the Benue state government who through the office of the Commissioner for Water Resources and Environment (MWR) allowed me access to their established water supply projects in the North Senatorial District (NSD). I am also grateful to the officials of the ministry as well as the water supply managers and related agents who willingly participated in the study.

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# Chapter 1: Introduction to the Study

Among all the natural resources, water is arguably the most important for survival. While other natural resources like oil have substitutes, there is no substitute for water (Aremu et al., 2011). The physical wellbeing and continued existence of every person depends to a large extent on the availability of good drinking water (Maitera, Oghgbuaja & Barminas, 2011). Although the most basic use of water is for consumption, there are other human activities in which water serves as an essential natural resource. These include: irrigation, food production, industrial processes, laundering, recreation, personal hygiene, environmental hygiene, economic development as well as the social transformation of people. Rural communities and countries especially of developing nations depend on the availability of water (Inyang, 2009; Maitera et al., 2011).

In order for water to be acceptable, it has to meet the quantity and quality requirements and standards in terms of its physical, biological and chemical properties set by the World Health Organization (WHO) (Maitera et al., 2011). The provision of potable water is particularly important in developing nations such as Nigeria, states like Benue, and rural communities such as those of the North Senatorial District (NSD) of Benue to prevent the spread of water borne diseases as well as other health problems and mortalities associated with the lack of water or poor water quality (Omezuruike et al., 2008).

The theoretical hypothesisfor for this study was that the economic development and social transformation of the rural communities of the NSD and Benue state, Nigeria are impacted by the lack or inadequate water supply. This hypothesis is supported by Hugo's theory of population growth and migration (2008), which has close links with the

phenomenon of migration and brain drain (Omamegbe, 2010). This theory helps in understanding how the absence of basic social amenities in most countries of the Sub-Saharan region motivates Africa's youth to migrate to the United States of America (Omamegbe et al., 2010). This has cumulative results in what Acey, (2011) described as growing industrialization and overcrowding. All these theories provide a deeper understanding of how factors such as loss of agricultural land and competing demand for water, as well as environmental hazards associated with population movement, have led to the scarcity of those meager existing resources.

Other factors associated with lack of potable water supply and their impacts on the economic development of the senatorial district (SD) are clearly articulated in this dissertation in order to enhance the reader's understanding of the problem. The focus of the research question was on the nature of the relationship between lack of potable water and the economic development of the NSD and the role played by Benue state governments to address the problem. The purpose of the study was to understand how the economic development and social transformation of the rural communities of the NSD and Benue state, Nigeria are impacted by the lack of water or inadequate water supply.

In order to achieve this objective, the study evaluated the impact of water availability on the economic development of individuals and communities. It also evaluated the impact of water programs on environmental sanitation practices, economic activities related to water, hygiene practices, and health. It also analyzed the impact of water programs on women and children to assess the connection between Benue state governments (human resources), documents and records, and the water supply problem in order to enhance socioeconomic development of the district and the state.

This chapter addresses the key definitions, basic assumptions of the research, the scope, potential limitations, delimitations, and weaknesses of the study. The chapter concludes with a summary of the key points, the gap in the literature, and my expectation about how the study would contribute to positive social change.

To obtain the literature and information that was used in this study, I utilized the library database of Walden University and ProQuest. In doing so, relevant key search words were employed. They included:  water supply, human life, rural communities, socioeconomicdevelopment, public health, water pollution, diseases and mortalities, as well as women, children, and water collection. Also included were: rural women and economy, investments in water and sanitation, population growth, climate change, migration, industrialization, environmental implications as well as evaluation of programs.

## Background of the Study

Benue state of Nigeria is endowed with a lot of potential, both, human and material. Its vehicle number plates bear an inscription that reads: “the food basket of the nation”. Benue earned this national distinction because its people produce abundant crops that are distributed to the entire nation. The provision of improved water availability and educating people about good hygiene practices with sanitary facilities are fundamental for the socioeconomic development of the communities of the NSD and Benue state, as well as other rural communities in the African Sub-Saharan region. During the dry season and in areas with little annual rain fall, for example, water projects that are established to supply water for livestock and irrigation of small gardens can potentially impact local

economies (Aper & Agbehi, 2011; Odiaka, Akoroda & Chukwunyem, 2008; Oboh, Sani & Biam, 2009).

The socioeconomic development of a nation, state, or community largely depends on the development and management of its water resources (Flynn, 2009). Clean water is necessary for combating water-borne diseases, ensuring a sustainable environment, eliminating hunger and poverty, improving maternal health, promoting gender equality, reducing child mortality rates, and allowing for orderly social change (Kolawole, Omali & Daniel, 2012; Olajide, 2011). The United Nation's (UN) General Assembly (2012) recognized potable water as a human right, which with other human rights has the potential to improve the social enjoyment of life by individuals and produce decent standards of living, as well as improving the mental and physical health of people. These human conditions can substantially facilitate the economic growth and development of individuals, communities, states, and nations (Ajao, Obafemi & Ewumi, 2011).

Over the centuries of human history and development, many nations have gone through environmental challenges, especially those associated with water (Solomon, 2010). The creative skills and abilities of those civilizations to deal with the challenges such as flooding, development of dams for irrigation as well as using water ways to expand territories and control of power are reflected today in the achievements they have made (Solomon et al, 2010). The classic examples of such historical realities are the warlords of ancient China who, by controlling water management, which was developed initially for irrigation purposes, gradually established their powerbase (Solomon et al., 2010).

Apart from been an administrative management tool, the water resources that were developed over time also led to the expansion of nations' territories. Nations and communities that have engaged in innovative water resources development and made water potable have increased their potential for food production, industrial, and economic development (Solomon et al., 2010). On the other hand, countries that have made little or no progress at all in developing and managing their water have placed themselves in the circle of poverty and economic underdevelopment.

This condition is typical of developing countries of Sub-Saharan Africa and those in other continents and regions where the lack of water, in combination with rapid population growth and poor social structures, has contributed to their slow development (Anger, 2010). For a region, state, or community to lack access to water can have a variety of implications such as limiting economic productivity and development opportunities, as well as reducing its capacity to produce adequate food to meet the needs of its population (Okpoko et al., 2008). In most countries of the developing world such as Nigeria, population growth is undergoing a steady increase such that, proportionally, the water supply is scarce or too limited to meet demand. Public health could be negatively impacted due to the lack of safe drinking water especially (Ajayi & Ugwu, 2008; Palaniappan et al., 2010).

In vulnerable and marginalized rural communities most affected by low water quantity and quality, it is common for women and girls to bear the burden of water collection and to walk for several hours or miles a day in search of water (Pickering & Davis, 2012, Sigenu & Pelser, 2009). There are other communities in more arid areas where people walk longer distances to reach a water source, and when they eventually get

to a stream or pond, it is usually overused and the water they collect is not safe for most domestic purposes (Terngu et al., 2010; Utsev & Aho 2012).

## Problem Statement

The problem to be addressed in this study was that the economic development and social transformation of the rural communities of the NSD and Benue state, Nigeria were impacted due to the lack of water or inadequate water supply. Improved water supply and sanitary practices alone cannot stimulate socioeconomic development; however, they remain crucial in the process (Nwankwoala, 2011). Potentially, it could bring about improvements in health, agriculture, and other aspects of state and rural economy (Flyn, 2009). The United Nations' International Children's Emergency Fund (UNICEF) and the WHO (2012) have identified water as the most basic of human needs. Every person knows by nature the fundamental necessity and value of water, without which human existence would be impossible (Aremu et al., 2011).

However, the reality is that some members of Nigerian society, for example the rural people of the NSD of Benue, do not have adequate access to potable water. The WHO (2010) quality standard is that a minimum of 55% of the water supply be deemed potable. It is not surprising that in most parts of the NSD of Benue most of the water sources are below the WHO standard and therefore unsafe for domestic use and consumption (Ocheri, 2010; Ocheri, Ahola & Atu, 2012). This leads to adverse consequences of related health issues as well as cases of death for rural communities and consumers.

There have been numerous studies conducted regarding water problems in Nigeria as well as the studies that focused on selected districts and local governments of Benue

state (Aper & Agbehi, 2011; Isikwue, Isikwue & Danduwa, 2009, Terngu et al 2010; Tse & Adamu, 2009) For example, Aper et al. (2011), focused on the Ugbokolo community in Okpokwu Local Government (LG). Isikwue et al. (2009) and Tse & Adamu (2009) focused on Makurdi metropolis, the capital of Benue state. Other studies were by Terngu et al. (2010) on the rural areas of Obi snd Oju in Oju LG, and Utsev & Aho (2012) examined the Tse-Agberagba, Akpagher and Ibbilaalukpo communities in Konshisha LG.

All of these studies were carried out to assess the water supply in selected areas of Benue state and to identify the factors responsible for the serious water supply problem and its effects on the people. However, none of the studies focused on the NSD as a whole and how this problem has impacted the socioeconomic development of the NSD and the state. Such studies were motivated by other factors, such as the predictions and fear of global warming and world population growth, or how these will impact water availability for certain segments of societies (Acy, 2008; Ibbi & Nmadu, 2012).

While these fears and conclusions are legitimate, in most cases the issue is not just about an insufficient supply of water, it is rather scarcity due to underinvestment in new and expanded infrastructure The recommendations of the researchers were therefore focused on underground and surface water development efforts that for several years have apparently not produced the desired results (Ishaku, Abayomi, Haruna & Dama 2011). Several water projects were developed a few years ago that are not working effectively due to poor maintenance, lack of maintenance, or other logistic constraints (Ocheri, 2010).

Those water projects are unable to generate enough water to meet the needs of the local people. Sometimes this condition has resulted in massive water losses, unreliable

supplies, inadequate coverage, and poor water quality. Some of the projects have broken down and have not been repaired, and some have been abandoned altogether (Ocheri et al., 2012). While it could be argued that potable water availability and improved sanitary practices alone cannot stimulate socioeconomic development, they remain crucial to the process and have the potential to improve both economic development, health, agriculture, and other aspects of rural and state economy, development, and social change (Flynn, 2009).

## Purpose of the Study

The purpose of this quantitative, nonexperimental, cross-sectional research was to evaluate the lack of potable water availability and its impact on the socioeconomic development of the NSD and Benue state. All forms of development, at the individual, community, state, or national level, have ties to economy and a range of socioeconomic factors that support it. When those economic and socioeconomic factors are lacking, broken down, or totally absent, they prevent any form of development from taking place. In this study, those factors engaged my attention and were among other factors that served as useful lenses for examining their overall impact on the economic development of NSD and Benue state.

This research filled an important gap in literature and in practice regarding the possible connections between potable water availability and the economic development of the region, as well as the impact the Benue state government has had on this economic development process (Ajayi & Ugwu, 2008; Nwankwoala, 2011; Waziri & Ogugbuaja, 2010). The results of this study may be useful in assisting the governments of Benue state and its policy makers to determine how lack of potable water has a direct connection to

the socioeconomic development and transformation of the NSD and the state, and the need to give this subsector of infrastructural development a central place in their developmental plans.

## The Nature of the Study

There is no existing baseline study concerning the impact of potable water availability on the socioeconomic development of the NSD and Benue. Some researchers as those discussed in the forthcoming chapter 2 utilized different research methods about water and environmental management (Reed, 2008) as well as investigations about the efffects of environmental forces on local socioeconomic status of people and communities (Emech et al., 2010). Other studies were an exploration of the factors associated with mirgation such as population growth and climate change (Perch-Nielsen, Batting & Imboden, 2008). Some of the studies were an assessment of water pollution or its quality and their health and mortality effects on residents and consumers (Akinbile & Yosoff, 2010; Dan'Azumi & Bichi, 2011).

Other study designs were longitudinal case studies that offered a before and after comparison of the conditions in the places of intervention (Adelekan, 2010). Against this background, an idea method for this study was challenging. I therefore conducted this study using a quantitative, nonexperimental, cross-sectional research design to evaluate the impacts of potable water supply on the communities of the NSD of Benue state. The advantage for this method of study is that it is unbias and objective. Additionally, according to Black (1999), when a research is about complex relationships and correlations between different variables as it is the case with this study, the quantitative approach is especially fitting. Further more, this method of study has the potential to be

more practically applied in water supply technologies and rural community settings such as those of the NSD that decision making bodies/agencies are involved (Black et al., 1999). Data collection in the quantitative research method is quick and relatively less expensive, it provides more accurate quantitative numerical data, and its analysis is less time consuming (Black et al., 1999).

The advantage of a nonexperimental survey method is that it takes into account information about individuals' experiences and analysess of events (Babbie, 2008). These experiences and peoples' analyses of events are more valid as a foundation for understanding a phenomenon and decision making by those in government or authority (Black et al., 1999). Due to some logistic factors that posed a challenge in conducting this research, such as finance and time constraints, a cross-sectional approach was also utilized. The financial support for this study was entirely my responsibility. This made a shorter time frame for conducting the study a huge advantage.

Based on these circumstances a cross-sectional approach enabled me to conduct the research at a single point in time and minimize cost (Trochim & Donnelly, 2008). The size of participant sample, as well as the instruments of survey both favored a cross-sectional choice for the study. According to Black et al. (1999) and Vogt, (2007), utilizing the survey method allowed a cross-section sample of the population that also allowed for the generalization of the findings. To achieve the objectives of this research and to be in line with the study method, I collected data from primary and secondary sources. I also adapted the quantitative survey tool that was developed by the WHO and the Regional Office for Africa (AFRO), which was modified, tested, and approved by the Uganda Ministry of Health (MoH) and the Central Public Health Laboratories (CPHL)

(Elbireer, 2012). A copy of this survey is located in Appendix A. Quantitative data were also collected from additional secondary sources. These data sources included publically available government statistics and survey data that confirmed the number and type of water supply projects established within the NSD by Benue state governments. The use of both primary and secondary sources provided valuable information concerning the topic under investigation.

With the use of the survey checklist (Appendix B), I collected data from one manager at each of the 43 community water supply projects at their respective community location. This publically available tool was an assessment checklist to assess and improve laboratory quality in Uganda and was used by Elbireer et al. (2012) in his dissertation research.

I also collected quantitative data fom additional secondary sources. These data sources included publically available government statistics and survey data that confirmed the number and type of water supply projects established within the NSD by Benue state governments. Participants were drawn from those whose knowledge and experiences contributed to the research, including five officials from the Benue state Ministry for Water Resources and Environment (MWRE). This brought the total number of research participants to 48.

It is worthwhile at this point to explain why the NSD of Benue was considered an ideal choice for this study. The NSD is made up of two geopolitical zones: A and B (Asogwa, Umeh & Ihemeje, 2011). It was an appropriate choice for the study because of its unique characteristics. Benue state derives its name from the Benue River, which is the second largest river in Nigeria and the most prominent geographical feature in the

state (Isikwe et al., 2009; Maitera et al., 2010). The state was created in 1976 from what was called the Benue Plateau State, and it is divided into 23 local government areas [LGs] (Agbidye, Ofuya & Akindele, 2009; Ocheri et al., 2012). The NSD is represented by 14 LGs: Buruku, Gboko, Guma, Gwer, Gwer-West, Katsina-Ala, Konshisha, Kwande, Logo, Makurdi, Tarka, Ukum, Ushongo, and Vandeikya (Asogwa et al., 2012). The people of the NSD of Benue state are charistically among the best farmers in Nigeria (Agbidye et al., 2009; Asogwa et al., 2011). Besides River Benue, several other rivers run through their land and for centuries they have successfully changed/transformed their countryside and are known for their agricultural excellence (Agbidye et al., 2009; Asogwa et al., 2011). It is predominantly the farming activities from the 14 LGs of the NSD that have earned Benue state its national identification as the "Food Basket of the Nation" (Agbidye et al., 2009; Asogwa et al., 2011).

Furthermore, there were reasons why water availability was an important problem for this research. First, because there is a relationship between the availability of water and development, and second because water investment has effects on economic growth and can bring about social transformation to people and communities (Flynn et al., 2009, Gleick et al., 2012;Hanak et al., 2011; Solomon et al, 2010; Sullivan, Cohen, Faures & Santini, 2010). What made the NSD and Benue an appealing choice is that many nonagricultural communities, industries, or states are able to pay high prices for water when it is a minor factor in their total production cost. It is however a different case in the NSD, which is predominantly agricultural. More than 70% of the agricultural produce that is distributed throughout the entire nation comes from the NSD; hence, the state's national identification as the Food Basket of the Nation comes from these LGs (Okoye &

Nyietagher, 2009). It could therefore be a disaster not only for the people of Benue state but the whole nation if the "food basket" itself goes empty due to shortages in rainfall, lack of potable water availability, or the inability of the SD to ensure food sustainability.

Conversely, the people, communities and the state at large depend on agriculture for socioeconomic and development purposes (Asogwa et al., 2012). The reality, however, is that sharp climate changes were resulting in shorter periods of rainfall and overall amount of yearly rainfall, which farmers depend upon for farming and other agricultural activities (Adamgbe & Ujoh, 2013). As a result of shortages in rainfall, farmers could not produce certain crops all year round, making some of the food crops seasonal. During those seasonal shortfalls in local crops and food production, those crops are transported from other states to Benue (Adambge et al., 2013). The result to this development is that the Benue state farmers end up paying far more heavily than they would otherwise on food had they access to potable water supply for irrigation to grow the crops themselves and have steady food and economic growth all year round (Asogwa et al., 2012).

It was my hope that the findings of this study would enable researchers and practitioners to gain a better understanding about the fact that apart from the impact of lack of potable water and sanitation on human health and mortalities that predominated previous studies, their impacts on individual, community, and state development are profound. The answers to the research question that is addressed in this study would be important not only because it will enable a full understanding of the experiences of the communities of the NSD who are impacted by the lack of water supply, but also that the outcomes would be utilized to improve the efforts of state governments and donor

agencies towards water provision which would ultimately bring about development and social change to the NSD and the state at large.

## Research Question

The majority of studies conducted about water problems in Nigeria focused on other parts of the country, with less of the literature focused specifically on the NSD of Benue state (Aper et al., 2011; Isikwue, Isikwue & Danduwa, 2009; Terngu et al., 2010; Tse et al., 2009). Researchers who were concerned with water problems in Benue state focused on selected areas as well as social and physical problems associated with lack of water. Some of these studies (Aper et al., 2011; Terngu et al., 2010) were devoted to the scarcity of water and looking at waterborne diseases associated with poor water quality and hence the need for interventions. The researchers did not look holistically at the issues associated with lack of water supply or how they have an impact on the development and social transformation of the NSD and the state at alrge.

The following research question was asked to support the objectives of this research project

**Q1.** What is the nature of the relationship between the lack of potable water availability and the economic development of the NSD and Benue state, Nigeria?

## Hypotheses

The main objectives of this study were to assess the quality of the high, medium, and small capacity water supply programs and examine the effects of two quality standard assessment factors on the poor quality of water or lack of water supply in the NSD. The following hypotheses were presented as specific statements of prediction for

the research question. To enable an evaluation of the research question, the null ($H_o$) and alternative ($H_a$) were tested.

**$H_o$1** There was no correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

**$H_a$1** There was a correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

## Theoretical Hypothesis

A theoretical hypothesis can be thought of as a collection of interrelated concepts or mediating variables that try to describe why or how there could be relationships between independent and dependent variables (Trochim & Donnelly, 2008). There are a number of reasons why a theoretical framework is important in exploratory studies, especially when a researcher is trying to learn more about a set of unknown phenomena (Babbie et al., 2008).

Theoretical hypothesis are also important as developed methods of approach that may be employed in any subsequent study (Babbie et al., 2008). A theoretical hypothesis is further explained as a process by which a core set of connectors are identified (constructs or variables) within a topic and show how and why they are related to the subject under investigation (Yin, 2014).

Due to the fact that theories or variables constantly change, researchers present their theories in proposals in different ways such as visual models, logic statements, or in a series of hypotheses (Babbie et al., 2008, Yin, 2014). The theoretical hypotheis for this study included three supporting theories: (a) Hugo's theory of population growth and migration (2008), (b) Omamegbe's theory of migration and brain drain (2010), and (c)

Acey's theory of growing industrialization and overcrowding (2011). These theories helped me to understand the interconnections between the factors of the lack of potable water supply and its impact on the socioeconomic development of a nation, state, and the NSD of Benue state in particular.

Hugo's theory of population growth and migration (2008) greatly contributed to understanding Omamegbe's phenomenon of migration and brain drain (2010). According to Hugo et al. (2008), population growth is fundamental among other factors to the loss of agricultural land in many countries, states, and rural communities. This theory can be understood in the context of the communities of the NSD of Benue state that are typically agricultural. The growth in population ultimately leads to competing demands for land for settlement and agriculture as well as the availability of water (Wei et al., 2009). The growing lack of resources accelerates migrations that have interconnections to development (Hugo et al., 2008). Whichever form these migrations take, they are interrelated to Acey's theory of growing industrialization and overcrowding of towns and cities that have impacts associated with health and environmental hazards (Acey et al., 2011).

Omamegbe at al. (2010) presented a model for understanding how the absence of basic social amenities in most countries of the Sub-Saharan Region motivate Africa's youth to migrate to the United States of America for green pastures. For the purposes of local and national development, the migration of the skilled labor force impacts the development of their countries of origin. There is a close link between what Omamegbe described as the "brain drain" of the migrating youth of Africa and those of the NSD of Benue state who migrate from local communities and villages to towns and cities in

search for a better life and social comfort. I understand Omamegbe's use of "brain drain" to mean the process by which a country loses its human capital: educated, talented and technological workers to other countries. The process creates a problem, for the countries they leave suffer economic hardships because they no loger contribute with those who remain to make a difference. As pointed out by Omamegbe et al. (2010), the countries of origin of the emigrating youth of Africa are greatly impacted by their exit because their skills and developmental contributions are lost. This is very similar to the way that communities and villages of the emigrating youth of Benue are impacted, especially relating to food production and other development initiatives of their districts and the state.

As Omamegbe et al. (2010) further pointed out, if African nations were developed and the basic social conditions for a life of comfort were provided for, there would be no need or reasons for the young to leave. This assertion was confirmed by Okpoko et al. (2008), who explained that decent standards of living, job opportunities, socioeconomic development, and the availability of basic social amenities in communities, states, or nations have a close relationship to the development, management, and supply of water resources. Ajao et al. (2011) pointed out how, due to the slow efforts of state governments such as those of Benue, a sizable portion of the population of the NSD has limited access to potable water. According to Galadima, Garba, Leke, Almustapha & Adam (2011), from an economic point of view it is those members of society who are very poor and with less access to potable water that nonetheless spend more money to procure it and on health related issues when such resources could be better expended on other development programs or gainful activities.

Figure 1 below was created by me in close relation to the literature review, particularly based on the writings of Aper et al. (2011) and Okpoko et al. (2008), to give some sense of understanding and structure about what was considered an important political process to rural development in its descending order. The rural development and social change of the communities of NSD and Benue largely depend on the availability of potable water which cannot easily occur without the decisive role and intervention by Benue state governments (Aper at al., 2011; Ocheri et al., 2010; Okpoko et al., 2008). Similarly, Figure 2 was also created in line with the review of literature and was intended to provide an overview of the interactions between the variables that engaged my attention and also served as a guide to be followed in this research (Ocheri et al., 2012; 2010). A significant aspect of the construct was that it projected my assumption that lack of potable water availability has direct links with the other variables and in the long run they both have impacts on the development and social change of the NSD and Benue state (Chudi, 2010; Ibbi, 2012; Sigenu & Pelser, 2009).

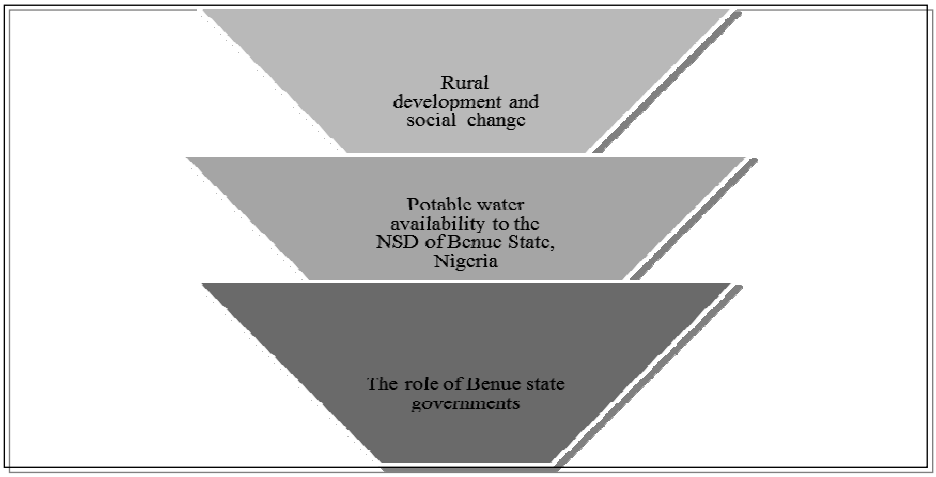



Figure 1. The Research - Political Flow

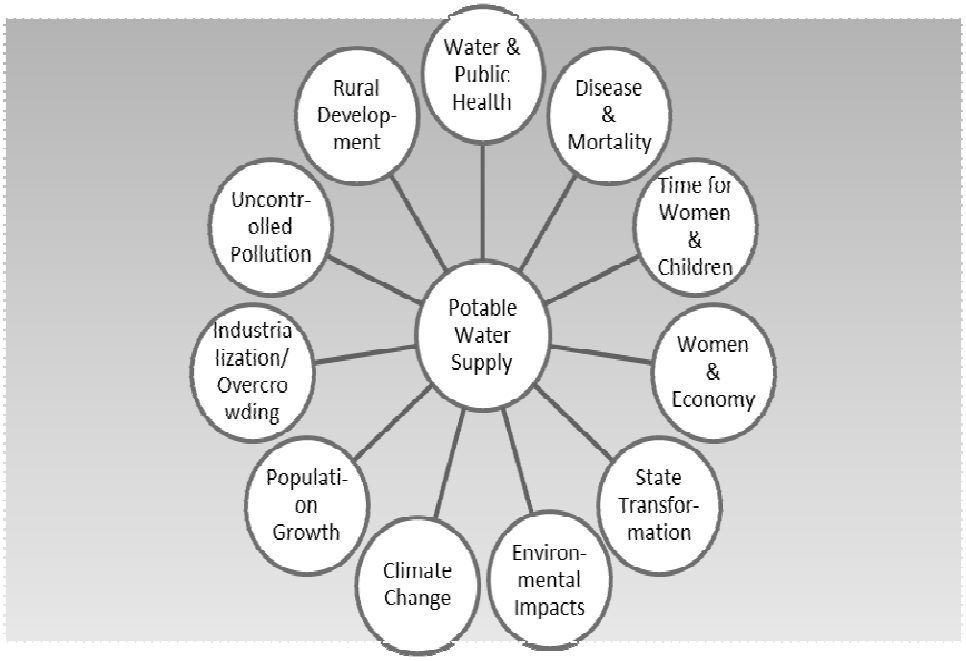



Figure 2. The Research – Environmental Issue

In this quantitative study I adopted the survey tool that was developed by the WHO and the African Regional Office (AFRO) (refer to Appendix A). This tool was modified, tested and approved by the Uganda Ministry of Health (MoH) and the Central

Public Health Laboratories (CPHL). This tool was used as an assessment checklist to assess and improve laboratory quality in Uganda and was utilized by Elbireer et al. (2012) in his dissertation research. Although the objective for which this assessment tool was utilized by the Uganda MoH and CPHL is similar to that of the current research, I slightly modified the tool (refer to Appendix B). This slight modification was considered necessary for a number of reasons. For example, one section: section 4 of the laboratory assessment checklist was not related to this study so I removed it. Some factors that were not essential in this current study

Were also removed or changed.

Furthermore, in the adopted survey checklist, the term "laboratory technologies" was used in consonant with the objective of that study (Elbireer et al., 2012). However, the survey about which the instrument was adopted for this study was water supply technologies. Although these water technologies were likened to but were nevertheless different from laboratory technologies and their functions. It was in keeping with this study objective and survey that the term "laboratory technologies" was replaced with water supply systems. Since these water systems were more than one in type, by system's use here I referred to water technologies of high, medium and small capacities respectively (please refer to Appendix B).

A key gap in the current literature and an important element for evaluation in the study was the water supply technologies used in the developing countries such as Nigeria and the quality of services they were intended to deliver (Biswas and Tortajada, 2009). The attention of researchers and evaluators of water and sanitation interventions has always been on the kinds of factors identified in Figure 2 above (variables) that makes

the assessments less holistic (Danazumi & Bichi, 2010; Okoye & Nyiatagher, 2009; Otufale & Coster, 2012; Tse et al., 2009). In some instances where an assessment of the projects were made the focus was more on establishing the successfulness of their implementation with the aim to justify the projects' costs (Pattanayak, 2009). This approach usually excluded other essential components such as the human resources associated with the programs' effectiveness, efficiency and sustainability and how these deficiencies can and do impact the overall goals of the programs (Davis et al., 2008). In this study, the factors associated with water supply projects and their technologies such as human resources and infrastructure, documents and records and internal audit among others were examined.

I considered the evaluation of these factors to be important and necessary apart from the reasons given above for other reasons as well. It is common for regimes and leaders who have corrupt tendencies and practices to beat public drums about all kinds of socioeconomic development projects that are implemented and the huge finances expended for the said projects (Anger et al., 2010). It is also common in a number of cases and instances that those projects are practically none existent. In a few cases where they exist at all, the quality, durability and the standard of services offered from what was implemented hardly justifies the public drums and expenditures (Anger et al., 2010). Since corruption is the direct intent, there are usually no documents and records for verification or to justify those reports even if anyone sought to (Adenugba et al., 2013).

It is also possible for high capacity water supply technologies for example not to be assigned competent trained personnel. Those appointments would intentionally be made so that the lack of skills would lead to incessant break down of the technologies

(Oalniyan et al., 2008). When this happens, huge “repair expenses” are reported when in fact those resources are again misappropriated (Adenugba et al., 2013; Agba, 2010). Ultimately, the absence or lack of effective, efficient and sustainable development programs or their failures have direct connections with human resources and the factors evaluated in this study (Oalniyan et al., 2008).

I collected data from one manager at each of the 43 water supply projects at its respective community location. A previously validated and publically available survey was used to collect all data. This survey tool was first developed by the WHO and the AFRO and recently modified, tested and approved by the Uganda MOH and the CPHL (Elbireer et al., 2012) (refer to Appendix A). This publically available tool is an assessment checklist to assess and improve laboratory quality in Uganda and was used by Elbireer et al. (2012) in his dissertation research.

I also collected quantitative data from additional secondary sources. These data sources included publically available government statistics and surveys that confirmed the number of water supply projects established within the NSD by Benue state governments. This highlighted the inter-connection between the quality of water supply services variables and the outcome of the research. I had an assumption that the water supply human resources, documents and records factors had direct links and correlation with other factors that ultimately affected water availability and the quality and delivery of water services to the NSD (Adenugba et al., 2013; Agba et al., 2010; Olaniyan et al., 2008).

## Definition of Terms

This section contains definitions of some terms that in their everyday usage may not be complex but might nevertheless need to be clarified as they are implied in this research. From this background these terms or concepts may enhance a better understanding of the paper and its objectives.

*Access to Safe Drinking Water*- the proportion of people drinking or using water from sources or delivery points that, by nature of their construction and design, are likely to protect the water sources from outside contamination, in particular from fecal matter. These include piped water into dwelling, plot or yard, public tap/stand pipe, tube well/borehole; protected hand dug well, protected spring and rainwater collection (UNICEF & WHO, 2010).

*Access to Improved Sanitation*- the proportion of people using sanitation sources that hygienically separate excreta from human contact. These include flush or pour-flush to: piped sewer system, septic tank, pit latrine, ventilated improved pit latrine, pit latrine with slab and composting toilet (UNICEF & WHO, 2010).

*Community Water Supply*- a public water system that serves at least 25 residents throughout the year and may consist of one or multiple wells or reservoirs (Mimrose, Gunawardena and Nayakakorala, 2011).

*Adequate Supply of Portable Drinking Water*- the proportion of people that has access to WHO quality standard of water supply services of 55% or greater (WHO, 2010).

*Cost Benefit*- designation of an analysis that evaluates the cost-effectiveness of a project or policy (Michael et al., 2010).

*Cost Effective/Effectiveness*- economically worthwhile in terms of what is achieved for the amount of money spent or the cost that has been calculated for undertaking a project (Michael et al., 2010).

*Mortality*- death on a large scale as from disease or war or the proportion of deaths to the population of a region, nation, state or community (Michael et al., 2010).

*Potable Water*- drinkable water; water used for hygiene and amenity purposes. Usually it must comply with statutory requirements, such as the WHO guidelines for drinking water quality (Friebel, 2013).

*Stakeholders*- a person or group with a direct interest, involvement, or investment in something, e.g. the employees, stockholders, and customers of a business concern demonstrating how to build powerful stakeholder relationships based on trust (Michael et al., 2010).

*Water Availability*- access to water of quality and quantity at all times by individuals, within communities, states or nations (Gleick et al., 2009).

## The Boundaries of the Study

According to Michael et al. (2010), a boundary is any line or thing that marks a limit or border. From the perspective of this definition, this study too had its limits or border. It focused on the people and communities of the NSD of Benue state. These communities are agricultural in setting and produce food in substantial quantities that is circulated to the entire nation. Due, however to climate change and reductions in annual rainfall and lack of potable water availability, their economic development are impacted. In order to answer the research question, I used the survey checklist for one manager at each of the 43 water supply projects at their respective community locations. These data

sources included publically available government statistics and survey that confirmed the number of water supply projects established within the NSD by Benue state governments. Participants were drawn from those whose knowledge and experiences contributed to the research such as government officials in the Benue state MWRE. Data collection sources included publically available government statistics and surveys that confirmed the number of water supply projects established within the NSD by Benue state governments. As already stated above, the NSD of Benue state is represented by 14 LGs that have significantly contributed to Benue state's status as "The Food Basket of the Nation."

## Assumptions

Among a number of ideas given by Michael et al. (2010), about assumptions such as to pretend, put up, fictitious or taking too much for granted, I favored for this study and this section in particular, pretend. I pretended or assumed that a lack of or inadequate potable water availability impacted the economic development of the NSD of Benue state. Given that this was the first study that holistically examined the impact of potable water availability on the NSD of Benue, I assumed that the participants who were selected would provide truthful accounts of their knowledge and experiences about water supply and its related activities to the SD. I also assumed that the sample size of participants would be adequate to allow for generalization. I also assumed that this research would make an in-depth assessment of the causes and impacts of potable water availability on the development of the NSD in order to help policy makers and the government of Benue state to take appropriate measures to address the problem to ensure not only the development of the district and the state but to also bring about its social transformation (Ocheri et al., 2010; Ocheri et al., 2012; Tse et al., 2009).

## Limitations and Delimitations

Michael et al. (2010) has given a number of definitions of limitation and the purpose they serve. I did not in any way make this another section of terms' definitions. What I did here was only an attempt to place ideas or concepts in their right perspectives in order to enhance a common understanding. From this background, limitations meant: "Confined within bounds or narrow in scope and extent" were therefore implied in this section. The first and most fundamental limitation of the study was that only the people of the NSD of Benue state were included in the study. This means other geographic areas of the state were not included in the study even if they had the same or similar experiences about water availability impacts. Another limitation was that it was not practically possible for the whole population of the NSD to participate in the process of data collection.

Data collection cut across the two geopolitical zones: A and B that were markedly the NSD of Benue. It was however limited to a given percentage of the population which nevertheless formed the bases for generalization (Creswell et al., 2009). There were other logistic limitations that I had. Financially, the study was entirely my sole responsibility, a condition that did not support a far more robust project than I could finance more so that the water projects implemented by the Benue state governments were small in quantity. On the basis of this constraint a shorter time frame for the project was a huge advantage to me and it minimized the stress associated with it.

Aside from these limitations, based on the fact that the participation in the study was voluntary, there was the likelihood that some of the targeted population for sample would decline to take part in the study within the scheduled time frame, or would decide

to not take part in the study at all. This could have led to another possible limitation that those who declined to participate in the study could have a different perspective from those who agreed to participate (Babbie et al., 2008). The reason why this could be a limitation was that some of the study participants were government officials who could suddenly be transferred. In an event that any or some of them who were selected to participate in the survey got suddenly transferred before data submission, that could have hampered the process, although this depended on how significant the number of transfers would have been.

Another potential limitation was that I did not know all the communities at which some of the water projects were located. This handicap necessitated seeking the help of three research assistants from the Benue state MWRE who also served as tour guides. However, data collection was coordinated directly by me. Those individuals were presumed to be familiar with the different locations of the water projects as well as each project manager whose information was solicited for the survey. This condition pointed to yet another limitation namely; the inability or failure of the assistants to show up on some scheduled dates could have inadvertently delayed or prolonged the duration of data collection.

## Significance of the Study

This is the twenty first century and yet concerns are still growing globally about the lack or poor accessibility to potable water supply by millions of people around the world. Globally, about 137 million people in urban areas still live without potable water supply (WHO et al., 2010). These concerns about lack of water accessibility are even more pertinent in the developing nations especially in the Sub-Saharan Africa and

Nigeria as well as the NSD of Benue state in particular (Okpoko et al., 2008, Olajide, 2011). There were about 884 million people in rural areas of Sub-Saharan Africa who lived without access to potable water supply (WHO et al., 2010). From the perspective of these concerns, most governments of the developing nations and states such as Nigeria and Benue have an urgent task to make potable water supply available not only in cities and towns but also in rural areas and communities such as those of the NSD (Aper et al., 2011; Terngu et al., 2010; Tse et al., 2009; Utsev et al., 2012).

In most rural areas such as those of the NSD, the problem is not only about the lack of water quantity it is most importantly about quality as well since some of their water sources are below the WHO standard for drinking and other domestic purposes (Sanusi, 2010). The lack of potable water supply or its poor quality results into outbreak of waterborne diseases, numerous mortality cases, diversion of financial resources to disease treatments and prevention (Ishaku et al., 2011). These problems have cumulatively exacerbated the economic development efforts and social living standards of individuals, families and communities as well as the rural and state transformation that should have occurred (Ifabiyi, 2011).

In view of this situation, if the possibilities were explored for developing and sustaining the supply of potable water to the rural areas, it could ensure its quality and availability to urban and rural communities (Nkwocha & Egejuru, 2010). Developing an effective and efficient potable water supply is therefore crucial for the health and well-being of people across the nations, states and rural areas (Okoye & Nyiatagher, 2009; Omobowale & Temitayo, 2011; Tse et al., 2009). This approach would significantly reduce the experiences and burden of diseases and mortalities just mentioned above by

people in rural communities (Isikwue et al., 2009; Kughur, 2012; Maitera, Ogugbuaja & Barminas, 2011; Ocheri et al., 2010; Ocheri et al., 2012).

There is a compelling need therefore to develop a conceptual model for improving and sustaining effective potable water supply in the NSD of Benue. The result of this study would provide readers with information about the impact of potable water availability on rural communities and states' socioeconomic development. Conversely, the knowledge and information could be used in other states of Nigeria, as well as other nations within the African Sub-Saharan Region. Apart from this, an examination and analysis of the impact of potable water availability on the socioeconomic development of rural communities would contribute to the existing literature and perhaps, provide guidance for future project development.

Additionally, due to the skeletal services of potable water supply where the resource exists, residents and other public consumers are not allowed to utilize it for other activities apart from drinking. This is a disadvantage to rural communities such as those of the NSD of Benue. I therefore ascertained if there was evidence to support the formulation of policies that would be helpful in situations where rural communities would be willing to offer collaborative support to the programs. Key players: the rural people, their knowledge and awareness about the consequences of water related problems, good environmental practices, incorporation of a broad range of stake holders as LG officials, cost-effectiveness and cost-benefits as well as human resources, technology types and availability of documents and records (transparency) are important aspects that can potentially result from the kinds of initiatives this study proposed. It was my hope that this approach would ensure a better understanding and relationship between

water program interveners and the rural people. Ultimately, this would also serve as a positive approach to change and a more effective and efficient management of water supply to the NSD of Benue.

It was also my hope that this study would identify some of the concerns rural people and communities usually have related to their lack of supportive participation in the development and management of water resources and projects. This was a helpful approach to decision makers, governments and donor agencies in understanding the position of key players when those decisions are made to implement intervention projects. This could further help the sustainability of the projects as well as a mutual acceptance and management of those projects by local beneficiaries.

## Summary

This chapter provided the introduction to the study and the background upon which the research was motivated. It also presented the statement of the problem as well as the objectives which the study accomplished and the study was designed in order to accomplish those objectives. The question the study addressed was also presented including reasons why the NSD of Benue state was chosen as an ideal area of study and the theoretical hypothesis that grounded the research also answered the research question about the impact of potable water availability on the socioeconomic development of the NSD and Benue state. Potential assumptions, limitations and delimitations of the study were also addressed.

All the variables in this study were uniquely important in their contexts. The chapter showed why and how the research in general was significant. Its importance was not just because it provided the lenses through which readers, other researchers, decision

makers and governments of Benue state would see how lack of potable water availability, sanitary facilities and good hygiene practices were vital ingredients for individual and community wellbeing and social change. It has also showed that their lack had therefore impacted the development and social change of the NSD and the need to give these interventions priority attention in their development policies and projects initiatives.

Chapter 2 is a critical review of literature about important issues concerning water, human growth and economic development. It examined in-depth studies in which researchers highlighted the necessity of potable water supply for human existence and sustenance. The availability of potable water supply or its lack has direct influence on human health. The prevention of diseases and mortalities associated with water has direct links with its quality. The chapter described how based on these factors it was absolutely important for water supply sources to be adequately protected, for a healthy life is a healthy society. Unprotected water supply sources can lead to poor water quality as well as the adverse health consequences to residents and consumers.

The literature review also examines the studies that assessed the different kinds of diseases associated with poor water quality in the developing countries including Nigeria with focus on the NSD of Benue state in particular. In addition, the chapter treated in detail the need to provide safe water supply especially to rural communities in order to reduce the burden of disease and death. In the review and evaluation of the literature existing gaps were addressed. There are many benefits or advantages to be derived from improved efforts in the provision of water and sanitation. Among others, these can result to reduced expenses incurred from disease prevention and treatment especially by the rural poor and marginalized who due to these circumstances are usually impoverished. It

could also significantly save the time spent by women and children in water collection that can be more productively and gainfully used to enhance community development and social transformation.

# Chapter 2: Literature Review

The purpose of this literature review was to understand how the lack of potable water availability impacted the economic development of the communities of the NSD and Benue state of Nigeria. In order to better understand the type and level of the impact, the literature search included relevant sources concerning water problems in general, but focused on the NSD of Benue. The category of resources were domestic and foreign peer-review journals, organization and agencies materials, books, research from national organizations, policy theories, and university research. Aside from exceptions that contained information of substantial value to the subject matter, the age of literature employed was not older than 5 years.

Chapter 2 includes the relevance of literature to the research question, data sources utilized, a review of the impact of lack of potable water availability on the economic development of the NSD of Benue, the role Benue state governments in addressing the problem, and an assessment of the current literature. The literature conducted for this study yielded sources with a variety of methodologies and theoretical frameworks. Therefore, it was challenging to formulate the study based on previous research. It was also an opportunity to explore this important area and open new, uncharted areas to be investigated, and to create innovative models for improving potable water availability in the developing countries in the African Sub-Saharan Region, focusing specifically on the case of Benue state, Nigeria.

An important factor discussed in this chapter is the inalienable value of water for human life. I also discussed how potable water supply is a necessity for community development and ultimately social change. The literature review includes the direct

influence of potable water availability on economic and community development. In the literature review I evaluated the environmental implications and the impact of climate change as well as population growth. Also included is information on growing industrialization and overcrowding, rural development and environmental implications, investments in water and sanitation, evaluation of rural water programs and the gaps in the literature.

## Water and Human Life

Water is essential to individuals and societies. Communities develop when people gather to live near water, or they bring water to a centralized location in order to develop the community (Solomon et al., 2010). Hence, towns and cities are located with a view to water (Solomon et al., 2010). Therefore, the social change of rural communities, states, and developing nations in particular, has connections to the availability of potable water supply.

As important as water is to human survival, the reality is that some members of the Nigerian society, and the people of the NSD of Benue state specifically, do not have access to potable water. Lack of access to safe water and proper sanitation are the major causes of disease and mortality, among children in particular (WHO, 2012). It is not surprising that for the most parts of the NSD of Benue, when water is available it is below the WHO standard and therefore unsafe for domestic use and consumption (Dada, 2009; Okoye et al., 2009). This situation leads to adverse consequences of related health issues for rural communities and consumers, as well as the underdevelopment and lack of social change of the SD and the state.

In Nigeria, while the leaders have access to bottled water, hundreds of those they govern die annually from waterborne diseases caused by the lack of access to potable drinking water (Ajao et al., 2011; Ajenifuja & Bolaji, 2011). In a survey about water and sanitation services in Nigeria conducted by Okpoko et al. (2008), Nigeria's water supply coverage on the ational level was about 57% and the national sanitation coverage was about 42%. Water supply coverage in state capitals was about 67%, urban coverage was 60%, and semiurban was about 50%, while rural coverage was estimated at 55%. In communities where these amenities are available, the supply is disrupted by unstable systems and the water needs of the residents are not consistently met (Utsev & Aho 2012). What is significant about these estimates is that they showed not only how inadequate Nigeria's efforts are but also how far behind Nigeria is in the process of contributing to achieving the Millennium Goal (MG) to reduce to half the population of people without access to potable water and sanitation services by 2015 and beyond (Anger at al., 2010).

The focus of this chapter is on previous studies that examined the necessity of water for human existence, as well as the historical perspective on the lack of potable water availability and its impact on the quality of life and the economic development of the NSD and Benue state. Recent studies reflect how the supply of potable water, sanitary facilities, and good sanitary practices are fundamental to the socioeconomic development and improved standard of living and wellbeing of individuals, households, and communities (Dunn & Derrington, 2010; Oni & Temitayo, 2011). Yet, most of the studies that assessed the impact of water quality and sanitary practices focused more on diseases, such as cholera and diarrhea, among others (Cairncross et al., 2012; Chudi et al.,

2010; Clasen, Roberts, Schmidt & Cairncross, 2009), rather than looking holistically at the impacts such programs have on individuals and society.

These approaches were relevant and useful; however, the evidence presented by former research was focused on the difficulties encountered by individuals rather than communities (Babanyara, Usman & Saleh, 2010). This lack of efficient evaluation of the impacts of rural water programs is multifaceted. For the evaluators to observe the behaviors and practices of people that could lead to authentic data collection, they need to develop meaningful grass-roots level interaction with community members (Pattanayak, 2009). Researchers need to devote sufficient time in order to do this, but sometimes such opportunities are lacking. One problem is a lack of interest concerning the social and economic problems faced by members of societies (Waddington, Snilstveit, White & Fewtrell, 2009). There are cases in which assessments are done, but they are done so with particular attention paid to the financial allocations with the view to ascertaining how the physical targets are effectively achieved rather than what effects the projects may have had on the community overall (UNICEF & WHO, 2010).

There are many challenges associated with impact evaluation (IE), both methodological and institutional (Conlin & Stirrat, 2008; Estache, 2010; Richards, 2008). From an environmental impact assessment review, some of the challenges reported included inadequate capacity of IE approval authorities, deficiencies in screening and cooping, poor IE quality, inadequate public participation, and weak monitoring (Nadeem & Hameed, 2008).Other challenges according to the authors included lack of political good will and cooperation by stakeholders but especially, governments: states, local and

districts to provide financial and logisitc support needed by the the IE team (Mimrose, Gunawardena & Nayakakorala, 2011).

Economic turmoil and weak financial resources in developing nations has created major constraints on engaging in such studies (Woolcock, 2009). In situations where such an undertaking becomes imperative, most governments engage their local officials to perform program assessments. There are also instances where the studies are done by outside teams, who are given inaccurate or at times misleading information (Woolcock et al., 2009). Additionally, there are situations where by, governemnts and their related agencies who receive financial grants from donor agencies prefered to utilize their local eveluators rather than evaluators provided by the donor agencies. The reason being that their local evaluators will cover up their dirty tracks associated with lack of proper documents to justify the evaluation expenditures (Woolcock et al., 2009). Lack of transparency that is directly associated with corruption also plays a major role in in the reluctance of governments or their ministries to grant permission for the evaluation of their programs (Conlin and Stirrat, 2008). Governemnts that engare in such activities justify their actions by claiming that local evaluators have better knowledge about the local customs of communities.

Another objective of this chapter was to examine and evaluate the nature of the relationship between the quality and quantity of potable water supply services in the NSD district of Benue and the impact on the socioeconomic development of the SD and Benue state. I evaluated the water supply projects and the kinds of technologies used for water suppoy in the NSD. I also evaluated documents and records for the projects in order to establish how these factors directly or indirectly impacted the economic development of

the SD. The aim was to know the role/efforts by Benue state governments to provide potable water to enhance the economic development of people, communities and state at large.

**Necessity of Potable Water Supply for Community Development**

Water has an inalianable value to people and communities. Adequate safe water and sanitary services potentially guarantee good health and improved lives of people. To ensure that people and communities have access to sufficient and good quality of water can help bring about economic benefits as well as an increase in productivity and development (UNICEF & WHO, 2008;2010;2012). According to reports from UNICEF and WHO, water plays a variety of roles in the reduction of poverty. Opportunities for new businesses are created for local entrepreneurs to invest in water and sanitation services while government provides an environment for such initiatives (Okpe & Abu, 2009). This view is supported by the public health sector and there are substantial gains to be made through improvements in overall health. This money can be invested in other activities of economic growth and social change (Nkwocha & Egejuru, 2010). When individuals experience improvements in health, they can more meaningfully participate in economic activities including efforts towrds the development of their societies (WHO, 2008; 2012).

Water was the major theme of the WHO summit in 2001 and safe water was identified as the key to global health and the transformation of societies (Schuster-Wallace, Grover, Adeel, Confalonieri & Elliott, 2008). This theme was important because it emphasized that there were 884 million people who still lacked access to improved sources of drinking water—37% of whom live in Sub-Saharan Africa—and highlighted

the idea of alternatives and opportunities that could be explored aimed at promoting health and development through safe water supply. For rural farmers, access to adequate water can potentially bring about improvement in food productionand vegetables which may help improve their nutrition and health that are key to human and community development (UNICEF & WHO, 2008; 2010; 2012).

There are a variety of water sources, including oceans, rivers, springs, dams, wells and boreholes that meet the needs of individuals and communities as well as impact socioeconomic development. The protection of these water bodies is therefore important and necessary for the good of people and communities (Ishaku, Majid, Ajayi & Haruna, 2011). Many of these water sources, especially boreholes and hand-dug wells that are not securely covered and protected, can be vulnerable to contamination (Babanyara et al., 2010; Ishaku et al., 2011). As potable water availability, sanitary facilities, and good hygiene practices are among the most basic of human needs, they are more urgently needed for developing nations such as Nigeria and the NSD of Benue in particular (Dun & Derrington, 2010; Montgomery, Bertram & Elimelech, 2009). The provision of these amenities will not only improve health, they will also provide other benefits unrelated to health. The interplay of these benefits as a process for community development is discussed in the following sections.

## Water and Public Health

Access to safe water has a direct influence on human health, economic productivity, and quality of life of the people. Most significantly, the prevention of ill-health has direct links with the quality of water (UNICEF & WHO, 2008; 2012). Poor water quality can lead to outbreaks of water-borne diseases and may cause serious

epidemics (Ahuja, Kremer & Zwane, 2010; Ishaku et al., 2011). It is estimated that up to 10% of global sickness and disease are due to inadequate sanitation, polluted water, or the unavailability of potable water (Schuster-Wallace et al., 2008). Aside from these cause of public health, according to Hogo (2008), In rural areas of the developing nations, other issues associated with public health include water contamination due to people washing, bathing, defecating, and urinating in water sources such as rivers and streams.

These forms of contamination are further magnified by inadequate sewage facilities. In communities where sewage facilities are nonexistent, the water that runs from local bathrooms has no source into which it is drained (Herero et al., 2008). In many communities, sewage runs into stagnant water channels that serve as breeding sites for mosquitoes, creating further severe health risks in the form of insect-borne diseases such as malaria (Herero et al., 2008). For people to benefit from sanitary facilities, it is important that they must understand the connections between water, sanitation, and health (Mimrose et al., 2011).

According to researchers and reports from previous literature, most sources of water in Nigeria are poluted or contaminated, and as a result are unsafe for drinking or other domestic purposes without purification and fear of health consequences (Adepelumi, 2008; Akpata, Danfillo, Otoh & Mafeni, 2009; Dan'Azumi & Bichi, 2010; Edet, Nganje, Ukpon & Ekwere, 2011; Ibbi et al., 2012; Ifabiyi, 2008; Momodu & Anyakora, 2010; Nwajei et al., 2012; Ochieng et al., 2011).

## Water Pollution

A number of studies have shown that in developing nations such as Nigeria, water pollution occurs in diverse ways besides those mentioned above and include the effects of industrialization and urbanization, as well as air and soil from oil spills or other contaminants (Akinibile & Yusoff, 2011; Babanyara et al., 2010; Kapila Tharanga Rathnayaka & Wang, 2012). There is also a high percentage of untreated waste discharged into water bodies in urban and sub-urban areas (Ogwueleka, 2009; UNICEF & WHO, 2012). It is quite common for the rivers running out of the cities to carry along mixtures of contaminants from domestic and industrial waste laden with chemicals, heavy metals, and other pollutants that have an adverse impact on drinking water and agriculture as well as the physical environment (Babayemi & Dauda, 2009; Fasunwon, Olowofela, Akinyemi, Fasunwon & Akintokun, 2008).

For environments that are saturated with such contaminants, it is also easy for such contamination to be taken up by plants and fruits, which may lead to the poisoning of consumers of such produce (Omowaye & Audu, 2012). The industrial dust pollution from the Benue Cement Factory at Yandev in Gboko LG of Benue state as well as the Niger Delta which is home to most of the oil companies in Nigeria are classic examples of plants, soil and water becoming contaminated through airborne pollutants (Puyate & Rukeh, 2008). At the extreme receiving end of these water sources are the poor residents of the slums who, due to the lack of potable water utilize these contaminated water sources for domestic purposes and irrigation of crops such as fruits and vegetables (Omowaye et al., 2012).

The direct use of this kind of water without treatment as well as the consumption of these types of food could result to food contamination that could also lead to human health issues or even deaths (Babanyara et al., 2010). Under ground water sources such as hand-dug wells and boreholes located near these water sources and dumpsites are also contaminated due to the presence of heavy metals in the water, which can pose severe health hazards to residents and water consumers (Utsev et al., 2012). These environmental conditions have forced many residents to migrate to other places, villages, cities, towns or states that results to the loss of their means of subsistence.

In many countries of the Sub-Saharan Region including Nigeria as well as rural areas of the NSD of Benue, due to lack of potable water availability and alternative sources of safe water people in rural areas as well as in some towns depend on and utilize water collected directly from rivers and streams that offer no guarantee of safety without treatment (Akinbile & Yusoff, 2011). Utilizing a quantitative method that employed Perkins Elmer and Oak Brown (UK) atomic absorption spectrophotometer for water analysis, (Aremu et al., 2011) discovered the presence of manganese, chromium, selenium, arsenic, lead, zinc, calcium, iron, sodium, copper, and potassium and other contaminants were in significant quantities in the rivers Doma, Farinruwa, and Mada in Nasarawa state, Nigeria. The concentration of these contaminants was too high above the standards and limits required for domestic water by the WHO (Aremu et al., 2011).

River Challawa in Kano, Nigeria also receives the discharge of heavy metals from industrial effluents (Dan'Azuma & Bichi, 2010). Here too like in Nasarawa state, the residents utilize the river for a variety of purposes including, irrigation, fishing, and water supply. A qualitative case study was utilized to analyize water samples drawn from the

point of discharge into the river during the two seasons of the year, wet [September] and dry [May] to determine the presence of heavy metals (Dan'Azumi et al., 2010). The result revealed that the discharge of Cr, Cu, Pb, and Zn into the river during these seasons was substantially higher than the approved limit prescribed by the Federal Environmental Protection Agency of Nigeria (FEPA) and WHO for drinking and other domestic uses. A similar qualitative case study was carried out in a densely populated university town of Ago-Iwoye, south-western Nigeria (Fasunwon et al., 2008). 40% of well water samples were reported to be contaminated with coli form bacteria, and 20% were contaminated with salmonella as well as other toxic chemicals above the WHO standards potentially dangerous to health and life.

In Lagos, Nigeria which as a result of urban migrations is highly populated, a large percentage of the population depends on hand-dug wells as their source of drinking water that is of poor quality (Acey et al., 2011). In a qualitative assessment of the water quality (Adepelumi et al., 2008) found that there is deterioration of water quality in the coastal zones of Lekki Peninsula, Lagos due to saltwater infiltration into the freshwater aquifer. In Surulere area of Lagos too heavy metal contamination of groundwater was detected by the use of a qualitative case study of water samples (Momodu & Anayakora, 2010). The degree of water pollution is so high that wells and boreholes in Surulere area that were analyzed using atomic absorption spectrophotometer for their aluminum, cadmium, and lead content when compared with WHO standards, the results revealed that 97.96% of all samples contained one or more of the three heavy metals (Momodu et al., 2010). The fact that there were variations in concentration notwithstanding, the risk factors remained significant, given the toxic level of the metals (Momodu et al., 2010).

The reason for concern stems from the fact that hand-dug wells and boreholes are the only sources of water supply for the population in the environment.

Another qualitative method of assessment was employed about water pollution in Ibogun, Pakoto, and Ifo communities in Ogun state, Nigeria (Adelekan, 2010). The sample assessment was to check for odor, color, and taste and were analyzed for pH, total solids, total hardness, chlorides, sulphate, nitrates, magnesium, calcium, Manganese, sodium, copper, zinc, iron, and lead; total viable count, total coliform count, faecal coliform count, and faecal streptococci count (Adelekan et al., 2010). The results showed that while the other predictors' levels did not exceed the WHO guideline value of 0.2mg/I for Fe in drinking water, most of the pH values of the samples were significantly outside the recommended rage of 6.5 -8.5 for drinking water.

Two other qualitative studies were conducted by Ochieng et al. (2011) and Omezuruike, Damiloa, Adeola, Enobong & Olufunke (2008) about water from tap wells, stream, and wastewaters used for domestic purposes in Abeokuta and Ojota in Nigeria as well as the South-East LG area of Ibadan metropolis, Nigeria respectively. In both cases the closeness of the wells to pollution sources such as pit latrines and indiscriminate dumping of refuse as well as lack of cleanliness of the environment significantly resulted to the pollution of the wells that led to high levels of microbiological and physicochemical contamination (Ochieng et al., 2011; Omezuruike et al., 2008).

Due to the low level of education about waste water pollution in Nigeria, despite the efforts of international agencies' policy focus, water pollution in Nigeria, appears to be increasing, giving rise to implications and concerns for health and economic development (Babayemi et al., 2009). A qualitative method of study was used to assess

some species of fish: chryschthys nigrodigitatus, clarius anguillaris, and tilapia zilli from River Niger, Nigeria. Both species were found to be polluted with metals such as manganese, lead, cadmium, nickel, and copper detected by the use of atomic absorption spectrophotometer (Nwajei et al., 2011). The bioaccumulation of the metals exceeded the WHO standard for fishes that could have adverse health consequences to consumers.

It is worth noting that River Niger is the largest river in Nigeria, and flows through a number of states in the country. Apart from utilizing the river for a variety of economic ventures such as transportation, irrigation of crops and vegetables, a sizable number of people in those states depend on it for fishing as their primary source of income and livelihood (Nwajei et al., 2011). The direct impact of fish contamination is not more on the fish than it is on those farmers whose business is disrupted, and their source of revenue and livelihood abruptly grounded. Subsequently, this impact could also be on the overall development of families and the communities at large (Nwajei et al., 2011). In a good number of cases, the magnitude of river pollutions has greatly hampered the natural capacity for self-purification that was typical of these water sources several years ago.

## Loss of Capacity for Self-purification

An age long for freshwater streams and rivers self-purification has passed when industrialization and urbanization had not reached their current levels. Although pollution of those water bodies occurred several years back, they were different in kind and magnitude from the current forms (Ifabiyi et al., 2008). Back then, it was naturally easy for rivers, streams and other freshwater sources to undergo self-purification. In many countries, states, cities and rural communities of our time the concentration of sodium,

calcium, potassium, magnesium, phosphorous, and nitrate have grown too high for that self-purification of those sources of water to take place (Ifabiyi et al., 2008). A good example is a stream in Ile-Ife, Nigeria, that took its source from a large refuse dump in the central market (Ogbe market) that flowed into a dam. In utilizing a qualitative method of assessment the sediments in most cases were found to exceed both the natural self-purification of the water as well as the WHO standard permissible for drinking water (Ifabiyi et al., 2008).

Akpata et al. (2009) conducted a quantitative cross-sectional research to determine fluoride levels in drinking water sources in Nigeria. Drinking water sources from 109 randomly selected Local Government Areas (LGs) in the 6 Nigerian geo-political zones were used for study samples. The result of the study revealed that, even though in most parts of the country fluoride levels were low, in most of Nigeria's water sources the concentrations were excessive (Akpata et al., 2009). The study concluded that in communities where the levels of fluoride are high, the waters will need to be de-fluoridated, or such communities should be provided with alternative sources of drinking water (Akpata et al., 2009). What the researchers failed to show however was specifying those LGs with low and high fluoride levels and the geo-political zones in question where that attention is very crucial.

## Effects of Dump Sites

Many Nigerians have a sense of conviction that water from boreholes is safe for drinking and other domestic purposes even if untreated regardless of their locations. A qualitative assessment was conducted by Ogundiran and Afolabi (2008), about heavy metals and the physicochemical characteristics at different sites of municipal solid waste

dumpsites at Olusosun landfill in Lagos, Nigeria. Water samples were taken for analysis from three boreholes located at distances of 50m, 80m and 100m away from the dumpsite. The presence of contaminants such as Pb, Cd, and Zn as well as Cu and Cr were reported that could be risky to rivers, neighboring ground water, environment and people (Ogundiran et al., 2008). The distances notwithstanding, ground water pollution was discovered to have occurred with substantial levels of iron, nitrate, zinc, and Lead found in two of the boreholes (Ogundiran et al., 2008). The water was below the WHO standard for drinking and could have adverse health impacts on consumers if untreated.

The situation of municipal solid waste in a county such as Nigeria is further compounded by insufficient methods of collection and insufficient coverage of the collection system at different locations even within cities and towns (Ogwueleka et al., 2009). Other factors include the lack of institutional arrangement. Government and political leaders at all levels (federal, state and local) pay less attention to the solid waste and refuse dumps even at strategic areas quite unpleasant at sight. Although lack of attention and inaction is justified by insufficient financial resources, the problem hinges more on lack of good will for the common good of the citizens than resources. Due to the fact that there are no policies or regulations that governments too could foster, in a few number of cases where the mechanisms exist inflexible work schedules and standards complicate matters (Ogwueleka et al., 2009). These factors are worsened by lack of education about the environmental health risks associated with the solid wastes by the public as such; it is common in cities and towns to find streets covered with the wastes (Ogwueleka et al., 2009).

The reality remains that in places where the residents have no alternative sources of safe water supply they depend on water of this quality (Akinbile & Yusoff, 2011). In utilizing a qualitative method of water assessment, water quality from boreholes located near a landfill in Akure, Nigeria revealed the severity of dumpsite pollution on ground water by the physical, chemical and bacterial presence (Akinbile et al., 2011). Apparently, Nigerians' safety expectations about borehole water were proved to be misleading.

In a country like China as well as in other nations, population and rapid economic growth, including the rise in standards of living of communities are among the factors contributing to solid waste quantity generation. This assertion is confirmed by Minghua et al. (2009) from an analysis that was made about municipal solid waste generation and composition as well as a comprehensive review of its management in Pudong New Area, Shanghai, China. Utilizing a qualitative method of survey Al-Khatib, Monou, AbuZahra, Saheen, & Kassinos (2010) reported a similar problem in the Nablus district of Palestine. Conversely, increases in population growth and the development of cities at the current trend would mean that solid waste quantity generation too will continue to increase (Minghua et al., 2009).

To undertake studies to establish the relationship between the quality of water supplies, sanitation, and human health poses serious methodological challenges which lead to variations of results (McNamara & O'Hara, 2008 Tullos, 2008). Some of these constraints include political and institutional factors at the national and state levels, as well as lack of capacity building that often excludes district actors such as politicians and extension workers (Hien, Takano, Seino, Ohnishi & Nakamura2008). This fact

notwithstanding, enough evidence exists to support the conclusion that improved water quality and sanitation have a profound impact on human health and socioeconomicdevelopment.

## The Burden of Disease and Mortalities

As pointed out earlier, health issues associated with water quality and sanitation are the major challenge of the twenty first century that humanity is facing especially in developing countries (UNICEF & WHO, 2010; 2012). Poor water quality has a direct influence on out breaks of water-borne diseases such as malaria, guinea worm, schistosomiasis, trachoma, skin cancer, and diarrhea (UNICEF & WHO, 2012). Conversely, improvement of water supply quality, sanitation and good hygiene practices have direct health benefits by preventing such diseases and so reducing the high annual mortality rates resulting from those diseases (Adelekan, 2010; Akpata et al., 2009; Dan'Azumi et al., 2010; WHO, 2012).

Schwarzenbach et al. (2010) in an annual review identified a number of sources through which, for more than five decades persistent organic pollutants have affected water systems on a global level. Some of the pollutants that were said to have long term impacts on regional and local water pollution occurred from mining operations, as well as hazardous waste sites (Schwarzenbach et al., 2010). There were also some of the pollutants that were said to have short term impacts on regional or local scales. Such pollutions occurred from agro-chemicals, and sources of waste water. Kughur et al. (2012) made a similar confirmation about the effects of herbicides on crop production and the environment in Makurdi LG of Benue state, Nigeria.

It is not uncommon for annual statistics to vary on each of these variables from individual and group studies, as well as from country to country. It was estimated on a global level that lack of access to improved water and sanitations caused 1.6 million deaths per year, more than 99% were said to have occurred in the developing countries (Schwarzenbach et al., 2010). From these incidents, nine out of ten were reported to be children, and about 50% of childhood deaths were in Sub- Saharan Africa. Lack of safe water, sanitation, and poor hygiene accounted for 6.1% cases of health related deaths annually (Schwarzenbach et al., 2010). Apart from health and the mortality rates associated with the lack of potable water, sanitation and hygiene, these amenities have a direct impact on the reproductive health of people in Sub-Saharan Africa and can adversely impact the development and social change of a community or nation (Chudi et al., 2010; Inyang et al., 2009).

In countries of low-income and middle-income, cases of maternal and child under-nutrition are quite common, and have resulted to significant mortality rates and the burden of disease (Black et al., 2008; Black et al., 2010; O'Brien et al., 2009). Black et al. (2008) gave global estimates of wasted and retarded growth for children younger than 5 years to have resulted in 2.2 million deaths and about 21% of disability adjusted lifestyle (DALYs). There were also 0.6 million and 0.4 million deaths caused by deficiencies in Vitamin A and Zinc with a total of 9% cases of global childhood DALYs, while iron deficiency accounted from 115, 000 deaths globally. Other factors associated with poor nutrition caused about 35% of global child deaths and at least 11% of global burden of disease (Black et al., 2008).

In their systematic analysis of global, regional, and national causes of child mortality in 2008, Black et al. (2010) presented their findings with the following record: there was an estimated 8.795 million deaths in children younger than 5 years worldwide. Infectious disease causes accounted for 68%, (that is 5.970 million) globally of which pneumonia alone accounted from 18% (that is 1.575 million). Other causes that were not highly identified accounted for 1.046 million (that is 1.874), diarrhea 15% (that is 1.336, 0.822 million to 2.004 million), malaria 8% (that is 0.732 million, 0.601 million to 0.851) million globally (Black et al., 2010). The significant number of those deaths occurred in five countries: India, Nigeria, Democratic Republic of Congo, Pakistan, and China (Black et al., 2010).

Even though there is serious progress made towards the Millennium Development Goal 5, O'Brien et al. (2009) reported that there were about 14.5 million cases of pneumococcal disease with other uncertainty cases of 11.1-18.0 million cases globally. The disease was responsible for about 826,000 deaths (that is 582,000 – 926,000) among children between the ages of 1-59 months. Most of these episodes were reported to have occurred in ten African and Asian countries. According to Hill, You, Inoue & Oestergaard (2012) who conducted a similar study about child mortality, they reported that even though the annual numbers declined from 12.0 million to 7.6 million in 2010, nearly 21,000 children were still dying each day. The majority of these cases were associated with poor water, sanitation, and hygiene in Africa and Asian countries.

In developing countries such as Nigeria, there is close relationship between poor household sanitation and mortality rates. Utilizing a quantitative, cross-sectional method of survey, Ajao et al. (2011) found that lack of improved water supply, refuse disposal

systems, and the kinds of toilets used within households were the major sources of disease transmission resulting to death in some cases. The survey reports from National Bureau of Statistics showed that the number of deaths, especially for Benue, Imo, Jigawa, and Kano states were significantly associated with the condition of household sanitation (Ajao et al., 2011). There are sufficient reasons to conclude that interventions that improved water supply quality and sanitary facilities, and introduced modern waste disposal systems and efficient management practices would greatly reduce the rate of disease and death (Ajao et al., 2011).

## Common Water Related Diseases

Among all the water related diseases, aside from other sources and forms of water contamination are majorly environmental and have as their agent of transmission the malaria mosquito. The spread of the disease is common in communities where people live in unclean environments with features such as stagnant water channels that are fertile breeding sites for parasites and their vectors such as malaria, filarial, and trypanosomes, (Mazigo et al., 1010; Yirenya-Tawiah et al., 2011). The studies by Mazigo et al. (2010) focused on plasmodium falciparum-malaria, intestinal schistosomiasis; soil transmitted infections as well as other co-infections that were prevalent among school children in northwest Tanzania. Yirenya-Tawiah et al. (2011) in a similar study focused on school aged children from 30 rural communities of the Volta basin of Ghana confirmed the prevalence of schistosomiasis. In a WHO report conducted in 2006, cases of malaria for example were estimated to be 247 million and in another study in 2008, from 109 countries (45 in Africa) malaria was still endemic (Aregawi, Cibulskis, Otten, William & Dye, 2008). In Binh Phuoc, Vietnam, Abe et al. (2009) in their qualitative case study

reported that despite the introduction of a national malaria control program in 1992, the level of infections was still at 6.2%, with the highest rates among children between ages three to five years based on studies conducted in 2006 and 2008.

Statistics at the global and country level about the diseases, their magnitude and impacts vary considerably (Abe et al., 2009; Feachem, Phillips & Targett, 2009). Although it is true that a lot of countries have made appreciable efforts at combating the infections and spread of malaria, the challenges were yet to be overcome. In a qualitative case study Aregawi et al. (2008) presented their finding about the global clinical burden of malaria which showed that there were 451 million 95% cases of infection worldwide. The burden and frequency of the disease and the abundance of its mosquito vector can be reduced with improvements in the quality of water and in the environmental hygiene of households, and indeed those of entire communities, as essential measures (Aregawi, 2008).

People who drink contaminated water from open sources such as ponds and shallow wells are at high risk of becoming infected with guinea worm disease. The assertion was made based on a qualitative case study conducted by (Palaniappan et al., 2010). This view was supported by Hopkins, Richards, Tiben, Emerson & Withers (2008), based on a review of reports from previous endemic cases such as in Africa, Asia and Latin America. The physical damage or body deformation caused by the disease to those who suffer from it can be devastating. Victims are gradually rendered incapable of physical activities such as farming, physical labor, or even the ability to attend school (Palaniappan et al., 2010).

There were also evidences that epidemiological studies often find the level of schistosomiasis to be more prevalent among children of school-age than adults (Yirenya-Tawiah et al., 2011). Based on this assumption, adults are usually not the focus of such studies; hence school-aged children are mostly the main targets of control programs. A quantitative case study showed evidences about urinary schisotosomiasis among adults in the Volta Basin of Ghana as well as Nigeria with an overall prevalence rate of 46.5% among all the age groups (Njepuome et al., 2009; Yirenya-Tawiah et al., 2011). However there were variations in reports and data about the disease among researchers.

In a cross-sectional study conducted by (Mazigo et al., 2010), the disease was reported to be endemic in 76 countries of the world. However, out of 662 million people who were reported to be infected worldwide, 85% were reported to be from Africa. Another study showed that 160 million people in 74 countries suffer from the disease which was responsible for 200,000 deaths in Sub-Saharan Africa alone, (Palaniappan et al., 2010). Based on a quantitative meta-analysis it was concluded that the severity effects depends on the species of the worms or their mixture, duration of infection, the number of the worms, as well as the size and nutritional condition of the infested person (Hall, Hewitt, Tuffrey & Silva, 2008).

The disease is commonly associated with large dams constructed for irrigation projects that become ideal environments for the snails that serve as a vector for the parasites. Humans become infested when they come in contact with waters containing the cercaria stage of schistosomiasis parasite. Palaniappan et al. (2010) cited the example of the Sennar Dam in Sudan which led to the infection of a sizable portion of the population of those who lived nearby. Access to potable water and adequate sanitation could

potentially reduce the level of infection by not less than 77%. What this report highlighted is that while dams are man-made water resource development aimed at harnessing water for domestic, economic, and industrial needs and development (Kolawole et al., 2012), perspectives differ about an ideal size for such projects. Based on the negative impact just mentioned among other consequences, small dams that can be managed more efficiently seem preferable to large ones in order to reduce these severe effects.

Trachoma, another disease, was identified as the leading cause of blindness worldwide, but is most prevalent in the African Sub-Saharan region, and is associated with poor water quality (Hopkins et al., 2008). According to global reports, 1.2 billion people who live in endemic areas of the disease; 40.6 million had active trachoma, and 8.2 million had trichiasis (Mahande, Mazigo, & Kweka, 2012). In 2003 the WHO estimated that 84 million people were suffering from trachoma infections, and 7.6 million people were adversely impaired or blind. The WHO (2008) and Mariotti, Pascolini & Nussbaumer (2008), reported an estimated 5 million people within the African Sub-Saharan region who suffer from loss of sight, with 146 million severe cases worldwide. Improvements in sanitation would lead to a reduction of breeding sites for flies which can serve to spread the disease and ultimately, the over-all rate of infections may be reduced by 27% (Mariotti et al., 2008). Another measure was for children to be taught good hygiene practices such as washing their faces with clean water. There were evidences that if this approach or similar measures were taken, even if it did not entirely eradicate trachoma infections, it could at least reduce it significantly, with Mali as an example (Mahande et al., 2012).

Arsenic in water is known to be highly toxic, and once water is contaminated with it, it becomes unsafe for people to use for domestic purposes such as drinking, cooking, or bathing because it is said to lead to skin cancers, (Palaniappan et al., 2010). Research has shown that the degree of arsenic contamination varied in from place to place, and minimal levels of it could fall within the WHO standard guidelines for safe drinking water, it can pose hearth hazards beyond those limits (Palaniappan et al., 2010). Example of countries that have high levels of arsenic concentration in their water in some areas rendering it unsafe for domestic use without treatment included the regions of South East, and North West of China in Asia (Amani et al., 2008). Other countries included Central Australia, New Zealand, Northern Afghanistan, Northern Mali, and Zambia in Africa. These findings were based on a quantitative novel rule-based statistical procedure of about 20,000 data points around the world.

In a mixed method approach that was utilized to assess ground water quality by (Polizzotto et al., 2008), reports were made about arsenic contents in ground water in the south, and Southeast Asia where tens of millions of people drink water that contained high levels of it. The reports were cited with specific example of the Mekong River in Cambodia and other major deltas in Asia. These findings were supported from reports by (Buschmann et al., 2008), which was based on a qualitative survey that was conducted about groundwater used for drinking in other Mekong delta floodplains in southern Vietnam bordering Cambodia. From the survey, it was found that 37% of the wells that were studied had high levels of arsenic concentration that exceeded the WHO guidelines for drinking water (Buschmann et al., 2008).

According to researchers, of all the water-borne diseases, diarrhea is the most serious. In the developing nations more than 88% of diarrhea disease was reported to be caused by unsafe drinking water, poor or inadequate sanitation and hygiene (Fasunwon et al., 2008). In a study conducted that employed a quantitative method of survey (Kalulu, Hoko, Kumwenda & Mayo, 2012), although it was focused on 6 villages in Mulanje district of Malawi, the study showed that diarrhea alone accounted for about 1.8 million deaths every year in the Sub-Saharan Africa. While these remained the common causes of diarrhea, especially in the developing countries, another cause of diarrhea (bacterial diarrhea) which is a food-borne transmission was also detected (DuPont, 2009). In places such as rural Mexico, although with an increased knowledge about good practices of domestic hygiene among the population, transmission was reported to be high (Dewilde, Milman, Flores, Salmeron & Ray, 2008).

In a New York Times (January 1, 2008), it was reported that one fifth of all global deaths associated with diarrhea occur most commonly in three countries of Africa: Congo, Ethiopia, and Nigeria (Halperin, 2008). This view was argued to be oversimplified based on a qualitative randomized place-controlled study that was conducted by Madhi et al. (2010). According to the study, the presence of the disease was identified in other countries of Africa such as South Africa and Malawi. In South Africa, 3166 infants, 64.1% total; and in Malawi, 1773 infants, 35.9% total were enrolled for vaccine trials. Of all the trials, 9.7% of infants were reported to have adverse events of the disease even though mortality figures were not reported. According to the WHO (2008), the impact of diarrhea is severe on vulnerable communities with less access to portable water, and poor sanitation or a lack of hygiene. It has affected about 4 billion

people worldwide and leads to 1.5 million deaths annually, most of them children under 5 years of age. These numbers, according to the studies, could be reduced by 26% and the disease controlled if there were improvements in water supply quality, hygiene, and sanitation WHO (2008).

The objectives of rural communities' drinking water projects are to improve their water source and general wellbeing. In the United States in particular, controls or regulations were established under the Safe Drinking Water Act in 1974 that necessitated water treatment changes (Cupas, 2009). Also included in the Act were the disposal practices of chemicals and residential medications, especially in drinking water (Glassmeyer et al., 2009). This form of water contamination was however not confined to the United States as such practices were reported elsewhere. Across other nations, such as Canada, China, Germany, Israel, Italy, Netherlands, Spain, Sweden, Switzerland and the UK, pharmaceutical products were detected in streams, rivers, reservoirs, and lakes (Caliman & Gavrilescu, 2009). It is therefore possible to incur the risk of water-borne diseases arising from unfiltered surface and ground water sources when their safe quality is overconfidently presumed especially in developing nations where water treatment facilities are very critical.

While it may be true that the greatest beneficiaries of health improvements associated with water quality and sanitation are children who have no direct contribution to the labor force, there are great benefits to be derived nevertheless from their healthiness. The health and medical expenses incurred for services given or received can be saved when a population is healthy. Such financial resources spent on hospitals or health care centers, transportation, medications, doctors, nurses, and other health

professionals, as well as fighting disease eradication (for instance, expensive efforts to rid an area of cholera and guinea worm) could be diverted to meaningfully raising living standards and other developmental purposes.

**Release of Time for Women and Children**

The overall impact of water quality improvement on rural communities of the developing world, quite apart from people's health, might best be seen in the proportion of time and energy spent by women and children who bear most of the responsibility for collecting water (Crow & McPike, 2009; Segenu & Pelser, 2009; WHO, 2008). Lack of access to water often times does not include the use of latrines because this might require more water and hence the additional burden on water collectors WHO (2008). Women and children walk for long distances and hours to and from sources of water which, depending on the size of the family and its domestic consumption may require multiple trips (Pickering, & Davis, 2012). When this happens, not only is their time for the day wasted, but also they are physically exhausted beyond the point of reasonably engaging in other productive activities (Pickering et al., 2012; Segenu et al., 2009).

In rural communities, the lives of women, and their income generating opportunities are greatly impacted by the lack of water supply (Crow et al., 2009). When improvements in water supply are accompanied with opportunities for women to generate income through small gardening and other micro-economic activities, the time freed from water collection can be converted into income earning as well as greater opportunities for children to attend schools (Crow et al., 2009). The 2001 policy decision by the government of South Africa to provide basic water free to all the citizens is a good example (Muller, 2008). However, this policy decision was not only controversial to

many citizens; it was criticized on the bases of defects of exclusion and inclusion. These challenges notwithstanding, the program enhanced social equity as well as conservation, and environmental sustainability. The development accorded women the opportunity to grow vegetables, fruits, and grains for domestic consumption as well as other economic ventures (Segenu et al., 2009).

The path towards sustainable development and social change is the collective efforts and responsibility of all citizens (males and females). It is incumbent on all to participate in the economy, policy, and social change of society (Ukpore, 2009). An important strategy to achieving the objectives is by improving the role of women in sustainable development by educating the girl child. In doing so, women will be liberated from poverty, become more involved in politics, social, and the economy of the community, state or nation (Ivens, 2008). The time spent for water collection by women and children could be saved with portable water supplies made available to homes or established within short distances of homes (Davis, Crow & Miles, 2012). Hence time devoted to water collection is time shortage of women and children.

The burden becomes more when nearby sources of quality water decline. During the dry season and in arid regions when most springs and wells dry up, women and children can be forced to travel a full day in search of quality sources (Pickering et al., 2012; Segenu et al., 2009). For practical reasons, the distance and circumstances also have attendant health risks to women. Matinga (2008) cited an example of sexual violence about women in Cuntwini, South Africa where women were raped while conducting their daily activity of water gathering. Some victims were infected with HIV/AIDS virus by their attackers (Matinga, 2008). This situation, aside from the

economic losses as a result of the time spent in search of water, such victims had to spend extra money for medical treatment.

From a quantitative study that utilized simple random technique to select 120 respondents in Ogun state, Nigeria (Otufale & Coster, 2012) found that the majority of women involved in water collection expressed concerns that they felt tired after walking for long distances collecting water. There are benefits from improved access to safe water in more productive activities such as attending to farm, school, technical training, education and participating in community development meetings, tending children's health or relaxation (Sigenu et al., 2009). When there is outbreak of water-borne disease in which children and other family members are victims, women bear more of the responsibility of caring for them. The quality time spent on care giving is estimated to be higher than that spent in the search for and collection of water (Otufale et al., 2012). For poor women in developing countries, time saved from these tasks can be invested in income generating activities including animal husbandry, gardening, caring for children, preparation of food, and education. This would contribute to women's empowerment and promote gender equality (Otufale et al., 2012).

From a qualitative study that utilized a random selection of participants (Ukpore et al., 2009), it was reported that opportunities and the futures of millions of children, especially girls, are limited or destroyed due to lack of availability of quality water and sanitation due to several hours spent each day in search for clean water with limited time for school. It was argued further that naturally, at the end of several hours of round trips a day covering long distances collecting water the children are too tired to go to school, or their school hours were shortened (Ukpore et al., 2009). The impact of these programs on

the education of girls was evident in a country like Nigeria where the gross enrolment of boys was consistently reported to be higher than that of girls by 10% with a male-female ratio of 55.9%: 44.1% (Ukpore et al., 2009).

The provision of portable water at locations near homes is particularly important for girls as this would decrease water collection time, and encourage their primary school attendance and improve an overall attendance. Their education will guarantee a bright future for them as well as an improved social standing and status. In the absence of any public interventions, Fatab, Hasnain & Iqbal (2012) proposed rooftop rain water harvesting as a good alternative measure. Apart from this timeline, lack of a potable water supply and sanitary facilities at schools significantly impacts on children of all ages especially girls' school attendance because of the discomfort of using open spaces to defecate during their hours at school (Gunhu, Mugweni & Dhlomo, 2011). For the developing nations, what all of these indicate is that the time saved from water collection is important for the development of women, for preserving their personal integrity, and for improving life in rural communities; for the time saved affords women opportunities to participate in community development programs such as health care meetings and other productive activities that can contribute to the economy (Davis et al., 2012; Sigenu et al., 2009).

## The Role of Women in Economic Improvement

Around the world, the contribution of women to economic growth and development is becoming increasingly recognized (Akyeampong & Fofack, 2012). The researchers examined the challenges faced especially by Sub-Saharan African women in contributing to economic growth and development from the pre-colonial and colonial

periods. With a special sense of urgency in developing countries, the needs of low-income women have become a global concern (Bano, Faridi & Bashir, 2010; Sani & Danwanka, 2011). Faridi (2011) affirmed this assertion with reference to the rural women in Pakistan who were not permitted to work outside apart from the fact that their hourly wages were low.

To underestimate the level to which the productive and economic contribution of women can change both their lives, those of their families and communities could be a mistaken assumption (Akyeampong et al., 2012). The economic growth of communities, states and nations ultimately leads to better standards of living. For Bano et al. (2010) and Sani & Danwaka (2011), the economic activities undertaken by rural women in Pakistan and Kogi state, Nigeria respectively improved their household income as well as that of the societies. According to Sanusi et al. (2012), labor and capital were recognized as fundamental determinants of economic growth by early theories of economic growth. Although earlier growth models did not give human capital its deserved prominence, it is increasingly considered an inalienable tool for driving economic growth in the twenty first century.

In the 21st century and beyond, no matter the forms and levels of innovations to technology that are aimed at development, their efficiency depends on human capital (Sanusi, et al., 2012). Women in business are increasingly seeing as a formidable force in economic growth, and transforming the environment despite their constraints associated with resources (Lincoln, 2011). Women's contribution has indeed, gone beyond the economic sphere to include a wider process of social transformation. Although the contribution of women to economic development has grown high, researchers identified a

number of barriers or constraints impacting the realization of their economic potential (Budlender, 2010; Lincoln et al., 2011; Olarenwaju & Olabisi, 2012; Ross, 2008).

Some of these constraints among others included the inferior status of women in many African societies, the Middle East as well as in other developing nations, their underestimation as agents of economic growth, as well as gender bias that is rooted in their religious, cultural or tribal norms (Lincoln et al., 2011; Ross et al., 2008; Sanusi et al., 2012). Other constraints include limited access to finance, and such resources as land, and credits, as well as the lack of collateral for external sources of finance (Lincoln et al., 2011; Olarenwaju et al., 2012; Sanusi et al., 2012). In a number of cases, the major constraint of women was time allocation and use. These constraints together tend to lower the productivity of women. Their contribution to economic growth and development would be more substantial in the absence of these, and those that are domestic in setting (Lincoln et al., 2011).

Although women in developing countries are more directly affected by water issues, they are typically excluded from the opinion seeking process (Ivens, 2008). In most of the communities targeted for water supply projects, those involved in decision making (whether at the level of government, agency position, or local community leaders) are predominantly men who in most cases communicate more with other men than with women (Ivens et al., 2008). Out of 88 communities in 15 countries, and a desk study of 121 World Bank-financed projects, it was evident that for community water projects to be effective, they essentially required the involvement of women (Ivens et al., 2008). Their involvement could go beyond lip-service as was reported of women in the highlands of Western Kenya (Ivens et al., 2008).

The involvement and improved access to water can promote the economic activities of women. In a survey of 230 women in Kaduna state, Nigeria, Babanyara et al. (2010) found that, although Kaduna state had a sizable population of farmers only 24% of women were involved in farming decisions and only 11% of women had access to such resources as credit, land, equipment, seeds, fertilizer, transportation and storage facilities, and other resources. Their participation, apart from small-scale cash-crop production, nevertheless brought about increases in vegetables which led to improvements in nutrition and income. Such productive activities substantially augmented the incomes of households and reduced the stress of the over-dependence of wives on their spouses (Babanyara at el., 2010).

The women soap making agri-business enterprises and family sustenance in Dekina local government area of Kogi state, Nigeria, was also another example of women's gainful economic ventures that contributed to the overall economic improvement of the state (Sani et al., 2011). Based on the fact that those women had time released to them from the burden of water collection, they engaged in agri-business of soap making. Their net income improved the overall income generation and also led to an improved quality of life and welfare for women as well as the sustainability of their families (Sani et al., 2011). Yoruba women textile traders in Balogun market, Lagos-South West, Nigeria, were successful in contributing to the local and state economy (Olarenwaju et al., 2012). There was a similar report made about illiterate women farmers in Ogun state, Nigeria who despite the fact that they were illiterate nonetheless used their vast knowledge of traditional medicine and food production for economic improvement (Olatokun & Ayanbode, 2008).

In Uganda, the Katoki Women Development Trust, whose initiatives as an NGO trained 22 women as masons for the "ferro cement" tank design and construction in effort to improve the income of its members, affirmed the assertion just discussed, (Payne, Nakato & Nabalango, 2008). The results were that the skills these women acquired had not only broken down the social barriers that existed, but doubled the income of members, many of whom were the primary providers for their households (Payne et al., 2008). Their increased income was of great assistance to their families in paying for tuitions, food, and construction of home projects, among other development activities (Payne et al., 2008). Researchers were of the opinion that, if the major constraints of rural women in developing countries especially, lack of access to credits and finance were removed, women, just like their male counterparts will significantly contribute to the economy of their households, communities, states, and nations (Akyeampong & Fofack, 2012; Bano et al., 2010; Egyir, 2010; Faridi, 2011; Olarenwaju et al., 2012). The researchers made this assertion in reference to Pakistan, Nigeria, and Ghana respectively.

In a country such as Bangladesh where micro-credit programs were developed by the Bangladeshi governments and non-government organization, rural women borrowed from these financial institutions Afrin, Islam & Ahmed (2008). These programs were aimed at enhancing the income-earning potentials of rural women and empower them economically and socially. Women who borrowed money from these programs engaged in a variety of economic ventures such as paddy husking, pond aquaculture, petty trading, poultry farming, animal husbandry, dairy farming, planting nursery, weaving, handicrafts, and mini-garments (Afrin et al., 2008). What was discovered from the research is that aside from empowerment and increased productivity, their produce

increased nutritional and health status as well as improved housing condition. Most significantly, these programs contributed immensely to the socioeconomic development of the rural women as well as their communities (Afrin at al., 2008).

**Enhanced Community Development**

Water resources have to be developed in such a way that they meet the objectives of quality and quantity to support socioeconomic activities that will enhance human welfare (Ibbi, 2012). This requires that people be well informed about the plan for water projects or sanitary facilities. In this way they will have the opportunity to consider the benefits and advantages of development associated with such programs when compared with the cost, effects, and consequences of some water related diseases (Ademiluyi & Odugbesan, 2008). The results of team work and participation will enhance and sustain the projects as well as the community. These approaches are important especially for rural societies of developing nations where the problems are very acute.

As much as it could be argued that water supply and sanitary facilities have implications for the development of communities, such programs may not achieve their desired goals without the integral involvement of key stakeholders in the planning process, construction, implementation, and maintenance, as well as their financial participation (Kalulu et al., 2012). It will be hard for programs implemented for the good and development of communities, and for communities to succeed and be strengthened, without an effective collaboration with stakeholders in such initiatives, (Ademiluyi et al., 2008; Castro & Heller, 2009; Were et al., 2008). To achieve this goal, it is important for decision makers or agency donors to work closely in partnership with members of benefiting communities. The advantage of this approach is that it makes it easier for both

entities to understand better what the community's real needs and priorities are so as to develop appropriate projects that can be well managed and sustained locally (Ademiluyi et al., 2008). This assertion was confirmed based on a cross-examination of theory and practice from the experiences in rural Malawi where it was discovered how indispensable the local needs, aspirations, and local resource mobilization as well as local participation was to community development (Jimu, 2008).

In a study "localizing the strategy for achieving rural water supply and sanitation", Nwankwoala (2011) reported that demands for community water supply and sanitation are generally local demands. It is therefore important that management decisions about the location of facilities, level of service as well as cost sharing should also be made locally even if not totally (Nwankwoala et al., 2011). This approach is necessary because as rightly pointed out by Jimu et al., (2008), even though local participation in projects is ideal, it is however not a magic pill for rural community development, especially when projects are implemented under coercive rule. A similar perspective was expressed by Montgomery, Bartram & Elimelech (2009), who apart from effective community demand also added: local financing and cost recovery, and dynamic operation and maintenance as essential components. The presence of these components can lead to long-term functioning of water and sanitation. However, their lack can greatly undermine sustainability, development and social change (Montgomery et al., 2009).

To strengthen water, sanitation, and hygiene especially in schools, Mooijman, Snel, Ganguly & Shordt (2010) discussed about other components seen to be essential. One among these was an integrated approach or intersectoral cooperation. This approach requires reaching out to diverse networks with a view to forming partnerships on

international, national as well as local organizations and communities (Mooijman et al., 2010; Reed, 2008). The contribution of the diverse networks will be beneficial to all the participating teams and enhance what could be practically implemented in individual localities (Mooijman et al., 2010; Reed et al., 2008). It was further stressed that these interventions are considered a priority because improved hygiene practices and descent school environment can contribute to children enjoying worthy health standards. In the long run, these will empower communities to see improved hygiene and sanitation as a matter of dignity, and health that will enhance their wellbeing and development (Mooijman et al., 2010).

Another example of enhanced community development project was in agricultural extension and rural roads investment in fifteen Ethiopian villages (Dercon et al., 2008). In most parts of developing nations, the burdens on mostly women and children of water collection from sources that are long distances from their homes is compounded by the lack of good roads to both, those water sources and local markets (Dercon et al., 2008). Under this condition in typical agricultural settings, farmers experience intense hardship transporting water from distant sources to irrigate their small farms and backyard gardens. They must go through the same experience at harvest time to take their farm produce to available markets.

It was further argued that lack of roads and transportation to the markets further impacts farmers because produce such as fruits, vegetables and other crops cannot be well preserved for long periods of time, especially in countries or places with hot weather conditions (Dercon et al., 2008). As a result, produce was easily destroyed in homes leading to huge economic losses for already impoverished individuals and families.

People who are enthusiastic about rural roads claim that such projects can reduce transaction costs associated with agricultural activities as well as bring about significant social benefits based not only on easy transportation of products, but also their potential to induce local market development in places where these conditions had initially prevailed (Dercon et al., 2008).

## Environmental Implications

Water is critically vital to the livelihood of more than 1 billion people who cannot afford to live on more than $1 a day. It is a major factor impacting agricultural output, and the income of the rural poor communities of the world (Namara et al., 2010). Over time, where water projects are established, their use for irrigation and other agriculture purposes has increased and greatly benefited the poor and farmers. Improved access to reliable water can contribute to productivity; enhance non-farm products, sustained consumption, employment opportunities, and income, as well as economic development (Ajayi, et al., 2008). Aside from these positive contributions, there are however situations where agriculture has impacted water quality and the environment as well as both water and agriculture does negatively contribute to societal equity, nutrition status, health and environment (Siegford et al., 2008).

Despite the fact that water supply and sanitation programs are important and have positive impacts on the progress of developing nations, studies conducted in different parts of the world have shown that negative environmental impacts may also occur that potentially hamper community efforts and developments (Akinbile et al., 2011; Babanyara et al., 2010; Mahmoodi et al., 2008). In today's society, health problems associated with environmental hazards are increasing and becoming quite visible due to

the rapid changing environment, population growth, international migration, overcrowding, growing industrialization, and uncontrolled pollution from sources such as anthropogenic as well as other natural sources (Acey et al., 2011; Hogo et al., 2008; Omamogbe et al., 2010; Prowse et al., 2009).

## The Impact of Climate Change

Human activities for the purposes of growth and development coupled with climate change have profound effects on cultivated land, streams, lakes and other water bodies and the environment (WHO, 2008). The impact is profound in particular to developing countries such as Nigeria and the NSD of Benue where agriculture is the driver of rural, state, and in some places, national economy (Wei et al., 2009). Northern Canada is an example (Prowse et al., 2009) where economic activities aimed at development such as oil and gas development have undergone rapid expansion in recent years that have significant implications on climate change. The potential for these activities expanding further has posed concerns for other economic sub-sectors such as hydroelectric, infrastructure, transportation, both marine and freshwater; hence the necessity to adopt strategic measures to control the impacts (Prowse et al., 2009).

Awareness is developing slowly in most countries of the developing world about the impact and consequences of poor management of the environment on socioeconomic development (Babayemi et al., 2009). Some studies have been conducted about the rate at which Lake Chad which is shared by five countries: Cameroon, Chad, the Central African Republic, Nigeria, and Niger is fast drying up as a result of environmental degradation (Kolawole et al., 2012; Onuoha, 2010). It has been a vital source of economic livelihood for millions of people inhabiting its catchment areas in these states.

Aside from the fact that the lake is in a hot and arid climate where the rate of evaporation is observed to exceed precipitation, a lot of gainful economic activities such as irrigation and construction of dams with an extensive use of the lakes water are resulting into massive diminishing in the volume of water (Kolawole et al., 2012; Onuoha, 2010). This observation was made based on satellite images that revealed the lake has substantially diminished to about 3% of its area size as at 1963. For the local inhabitants: fishermen, farmers, pastoralists who depend on it as their source of livelihood, the diminishing of the water volume has become a source of tension as well as between state security agents. Those tensions grow sometimes to the potential of degenerating into large scale intra-ethnic, intra-state, and interstate conflicts (Kolawole et al., 2012; Onuoha et al., 2010).

The effect of seasons on the quality of water is also under those circumstances affecting the abundance of fish and the environment in other places (Offem et al., 2011). The case about Ikwori Lake in the South-Eastern Nigeria has added the perspective to understanding further the case of Lake Chad mentioned above. Water samples were collected from the lake during the dry and wet seasons for two years (January 2008 to December 2009). All the parameters of water that were measured showed substantial seasonal variations. It was concluded that seasons have great influence not only in the management of water quality; it also affects the production of fish, standard of living, and development for fishermen who depend on the lake for their livelihood (Offem et al., 2011).

In a journal article that was focused on the integrated water resource management for rural development and environmental protection in Afghanistan, Mahmoodi et al. (2008) discussed about some challenges faced by developing nations such as

Afghanistan. According to the researcher, although the country is reasonably rich in water resources and land, prolonged periods of draught have led to many challenges (Mahmoodi et al., 2008). It was reported further that aside from these conditions, human factors such as poor managerial coordination in the water sector, lack of information, data planning, insufficient information especially to stakeholders, and the destruction of "local traditional institutions" have worsened the situation (Mahmoodi et al., 2008). As a result of these factors, irrigated land in Afghanistan which as at 1980 was about 3.3 million hectares, was reported to have been reduced to only about 1.8 million hectares; a development which has affected both the economy and development (Mahmoodi et al., 2008).

As these concerns are growing so are studies growing towards a better understanding about the impacts of climate change to our environment and humanity, today and the future. Climate changes are found to have implications also for nitrogen retention, ecological state of lakes and adaption (Jappesen et al., 2011). Increased farming and the production of livestock in many parts of Western Europe including Denmark has led to substantial losses of nitrogen from agriculture (Jappesen et al., 2011). This has not only resulted in surface water contamination, it also has adverse environmental impacts. In a related development, even though hydropower is seen to be environmentally preferable to nuclear power because it is clean and renewable, it was however discovered to transform the ecosystems of rivers and altering their flow (Renofalt, Jansson & Nilsson, 2009).

## Population Growth and Migration

Literature discussions about forced migration commonly focuses on factors such as hunger, war, violation of human rights and poverty (Afifi et al., 2008). Based on recent developments and episodes, concerns are raised with a call about the inclusion of environmental degradation such as lack of water, soil degradation, environmental hazards and other factors that are also contributing to forced migration (Afifi et al., 2008). Hugo et al. (2008) introduced another dimension about population growth and migration. This was focused on the factors that contribute to serious impacts on development and the environment. Population growth accounts for among other factors to the loss of agricultural land and competing demands for water in many countries, states and rural communities (Hugo et al., 2008; Waziri & Ogugbuaja, 2010). The NSD of Benue state where the communities are typically agricultural in setting provides a good background for a deeper understanding of the challenges associated with these resources, the environment, economic development and social change as a result of population growth (Wei et al., 2009). The lack in these resources leads individuals or groups to migrate to places where the resources could be more accessible.

Raleigh et al. (2010) reported that apart from the natural factors mentioned above, increases in the frequency and chronic environmental hazards as well as sudden disasters are going to alter the common migration patterns of communities, and in some situations, those of entire countries. There are however some forms of migration such as labor migration from rural to urban areas that the researchers argued are a common segment of diversified local economies (Raleigh et al., 2010). It was however not easy to ascertain if the youth of the NSD of Benue could be associated with this form of migration. What

was obvious is that it puts further strain on a number of social infrastructures such as water supply and sanitary facilities that have implications for the environment (Hugo et al., 2008; Jonsson, 2010).

There is what Hugo et al. (2008) described as a "multidirectional relationship between migration factors and development". In regions and countries such as Nigeria and other developing countries where populations have continued to grow, it is easier to understand the social, economic, and environmental implications (WHO, 2008), and how these factors and growing populations have motivated migrations. These trends have linkages with economic development and social change (Emch et al., 2010; Hugo et al., 2008). This situation has interconnections with Omamegbe's phenomenon of migration and "brain drain" (2010). According to this theory, it is the absence of basic social amenities in most countries of the Sub- Saharan Region that motivate Africa's youth to migrate to the United States of America in search of greener pastures (Omamegbe et al., 2010).

Besides migrations that are induced by population growth and lack of basic social amenities, there are migrations that are caused by environmental hazards or environmental migration just mentioned above (Raleigh et al., 2010). As mentioned, they are caused by environmental disasters, that caused by environmental degradation, that which is caused by climate change, and forced movement caused by large scale projects (Hugo et al., 2008; Raleigh et al., 2010). These and other forms of migrations are noted to have occurred mostly from south-north, and so do the effects due to those population movements (Hugo et al., 2008). While it is possible for disasters to differ significantly in their potential to induce migration, there are some disasters that can lead to distress

migration (Jonsson et al., 2010). These include sudden disasters or chronic disasters such as drought or famine, floods and slides, cyclones, hurricanes, and waves. Others include extreme temperatures; rising sea levels, environmental degradation such as prolonged oil spills, as well as land degradation (Jonsson et al., 2010; Raleigh et al., 2010).

Afifi et al. (2008) discussed some cases where sudden natural hazards have forced migration in large numbers such as the 2004 tsunami in the Indian Ocean or the 2005 devastation of Hurricane Katrina on the New Orleans area of the United States. It was estimated that about 1.5 million people fled the New Orleans area, and only about 500,000 who were reported to have returned (Afifi et al., 2008). It was however argued that the linkages between these disasters and migration depend on the magnitude of the disasters hence in less severe events, only a few people actually flee (Afifi et al., 2008; Perch-Nielsen et al., 2008). Closely associated with these factors is the vulnerability of the people and the region where they occur, and if worsening environmental conditions can compromise their livelihoods especially in developing countries, people flee in less dramatic events (Afifi et al., 2008; Perch-Nielsen et al., 2008).

Why it may be true that there are inter-connections between these forms of migration and the factors that facilitate them, those factors may as well have inter-connection to yet another cause for migration for example the skilled labor force of the youth of African nations to the United States of America in search for green pastures (Omamegbe et al., 2010). This kind of migration and the factors that motivate it are either the same or similar to some migrations that are rather local or national, such as the one by the teaming youth of the NSD from rural communities and villages to cities and towns in search for a better life of comfort (Hugo et al., 2008).

The striking difference however between these local migrations and that by the youth of African countries to the United States of America is that the latter come with skills through which they contribute to the productivity, economy, growth, and development of the American society (Omamegbe et al., 2010). The rural youth of Benue, in a large percentage have no sound education and are lacking in skills. On the bases of these limitations, they have nothing to offer beneficial to their host cities and towns (Omamegbe et al., 2010). If anything at all, what they contribute is rather negative by increasing their demands on some of the basic amenities and infrastructures that are already epileptic.

Large projects' developments are other factors that also induce forced migration (Tilt, Braun & He, 2008). The researchers cited the example of large dam projects that displaced the communities in the Lesotho High-lands' water project in South Africa, and the Manwam dam project on the upper Mekong River in southwestern China. The residents of those communities were however not involved, not prepared and not re-located by their governments (Tilt et al., 2008). Conversely, due to the abrupt changes brought about in the relation to their environment and its resource base, the rural economy of the residents was impacted as a result of these projects (Tilt et al., 2008). Other significant impacts included the disruption to households' means of livelihood, losing potable water sources such as natural springs; they also experienced reduced access to important food and medicinal resources such as wild vegetables and herbs as well as loss of arable land and their river basins (Tilt et al., 2008).

The negative impact of rural settlements on natural resources in areas that are suddenly declared reserved such as those associated with Kovada Lake national part in

Turkey highlighted the perspective about forced movement caused by large scale projects (Alkan, 2009). According to the report, the policies of the Turkish government that designated 33 areas as nature conservation areas, 104 nature monument areas, and 33 national parks were received with animosity by the residents (Alkan et al., 2009). With reference to the Kovada Lake and its surrounding in particular that were declared as Kovada lake national park, the local people were not involved in the planning processes during their first and second long term development plan (Alkan et al., 2009).

Technically, the exclusion of the local people meant they were not compensated for their forced displacement of a natural resource that had been their source of livelihood for decades (Tilt et al., 2008). Although it may be true that such protected areas not only protect biodiversity and improve the health of people, they are expected to yield economic benefits for the local people (Tilt et al., 2008). Due to the manner the process was handled, the people were reported to have continued to exploit the natural resource for their gainful activities such as firewood, cooking, warming, and grazing land for their livestock, as well as timber for shelter and other non-forest products (Alkan et al., 2009).

## Growing Industrialization and Over Crowding

It could very well be argued that these forms of migration discussed above have connections to what (Acey et al., 2011) described in a research journal as the growing industrialization that have led to overcrowding of towns and cities. In a good number of cases there are mutual tradeoffs between the host nations, cities and towns and the emigrants such as the African Sub-Saharan youth to the United States of America mentioned earlier (Omamogbe et al., 2010). There are also cases where there are no tradeoffs at all especially when the emigrants have no contribution to make to their host

nations, towns or cities such as the teaming youth of the NSD. In this case whether there are mutual tradeoffs or not one thing remains.

There are both health and environmental hazards associated with population movement that has also led to the scarcity of those existing resources (Babanyara et al., 2010). In most countries, towns and cities are designed in consideration to their carrying capacity, and how adequately their facilities would serve the needs of the residents. There are also places where these logistics were not taken into consideration. The result is that the overcrowding of those towns and cities today has led to higher demands than the facilities and resources can meet (Babanyara et al., 2010). As a consequence, those at the disadvantaged level are the poor who are exposed to many conditions associated with health risks and environmental impacts (Ogundiran & Afolabi, 2008).

One among the major challenges associated with the growing populations in towns and cities is inadequate food supply. In a study, investing in water for food, ecosystems, and livelihoods undertaken as a comprehensive assessment of water management in agriculture Fraiture et al. (2010), concluded that there are sufficient water resources to produce enough food for the growing population. However, there are also concerns that if the trends in production, consumption, and environmental patterns continue; many parts of the world will face water crises as well as severe food shortages (Fraiture et al., 2010).

There are certain factors that make today's challenges even more crucial. The researchers pointed out today's differences from those of 50 years ago when the world experienced similar pressure on food supply and food prices in the 1960s and 1970s. The size of the population today is larger than it was 50 years ago (Fraiture et al., 2010).

Apart from this demographic difference, the number of people living in poverty today has grown higher than in the 1960s and 1970s. In close relation to this is the fact that the costs of agricultural imputes is higher today than in the past, hence the cost increase in producing food and the cost increase in sales (Fraiture et al., 2010).

Based on these fundamental issues, a poultry science article written by Siegford et al. (2008) focused on environmental aspects of ethical animal production. The topic requires a separate research and it is not the intent of this researcher to discuss it here at length. Animals, like other genetically grown food products are aimed at meeting market demands and the growing population (Siegford et al., 2008). According to the researchers, livestock and poultry producers are constantly challenged by the public to be good stewards of the environment and to employ welfare practices that are more humane to the animals they produce (Siegford et al., 2008). It is the general notion of consumers that large scale animal production systems are closely linked to environmental degradation and poor animal welfare.

The result of the study revealed as a matter of fact that the concerns of customers were legitimate. During grazing there are nutrients that are released on pastures that can result in stream and surface water contamination (Siegford et al., 2008). The outdoor production of pigs is particularly associated with nutrients leaching into the soil and contaminating ground water. Apart from these, the housing of hoop that are used as alternative to crates can also increase the risk of nutrients leaching into the soil causing groundwater contamination as well as release into the air by animal production systems. These forms of animal production can create toxic odors that pollute the air quality for people within such neighborhoods (Siegford et al., 2008). What has become a challenge

as a result of this process is how to avert the increasing health and environmental implications and ensure access to safe water supply.

## Uncontrolled Pollution

From the preceding sections, it has been uncovered that population growth and its movement of any kind to the receiving nations, cities and towns whether with or without basic skills or knowledge that will bring about mutual exchanges or not have interconnections with overcrowding of cities and towns (Acey et al., 2011). This may not essentially be induced by growing industrialization which in some places remains a factor. The cumulative impact from all of these is the level of uncontrolled pollution that occurs especially in developing countries where cities and towns are poorly planned with few or no sanitary facilities, drainages and waste disposal mechanisms (Acey et al., 2011).

Water and waste management that are potential sources of environmental hazards are a huge challenge in Nigeria and other developing countries. The consequences of these hazards are felt more by children whose immune systems are not developed as those of adults to be able to tolerate the health effects (Neira et al., 2008). With particular attention to Nigeria, Ibbi et al. (2012) discovered that the quantity and generation rate of solid waste has increased in Nigeria as well as in other developing nations. As stated in a previous section, this situation is due to lack of efficient and modern waste management technologies as well as ineffective legal systems and the lack of policy. The challenge Nigeria and other nations are facing is how to integrate environmental protection regulations into policies and development programs (Dupont, 2009; Mahmoodi et al., 2008; Namara et al., 2010; Onuoha et al., 2010).

In a journal of environmental management focused on rural industries and water pollution in China, Wang, Webber, Finlayson & Barnett (2008) discussed the fact that even though China has tough environmental laws, they were not effectively implemented especially in rural areas. Due to this legal weakness, in a qualitative survey it was reported that over half of the river sections were found to be polluted by small rural industries (Wang et al., 2008). Heavy metals' concentrations of surface dust from e-waste recycling were also detected in Southeast China that was of environmental and human health implications. Guiyu village which was selected as the study site was reported to be famous for the recycling of printed circuit boards and e-waste processing that presented environmental and human health risks (Leung et al., 2008). Surface dust was collected from recycling workshops, adjacent roads, a school yard, and an outdoor food market. Metal concentrations and pollutions were reported to be high at the food market and the school yard which posed health risks to workers and local residents of the village (Leung et al., 2008).

In Cerro Rico de Potosi, Bolivia where silver, Ag, Sn, and Zn ores are heavily mined and processed (Strosnider, Llanos & Nairn, 2008), using a qualitative survey, streams that receive their drainage from the slopes of the mining area and surroundings were sampled during the wet and dry seasons (March, and July –August) respectively. The study revealed that not only were the water bodies "degraded than class D" standard of Bolivia for receiving water bodies, they were unsafe for agriculture and domestic use. Aside from the health concerns, these resources became a source of health and environmental hazards (Strosnider et al., 2008).

In a journal of biochemistry, Peralta-Videa et al. (2009) focused on the biochemistry of environmental heavy metal uptake by plants and its implications for the food chain. According to the study, while some of the elements plants absorb from the soil are known to have biological functions in the body, some are however toxic and could be dangerous when consumed from those plants (Peralta-Videa et al., 2009). The study also found that toxic elements such as arsenic absorbed in other crops such as rice can cause cancer of the bladder, lung, and skin if such contaminated rice is consumed. Another toxic, cadmium can be consumed from rice or vegetables when the products are laden with it and can also cause cancer (Peralta-Videa et al., 2009). Without environmental protection regulations or policies that can slow down the magnitude of pollution, it is the same factors that accelerate economic growth and social change that will cause water and environmental pollution from industries to remain such a serious problem to developing nations (Leung et al., 2008; Peralta-Videa et al., 2009).

**Rural Development and Environmental Implications**

In some places, as much as water projects have contributed positively to changing environment by making the land green with gardens and plants, these can also create the problem of the need to constantly clean not only the garden beds, but also the compost debris surrounding households and communities (Dounias, 2010). Although this trend is most typical of developing nations, it could also happen in developed nations. For example, in a survey concerning land use, (Creasy, 2010) cited an example of Americans across the nation who waste or even pollute millions of acres of valuable agricultural soil around their homes.

In some Canadian provinces where upstream agricultural activities contaminate water, as a means to curb pollution and improve water quality, a cost sharing program was introduced (Dupont et al., 2009). According to the scheme, farmers who of their own and without regulations undertake actions that safeguard non-point of water source pollution were given an incentive or reimbursed for out-of-pocket expenses if any incurred associated with best management practices that reduced the pollution of water sources (Dupont et al., 2009). This initiative was confirmed as welcome development in the report from the WHO that those community incentives could be expanded to include private actions and behaviors consciously carried out at the household level associated with sanitation and hygiene for the good of the public (WHO, 2008).

There are several cases and examples where dams, lakes, and reservoirs constructed for agriculture and domestic purposes have over flowed as a result of heavy rain or the discharge of high volumes of water from other channels into those bodies (Babanyara et al., 2010). According to Babayemi & Dauda (2009), flooding for example in Lagos, Nigeria was due to clogging of drainage channels by dumped solid waste. In some cases both in Nigeria and other places, some flooding have also created erosion problems leading to environmental challenges, especially when roads are washed away (Babayemi et al., 2009). According to Nwilo, Olayinka & Adzandeh (2012), apart from erosion, other consequences of such flooding are often severe and result in devastating destruction of property and loss of lives.

Major floods have washed away hundreds of acres of farms, destroyed thousands of homes, and drowned hundreds of thousands of people around the globe. Apart from these consequences, disasters of this kind have always caused environmental pollution,

ecological destruction, or created health risks to communities and at times, surrounding districts (Jonsson et al., 2010; Nwilo et al., 2012). In this way, rather than serve the good objectives for which such programs were implemented, they hamper the development efforts of individuals, communities, and resulted to huge economic losses (Jonsson et al., 2010; Nwilo et al., 2012). Citing as an example in a qualitative case study concerning the Three Gorges Project in China Tullos (2008), pointed out the need to make an environmental impact assessment a fundamental component of the planning process for the construction of dams.

Enhanced water supplies and chemicals such as fertilizer have significantly boosted food production in many regions of both the developed and developing nations (Kughur, et al., 2012). Although this is a positive and welcome development, it also contributes to environmental degradation, and threatens the same resource that is our source of food production and survival (Kughur et al., 2012; Vinger, Hlophe & Selvaratnam, 2012). As pointed out by Do-Thu et al. (2011), in some places water projects that were designed and intended to improve food production, industrial activity, and hygiene have resulted in the disruption of local ecology. In cases where such unforeseen impacts have occurred, they have forced communities, states, or nations to find appropriate technologies or systems that safeguard and preserve environment so that, in the long term, the projects can have positive impacts on the people and communities (Do-Thu et al., 2011).

A simple technology that has become a common choice in most developing nations of the Sub-Saharan Africa e.g., Nigeria is the hand operated water pump. The pump, as with other water supply sources, poses problems by attracting large numbers of

people and livestock to the supply points, especially in the dry areas of the north, (Dunn & Derrington, 2010). The increased activity around these water sources leads to environmental degradation and has impacts on groundwater sources and the development efforts of communities (Cheever et al., 2011).

The researchers confirmed this assertion by another example of similar developments in Ethiopia where livestock was said to be the largest of any African nation and contributed to about 60-70% of the population. The evidence in these areas indicated that sheep, goats, and cattle were driven in thousands by nomads to those water sources, and the excreta of the animals were usually not cleared at the water supply points. The result is that programs intended to aid development initiatives for rural communities rather hampered those efforts due to these circumstances (Cheever et al., 2011).

**Investments in Water and Sanitation Services for the Rural Poor**

The big picture is that safe drinking water and adequate sanitation are crucial for the reduction of poverty, and crucial for sustainable development and social change UNICEF (2012). Conversely, investments in and access to potable water and sanitation services in the developing nations are crucial to improving people's health, education, life expectancy, and well-being, as well as bringing higher socioeconomic benefits and development UNICEF et al. (2012). However, initiatives and investments in these programs have remained significantly low in most of the nation UNICEF (2012). What causes the difficulty especially is, when programs' resources are compared with the benefits to be derived from those investments and are perceived with low interest value.

Lack of potable water or its lack in quality and sanitation inflict heavy economic cost associated with health spending as well as loss of productivity and diversion in labor.

If it was possible for everyone in the world to have access to potable water and sanitation services, it was estimated in a UNICEF & WHO report (2010; 2012), that the reduction in diarrhea disease alone would save the health sector about $11. 6 billion in treatment costs as well as people would gain over 5.6 billion productive days per year. In a UNICEF & WHO report (2005), it was also revealed that the income gained by those saved from premature death associated with diarrhea disease, in long term earnings would add up to US $ 3.6 billion a year. Health care services expenses saved by having to treat fewer patients and the reductions in the direct costs of medication and transportation by the patients themselves could be up to US $ 7.3 billion a year.

From studies that focused on diseases and economics by the WHO (2008), the result showed that there are financial benefits of preventive measures for diseases associated with water and the costs to society of not preventing those diseases. Aside from the direct and indirect benefits as well as those cost savings that are tangible and intangible, there is a return of between US$3 and 34 for every dollar that is invested (WHO, 2008). These economic returns appeared encouraging to influence proportions for both spending and policies.

The international community has an important role to play in efforts to overcome the many challenges such as political, institutional, financial constraints, and those that are technical militating against the supply of these services, particularly in developing countries (WHO, 2008). It is estimated that an investment of at least US $ 0.04 per capita per day from developing nations would enhance the realization of the MDGs. If the Millennium Development Goal by 2015 was met by all people gaining access to improved water quality and sanitation, less than two million children would die from

diarrhea each year. The time saved could be diverted to local productive activities that could add to direct economic benefits gained from improved water supply and sanitation services. The most recent costing published by the WHO (2012) showed that it would cost about $35 billion per year over a period of 10 years if all the developing countries achieved the MDG levels of coverage using full household connections for both water and sewage. It was also reported UNICEF (2012), that if economic gains of providing potable water and sanitation facilities at low cost were added together, the developing nations could save about $263 billion a year.

## Rural Water Program Evaluation

Before the 1960s, many development initiatives and activities in the social or education sectors were sponsored purely by the generous support of wealthy members of society (Estache, 2010). Evaluating the impact of projects and programs is not a new activity. It does have an emerging history as a special function in the social sciences developed in response to the demand expressed by bilateral and multilateral aid agencies as well as some NGOs. Evaluation is important as a service to interveners and a tool for improving the running of a project, collection of reliable evidence, accountability, transparency, lesson learning, and the ability to implement strategy (Crowford & Davies, 2008; Estache et al., 2010).

Zuccala &Van Eck (2010), in a poverty research paper stated that interest in evaluation developed in the United States, to be specific, as a structured process in the areas of formal and informal education and social sciences. This was prompted in 1964 when President Lyndon Johnson declared an unconstitutional war on poverty (Zuccala et al., 2010). The declaration according to the researchers led to the enactment of a new

federal policy on budget that was aimed at among other things increasing public spending on social welfare and to finance research. Also included in the policy were an examination of the social problems at that time, and an evaluation of those programs that were designed to mitigate them (Zuccala et al., 2010).

The underlying factor was that conventional research at the time was not able to meet the challenging demands for a thorough examination to bring about a clear understanding of what was going on in those fields (Margoluis et al., 2009). It is since the development of such interest that new tools and methods of looking at projects evolved and became what we now call, "evaluation" (Margoluis et al., 2009). Since then professionals started recognizing the necessity of evaluation for reasons of accountability as well as for improving program interventions (Richards et al., 2011).

According to researchers, from the mid-2000s, calls for and interest in rigorous or robust evaluations of the impacts of projects has expanded among members of the academia and field workers (Estache et al., 2010). These approaches according to the researchers are considered the most effective tools for measuring the success of programs right from implementation to their outcomes and impacts to ensure that the objectives for which they were implemented are achieved. It is through this process that the poor and rural communities will get the fair share both of the economic and social benefits expected to be derived through these programs (Waddington, Snilstveit, White & Fawtrell, 2009).

A comprehensive evaluation of budget transparency in 85 countries conducted by Heuty & Carlitz (2008) also confirmed this assertion when it was revealed that countries that depend on foreign aid from donor agencies and developed nations for their

development programs tend to be far less transparent than countries that are not resource dependent. Concerns about these international development projects and the transparency with which they are handled can be the object of evaluation studies Heuty et al. (2008). There are however increasing constraints for external surveillance systems that are compounded by lack of openness to foreign evaluators by benefitting nations. Due to these circumstances, internal or self-evaluation has considerably become very important (McNamara et al., 2008).

While these traditional roles of evaluation have maintained their importance, they have nevertheless become quite challenging because of the new world of development as well as the interconnection between evaluation and development projects (Collin & Stirrat, 2008). As a result of this new development, evaluators are faced with a series of new challenges (Collin et al., 2008). From a project-based approach, the necessity of evaluation is to ascertain the level of success or failure of a project or whether there are malfunctions in the process and operation and what, if any, might need to be improved or changed to ensure its efficiency for the good of the beneficiaries (Prokopy et al., 2009).

There is a growing tendency that intervention projects are implemented in view of the Millennium Development Goals (DGs) that have to be attained (Collin et al., 2008; Zuccala et al., 2009). On the basis of this development, it is argued that there is a departure away from the traditional project-based approach to a broader vision of development that is characteristically focused on the MDGs. This departure, whether from the perspective of donor agencies, individual governments or the MDGs notwithstanding, the common denominator in all is the wellbeing and social change of rural areas across the developing nations. What has become evident is the fact that there

is no common approach, neither is there a consensus on the definition of the term "evaluation". It means a variety of things to different people and is often confused with monitoring studies or process assessment (Richards et al., 2008). Pattenayar et al. (2009) stated that evaluation can be given a twist to blend with the discipline and background of those who define it.

Some of the definitions of evaluation provided include evaluation as a process that is constantly undergoing change and development because of its use for inspection and study. It could generally serve as a tool in the hands of decision makers, interveners or executives of activity or programs (Richards et al., 2008). This definition supports the idea of Pattenayar et al. (2009) given the assumption of flexibility that decision makers, executives, or interveners of projects or programs can bend it to their own understanding or interpretation, regardless of its specific goal as inspection and study.

For Woolcock (2009), evaluation is a process by which the value or worth of something is determined. This definition underscored the very foundation upon which many programs or projects are established, namely, to bring about social change to existing conditions or the appropriate measures taken and efforts made to prevent some existing conditions from deteriorating. This idea is supported by Prokopy et al. (2009) who pointed out that if all the rural projects in the developing countries had the goals of contributing to the social wellbeing and change of communities, they would be more than likely to bring about huge gains that would be in consonant with the expected benefits more than secondary benefits.

The focus of any impact evaluation as emphasized by Pattenayar et al. (2009) is therefore, to determine the impact of independent variables, namely, the interventions or

programs on the dependent variables such as existing problems and what the conditions would be were the interventions not implemented (Pattenayar et al., 2009). Only against these impacts or outcomes can interventions be evaluated as whether they were efficient, effective, successful, and their resources justified or not (Richards et al., 2011). Such evaluation may provide beneficial information about the required changes to be made in order to improve the project or program so examined.

Sometimes the desired changes to be brought about by interventions or projects do not occur as expected, and evaluation helps as a means to understand why and what may have happened or gone wrong instead (Richards et al., 2011). Without this process in some developing countries especially, the measure of success, or failure of projects and programs would hardly be realized. In this sense, according to Tilt et al. (2008), evaluation could serve a variety of purposes such as a tool to improve the effectiveness of projects or governance within countries, a tool for budgetary planning, policy formulation and implementation or it could be used to achieve gender equality and women's empowerment, especially in societies where gender inequality is high or prevalent.

Holland et al. (2011) expressed a similar view have seen the beneficial aspects of evaluation which include among other things an assessment of how projects that are implemented have an impact on their intended beneficiaries. In making the assessment, a number of issues arising from the projects could also be discovered and measures or changes could be sought on how the issues might best be addressed (Holland et al., 2011). When information about the operation, management, and maintenance of other projects from different places or territories is compared, there are useful lessons that can be drawn from the information that is gathered that can be fed back into project design.

The advantage is that such information could be relevant and might contribute to the evaluation of similar, bigger projects. Subsequently, experiences acquired from these evaluations can be used as examples to make generalizations of the success, or lack thereof, of such projects with a view to future improvements (Holland et al., 2011).

Alkan (2009) and Tilt et al. (2008) have decried the situation where, in most of the developing countries or communities, when many projects are established stakeholders are often not brought on board especially during the early stages of planning and implementation. Against this development, Alkan et al. (2009) and Mahmoodi et al. (2008) advocated for the involvement of all stakeholders at all the stages of projects and programs especially in Sub-Saharan Africa and other developing countries. This call was made based in part on the point just made, as well as on the basis of corruption. The long period of disregard for these factors has contributed to the disappointing social and economic performances of most countries of the developing world for the past several years. The outcome is that those failures have given a negative image about the countries or their governments as well as the negative effect the failure of those programs have on donor agencies as well as the targeted groups (Koestler, Koestler & Koestler, 2010).

Having made social welfare or change brought about by projects the focal point of evaluation, the challenge has remained, that there are no distinctly set boundaries in the field of evaluation, nor consensus on the best approaches to gathering reliable and valid evidence within the social sciences described by these broad definitions. Based on this loophole, Ravallion (2009) from the perspective of an influential group of academic economists, the randomistas, advocated for yet another approach. The social experiments

believe that the only clean way or process that the goals and impacts or outcomes of projects can be measured and determined as being successful or unsuccessful.

What stands out in this definition are the methods used by social science to judge and improve projects from the planning stages, and monitoring its efficiency and effectiveness in relation to the attainment of human services or goals. Evaluations can be systematic when they fulfill the requirements or employ approaches to collect evidence that is valid and reliable. There have been decades of efforts to adopt the methods of social science research to evaluate the impacts of water supply programs in rural areas of the developing nations. The next section is focused on rural water programs in Nigeria and the NSD of Benue in particular, and how the long years of un-improved efforts have impacted the development of those communities including the NSD and Benue state which is the center of this research.

## Rural Water Programs

The socioeconomic development, living standard, and social transformation of nations, states, and rural communities are highly inter-connected to water resource development and management (Galadima et al., 2011). Some studies have shown that Nigeria is endowed with about 267 billion cubic meters of surface water, and about 52 billion cubic meters of ground water yearly (Okpoko et al., 2008). The surface water resources include River Niger and River Benue which are the biggest rivers in the country with their tributaries as well as the Lake Chad. Other rivers include Katsina-Ala, Gongola, Hadeija, Jamaire, Kaduna, Cross River, Sokoto, Ogun, Oshun, Imo, and Anambra which are located in different states of the nation (Okpoko et al., 2008). If properly planned, implemented and efficiently managed, the water resource sector in

Nigeria has the potential to galvanize socioeconomic development of the nation, states and rural areas by way of improving livelihoods and poverty reduction as well as the general social transformation.

It is worth noting and acknowledging that several years have passed when the Federal Ministry of Water Resources established the River Basin Development Authorities with other parastatals under their supervision (Okpoko et al., 2008). These include Anambra - Imo River Basin Development Authority, Benin – Owema River basin Development Authority, Chad Basin Development Authority, Cross River Basin Development Authority, Hadaija – Jamaare River Basin Development Authority, Lower Benue River Development Authority, Lower Niger River Basin Development Authority, Niger Delta Basin Development Authority, Ogun – Oshun River Basin Development Authority, Sokoto – Rima River Basin Development Authority, Upper Benue River Basin Development Authority, and the Upper Niger River Basin Development Authority (Okpoko et al., 2008).

While these River Basin Development Authorities cut across other states within their geographical jurisdictions, their headquarters were mainly in the state capitals that are closer to the water supply source (Okpoko et al., 2008). The underlying reality is that construction works and connection of water distribution channels from the development headquarters as well as service delivery were directed to the state capitals, major cities, and towns within their jurisdiction (Sanusi et al., 2010). Rural areas and communities were not included or targeted as beneficiaries of those services from the early stages of water resource development in the country. The result is that this gap has made it

increasingly difficult, if not impossible in some areas to close, with the NSD of Benue and other communities in the country serving as examples (Sanusi et al., 2010).

There is abundant literature concerning water and its related problems in Nigeria (Adepelumi et al., 2008; Akpata et al., 2009; Dan'Azumi et al., 2010; Edet et al., 2011; Ibbi et al., 2012; Ifabiyi et al., 2009; Momodu et al., 2010; Nwajei et al., 2012; Ochieng et al., 2011; Utsev et al., 2012). These individual or group studies approached the subject from diverse impact indicators or specific areas of interest such as water development, pollution, contamination, quality, health, and disease among other aspects (Dan'Azumi et al., 2010; Ifabiyi et al., 2008; Inyang et al., 2009; Momodu et al., 2010; Ochieng et al., 2011; Okpoko et al., 2008; Sanusi et al., 2010). Sanusi et al. (2010) has cited an example of the growing settlements around Minna, Nigeria that are outside the limits of water from the city of Minna which is the main supply source. Right from the planning process, these settlements were excluded from water services. The situation has grown to such an extent that even with the current growth of the settlements; little attention is given to their water needs (Sanuis et al., 2010).

This development according to the researcher expresses the low standard of development as well as the risk to health the residents are exposed to. In a similar study Ibbi, & Nmadu (2012), have pointed out the fact that not only do rural and urban settlements where the resource exists lack effective water supplies, the outputs are too meager and meets the water needs of only a small percentage. The consequence is that the influx (migration) of people has worsened the problem of water scarcity (Ibbi et al., 2012; Nmadu, 2012; Sanuis et al., 2010).

There is a vast literature concerning water pollution or contamination in Nigeria. It will not be an exaggeration based on the literature to conclude that water contamination in cities, towns, villages, and rural areas in Nigeria is a huge problem (Inyang et al., 2009; Oyedeji et al., 2010; Waziri & Ogugbuaja, 2010). This problem is attested to from water analysis reported in the following studies. The journal in which Dan'Azuma et al. (2010) analyzed the effect of heavy metals discharge from industries on rivers attests to this assertion about the population of River Challawa in Kano, Nigeria. In an African health science study, Akpata et al. (2009) identified fluoride levels in drinking water sources in 109 randomly selected Local Governments (LGs) in Nigeria. In a similar study Galadima et al. (2011) discovered that due to intensified uses of water in homes, local markets, abattoirs, oil, agricultural activities, and the disposal of harmful waste, heavy metal poisoning of domestic water has occurred among local communities in Nigeria.

Nduka, Orisakwe & Ezanweke (2008) in a scientific assessment research revealed that surface water, shallow wells, and boreholes in the Warri area of Niger Delta region of Nigeria are contaminated with physicochemical substances that have made the waters unsafe for drinking and other domestic uses. In a qualitative assessment Inyang (2009) also found microbial load in borehole water samples taken from seven areas within Uyo metropolis in Nigeria. There was another study undertaken about ground water chemistry and its quality from Benin, Benue, Niger Delta, and Sokoto Basins. The results revealed that these sources of water are polluted and only good for agriculture and irrigation services (Edet et al., 2011).

Ochieng et al. (2011), in a structured questionnaire and oral interviews conducted an assessment about hand-dug wells in the South-east Local Government area of Ibadan

metropolis Nigeria, the results revealed that most of the wells were highly contaminated as a result of unsanitary practices such as proximity to pollution sources, indiscriminate dumping of refuse, pit latrines, and poor sanitation. These sources of water are therefore risky for drinking and domestic uses (Ochieng et al., 2011). Adelekan (2010) also confirmed in his studies the poor quality of water from hand-dug wells in Pakoto and Ifo communities in Ogun state, Nigeria, and how unsafe these sources are for drinking and other domestic services.

These levels of pollution, as well as those revealed in the studies conducted by Momodu, & Anyakora (2010), are so severe that in some places fresh water streams and other water sources are rendered incapable of the natural process of self-purification (Ifabiyi et al., 2008). Given the total dependence of so many communities and rural areas on these sources of water, the overall impact is the prevalence and outbreaks of water related diseases as revealed by Nwakor, Ekwe & Azoro (2008), with reference to their study of households in Ebonyi Local Government area of Ebonyi state, Nigeria. These factors have not only slowed attempts at poverty reduction, they have substantially hampered the efforts towards growth and development as well as the social transformation of individuals and rural communities.

## Rural Water Supply in Benue State

As discussed in previous sections, there is substantial amount of literature concerning water and water problems in Nigeria (Adepelumi et al., 2008; Babayemi et al., 2009; Chudi et al., 2010; Kolawole et al., 2012; Nwajei et al., 2012; Offem et al., 2011; Olajide, 2011; Omezuruike et al., 2008; Omobowale et al., 2011; Puyate & Rukeh, 2008). There is also a sizable amount of literature concerning water and water problems

in Benue State, Nigeria which is the center of this study (Isikwue et al., 2009; Kughur et al., 2012; Maitera et al., 2011; Ocheri et al., 2010; Ocheri et al., 2012; Odiaka et al., 2008; Okoye et al., 2009; Tse et al., 2009). Those studies, aside from their focus on the lack of water supply to some selected rural communities for their studies, they also focused on water shortages in the areas where such programs are established. Other areas of focus include water pollution and the causes of water contamination, hence the health problems associated with the lack or its quality as well as growth and social development.

In their qualitative case study about water shortage and the health problems in Benue that focused on the rural communities of Tse-Agberagba, Akpagher, & Ibbilaalukpo Utsev et al. (2012) discovered that there is shortage in water supply to meet the demands of the people. In the absence of alternative sources of water quality, people utilize sources that are unsafe which result to health and other related problems. In another qualitative case study that targeted two other rural communities in Benue state: Obi and Oju, Terngu et al. (2010) discovered that the quality of water from hand-dug wells was below the WHO standard for drinking water.

It is worth noting that Makurdi is the state capital of Benue state. This fact notwithstanding, right within Makurdi metropolis, a similar qualitative case study was conducted by Tse et al. (2009) about the quality of water from hand-dug wells. It was discovered that other than utilizing the water for irrigation, it required treatment before drinking due to the presence of some bacterial contamination. Although the researchers attributed the contamination to the proximity of the 19 sample wells to open solid waste disposal sites (Tse et al., 2009). The quality of water notwithstanding, Odiaka et al. (2008) in a quantitative survey that utilized questionnaires reported that farmers have

benefited from the water in the production of fluted pumpkin which is consumed by millions of people in Nigeria. It has to be acknowledged in any case that health issues associated with fruits intake of contaminated water cannot be ruled out.

Isikwue et al. (2009) conducted a quantitative cross-sectional study to determine the concentration of radioactive elements found in some public water used in Makurdi metropolis. Water samples were taken from hand-dug well, streams, boreholes, tap-water, bottled water, and sachet water from five geographical locations of the metropolis (North, South, East West and Central. It was discovered that agro-chemicals used by the agrarian community has resulted to water contamination with frequent health problems (Isikwue et al., 2009). Kughur et al. (2012) also affirmed the impact of herbicides on water quality in Makurdi local government of Benue state based on a quantitative study that employed descriptive statistics.

Ocheri et al. (2012) conducted one qualitative case study and two quantitative case studies on seasonal variation in iron in groundwater, lead in rural groundwater and water related diseases in Benue state, Nigeria by using atomic absorption spectrophotometer and data from the Benue state Ministry of Helath on water related diseases respectively. It was discovered that water from some of the boreholes was not suitable for drinking due to color, odor, and taste (Ocheri et al., 2010). It was also revealed that apart from effects due to iron minerals from soils and rock, other effects are due to corrosion of some components of water supply machines such as galvanized hand pumps (Ocheri et al., 2012). In a similar research, water samples were collected from boreholes across other rural communities in Benue state. Due to an increased use of

chemical fertilizers, the result showed that there was a significant amount of lead contamination of groundwater (Ocheri et al., 2012).

Another qualitative case study was undertaken by Okoye & Nyiatagher et al. (2009) about the quality of water from hand-dug wells in Gboko. This town is the next largest in size to Makurdi in Benue state. It was reported that the water contained some elements of iron and copper that was elevated higher than the maximum standard expected for drinking by the WHO. A similar study was carried out to assess water quality in Buruku and Katsina-Ala local government areas of Benue state by Houmsou et al. (2010). The findings revealed that the quality of water in these areas is unsafe for drinking. However, aside from drinking, other human activities such as swimming, bathing/playing in the water, washing and collection of edible snails have resulted to several cases of schistosomiasis infections.

River Benue is the second largest river in Nigeria that is the major source of water supply to communities along its banks as well as communities in Adamawa state. In a qualitative case study to assess the levels of organic and metal pollution, it was discovered that Mg, Zn, Pb, and Cr were high during the dry season (Maitera et al., 2011). According to the study, the pollution was associated with runoff from farms conveyed from rains. Cu, Mn, and Cd were reported to be within limits acceptable for drinking water by the WHO (Maitera et al., 2010). What this literature highlighted thus far was the fact that, intervention efforts were seriously needed by Benue state governments and organizations towards providing potable water supply to rural communities. It was also clear from the literature that the challenge was far from being over. This research was motivated by this fundamental challenge of the lack of potable

water availability and how this problem impacted not only the development and social change of the NSD, but Benue state in general.

This situation and motivation for this study was further confirmed as stated above by a general profile of water related diseases in Benue state Ocheri et al. (2012). The researchers obtained data from Epidemiological Department of the Ministry of Health Makurdi for the record time from 2000 to 2008. The result of the analysis showed that in all the LGAs of the state there were cases of water related diseases (Ocheri et al., 2012). These diseases placed in their magnitude, malaria ranked the highest. It was followed by diarrhea, dysentery, filariasis, onchereriasis, schistosomiasis, typhoid, and cholera.

Those who bear more the burden of these diseases are the people in rural communities of the NSD who are already impoverished and impacted by the lack of some basic infrastructures (Oboh et al., 2009). They are pushed further into the cycle of poverty by spending their meager income and resources for medical and health care services, rather than on individual and community development as well as social change. For poverty reduction to be sustainable as pointed out by Ogwuche (2012), the quantity and quality of, and access to environmental infrastructure and social services are fundamental. Since nation building is the corporate civic duty and responsibility of all citizens, interventions by government, good governance and stakeholder participation will go a long way to ensuring development and social change.

## Rural Water Programs, an Overview of Evaluations

There is a growing literature on evaluation which has examined the impacts and outcomes of rural water, sanitation, and hygiene interventions on the quality of life in the developing nations (Collin et al., 2008; Estache et al., 2010; Margoluis et al., 2009;

Prokopy et al., 2009; Richards et al., 2008; Richards et al., 1011; White, 2009; Woolock et al., 2009). In some places, governments, NGOs, and donor agencies favor only water supply services as an effective way to achieve intervention goals. Others favor combination of water and water quality, water and sanitation facilities, sanitation and hygiene, hygiene and its appropriate behavior interventions or household point of- use water treatment (Collin et al., 2008; Estache et al., 2010).

Although these interventions were effective at producing both health and non-health impacts, the regional and cultural differences that existed, especially between the societies of the developing nations, made it difficult or impossible to establish what single or multiple project intervention worked best for the targeted rural communities (Prokopy et al., 2009; White et al., 2009). Many of the studies therefore employed diverse methods and measures in their assessments and focused on and reported the results of interventions to reduce illness through improvements in drinking water, sanitation, and hygiene (Richards et al., 1011).

Among those studies was one conducted by Bertuzzo et al. (2008) on water services and public health with specific reference to the cholera outbreak in KwaZulu-Natal, South Africa. The government of South Africa since the post-apartheid period, devoted attention to the provision of safe water and sanitation services to rural communities. Due largely to poverty and lack of education of the communities on the impact of environmental deterioration on health, government efforts were disrupted by the sudden epidemic outbreak of cholera in KwaZulu- Natal province and other parts of the country (Bertuzzo et al., 2008). According to the study, the epidemic lasted for 2 years with confirmed cases of cholera about 140, 000 that claimed more than 260 lives in

nine provinces, with the majority of deaths occurring in the originating province. The lesson learned from this epidemic was that providing a supply of potable water without the accompanying knowledge or education about good hygiene practices may not yield the desired results of particular interventions (Bertuzzo, et al., 2008).

Poverty and lack of knowledge about the adverse health consequences of environmental pollution can and does lead to poor attitudes and practices that ensure good environmental quality. Jalan, Somanathan & Chaudhuri (2009) made a cross-sectional assessment about how knowledge gained from schooling, exposure to the social media, and other measures such as purifying water at home could influence the attainment of clean water and environment. From a sample size of 90,000 women and men between the ages 15 and 49, knowledge acquired and applied in order to reduce behaviors risky to the environment was used as the method of analysis (Jalan et al., 2009). It was revealed that these sources of knowledge had not only significant effects on home water purification, but also led to sincere efforts to have a clean environment.

Some assessment studies found that the formations of community-based watershed organizations are a great potential to enhance water quality and reduce behaviors that were risky to the environment (Stedman et al., 2009). However, in some places little or no attention is given to their impacts on the wellbeing of rural communities. These researchers conducted a survey through state wide mail and interviews of 28 watershed organizations in all of Pennsylvania. It was reported that, these organizations are important building blocks for local leadership, they also accord the rural residents opportunities to develop valuable skills as well as in collaborating with

other communities facing similar water resource as well as rural development problems in order to address the problems (Stedman et al., 2009).

This assertion was confirmed by Garcia & Brown (2009) whose research assessment was focused on rural watershed in the Colombian Andes. Key participants were the local youth. Community workshops were led by the team who promoted water conservation and water quality protection practices as well as monitoring water quality of streams and community water intake (Garcia et al., 2009). A broad participation by the community was reported to be beneficial in the management of water and land resources. In another assessment focused on irrigation management in Thailand, Bastakoti & Shivakoti (2010) found that community organizations are very influential and effective in managing water use among agricultural and non-agricultural sub-sectors across rural and urban areas.

In an assessment about the effectiveness of community driven development (CDD) approach to rural water supply and sanitation projects in Punjab, Pakistan Padawangi (2009), it was reported that there are some advantages associated with the approach based on the fact that community choices are more aligned to local needs. Other benefits include the fact that social capital is built and there is greater level of participation by stakeholders in the programs. When stakeholders and communities view a project as their own, such projects are given better supervision and it reduces corruption. All these factors further lead to enhanced sustainability of projects (Padawangi, 2009). Aside from these, this approach contributed to the extension of water supply, drainage, and sanitation coverage to other poor rural communities as well as a change in water tariff and cultural attitudes (Padawangi et al., 2009).

There was also a cross-sectional assessment conducted by Whittington et al. (2009) about how well the demand-driven community management of water supply was doing that focused on Bolivia, Peru, and Ghana. Data were collected from households, village water committees, focused groups of village residents as well as system operators and key informants in 400 rural communities of Bolivia, Ghana, and Peru (Whittington et al., 2009). The findings revealed that the rural water supply projects in all the three countries sampled were working. According to the researchers, 95% of households pooled in the sample in Bolivia and Peru reported that their taps were functional, perhaps at the time of the study; 90% of respondents in Ghana also reported that all their hand pump projects were working (Whittington et al., 2009). The facts that these water projects were functional notwithstanding, some households were reported to have still used water from other sources. This practice was reported to be prevalent in Ghana with 38% of households that utilized water from un-protected sources (Whittington et al., 2009).

In conducting an evaluation such as the one that was centered on demand driven community management of water projects, it was critical that the researchers revealed how well the projects were doing in terms of their functionality and thus fulfilling their goal to supply water to the communities. There is another thing that emerged from their finding that was also important for them to have given some specifics about the factors that led to the practice. Their report indicated that about 38% of households particularly in Ghana were regardless of the proper functioning of the water projects, nevertheless utilized water from unprotected sources (Whittington et al., 2009). It would have been interesting to know the motivating reasons or why those households preferred water of

less secure sources, whether their reasons were associated with factors such as taste, color, odor, or distances among others. While this aspect of the result may not have been the researchers' pre-occupation, their oversight about it has resulted to a potential shortfall.

In Imo state, Nigeria, the level of water and sanitation services in rural communities are reported in a qualitative assessment to be generally unsatisfactory (Nkwocha & Egejuru, 2010). This situation according to the researchers has resulted in many diseases associated with water scarcity and quality as well as poor sanitation. The focus was on the role and impact of the European Union Micro-Project Program in water and sanitation services to reduce the rate of diseases in the rural areas of the state (Nkwocha & Egejuru, 2010). From 25 rural communities that benefited from the water and sanitation projects between 2003 and 2007, 540 subjects were randomly selected and interviewed. The evaluation was based on water quality and quantity as well as the incidences of diseases and their rate of reduction. The result showed that there were significant improvements in quantity supply of about 62%, sanitation 52% and disease reduction to 40% respectively (Nkwocha et al., 2010).

McGarvey et al. (2008) conducted an analysis of water sources, social settings, and household drinking water in six costal districts of Komende- Edina- Eguafo-Abirem, Cape Coast, Abura-Asebu-Kwamankese, Mfantsiman, Gomoa and Awutu-Efutu-Senya 1 of Ghana's Central Region. Thirty six areas were randomly chosen out of which 90 representatives in rural, semi-urban and urban residences were picked (McGarvey et al., 2008). In each of the targeted groups, 24 households were randomly selected for water quality sampling. In tests of 100ml of water from each household, the result of the study

revealed the presence of E. coli in at least 74% of households. Tap water had a lower percentage of E. coli levels compared with surface or rain water. Well water had the highest percentage levels of E. coli (McGarvey et al., 2008). The researchers observed, however, that differences in social standards and behaviors in the household and the community were key factors that determined the quality of drinking water; hence, poor social standards and hygiene behaviors can greatly impact water quality (McGarvey et al., 2008).

The attitude of "business as usual" has persisted for centuries in so many countries and slowed the progress of providing potable water and sanitation to rural societies. In some places the attitude is difficult to overcome, and in others it has rendered such efforts unsuccessful or altogether impossible (Davis et al., 2008). However, in other places the long delay or insufficient action by leaders have caused more people than expected in the 21st century to be drinking water in certain areas from "improved" sources that are not safe (White et al., 2009). Schmidt & Cairncross (2008) reviewed some assessment studies done on household water treatment in poor populations. Their aim was to establish if enough evidence existed on the level of acceptance and on value measurements of the effects and nonhealth benefits of water interventions to scale up their implementation (Schmidt et al., 2008). This was based on the popular view that treating water at the household level can potentially reduce the impact of diarrhea and enable the attainment of the Millennium Development Goals.

When these aspects were compared with evidence of the impact of household water treatment on diarrhea, the evaluators found that the degree to which the program was accepted and its beneficial outcomes were not clear enough to warrant any basic

conclusions (Schmidt et al., 2008). Apart from this, other impediments made it difficult to identify populations that would have benefited from the program, so much so that the non-health benefits, according to the researchers, were insignificant (Schmidt et al., 2008). Even though beneficial outcomes of the trials may have reduced diarrhea by 30% to 40%, such conclusions were laden with bias which may have also affected the observed evidence on diarrhea reduction. The evaluators concluded it was premature to push wide spread promotion of household water treatment, given all the concerns (Schmidt et al., 2008).

Contrary to the preceding opinion Sobsey et al. (2009) who based their evaluation of point of-use (POU) household drinking water filtration, affirmed that POU water treatment is a new technique that is effective for addressing problems associated with the quality of water in households. No matter the technology employed, as an innovative approach it can afford people and communities who have no access to potable water the opportunity to improve their water quality by treating it in their homes (Sobsey et al., 2009). Among the currently available POU water treatment technologies, none worked better in terms of large scale use than simply boiling the water, the study pointed out.

This argument notwithstanding, the success of any treatment technology depends on its prolonged use which is essential for achieving positive results. The difficulty in realizing the goals of interventions has, however, lingered in some places because of factors such as socio-cultural attitudes and lack of compliance, according to the evaluators (Sobsey et al., 2009). The evaluators concluded that among the five POU water treatment technologies such as chlorination with safe storage, combined coagulant-chlorine disinfectant systems, sodis, ceramic filters, and biosand filters, the last two

especially, judged on the basis of evaluation criteria, were proved to be more effective and have a higher potential to become more widely used to improve household water quality, and so reduce water borne diseases (Sobsey et al., 2009).

The short coming of this study is that all the POU technologies were deployed as laboratory experiments and the conclusions were based on their use in the same setting since the study made no reference to a country, state, or rural community as the target group. Other aspects of concern include the fact that no indication was made of household samples and the specific technologies that were employed, as well as what the findings were from each technology intervention (Sobsey et al., 2009). Also, quite apart from these problems, the fact that the experiments were carried out in laboratories and by officials who had scientific orientations raised concerns associated with bias and integrity of the conclusions.

In their own assessment Ahuja, Kremer & Zwane (2010) reviewed some evidence from randomized trials on access to, and the quality of domestic water in developing nations in relation to its impact on diarrhea disease. According to their findings, although there was lack of sufficient evidence to support a call for massive funding of the programs, there was enough reason to support funding for water treatments which were said to be cost effective in reducing diarrhea disease (Ahuja et al., 2010). As important as this benefit was, the evaluators found that households were reluctant to purchase water treatment materials. They optimistically felt acceptance of water treatment could increase with basic information about the value and necessity of quality water.

Smits et al. (2010) conducted an assessment that was based on multiple use services as an alternative rural water supply. From the evidence they collected from eight

countries in Africa, Asia, and Latin America, the findings revealed as a universal trend that people make multiple use of water such as domestic and other productive activities (Smits et al., 2010). It was also discovered that even though water may not be the main source of people's income and food production, the activities associated with its use are significantly important for their livelihoods. The study concluded that both the types and a combination of well-known technologies can improve people's access to water (Smits et al., 2010).

A participatory approach to engineering action research was conducted that focused on water supply and treatment design in rural Belize by Magoon (2010). The team used biofilters to purify spring water and rain water. The same systems were developed in a government school at a village that was intended to serve as a model for replication in households throughout the village (Magoon et al., 2010). Based on the effectiveness of the systems in the intervention areas, it was concluded that for any technology to be successful, there has to be a balance between the design and its relevance to the people or benefiting communities (Magoon et al., 2010).

Despite the fact that progress has been made in developing low-cost technologies that are easier for communities in the developing countries to maintain that could enhance sustainable outcomes, rural water interventions have over the decades produced poor sustainability records (Davis et al., 2008). Part of the problem is the lack of attention and support following the post construction period. The concern of these researchers was to determine the amount of post construction support given to water supply projects in Bolivia towards its sustainability (Davis et al., 2008). The comparison of results showed that communities who benefited from post construction visits by management as well as

external agencies including training workshops for operators had better performing systems than communities that did not receive such support (Davis et al., 2008). Masduqi et al. (2010) using the example of East Java, Indonesia, analyzed the factors that can contribute to sustainable rural water supply. Factors such as the choice of technology, sources of water, investment cost, community participation, technical operation as well as institutional management were reported to be important. Many cases of programs' disfunctionality or failure are due sometimes to lack of attention to these factors.

Using another approach Clasen et al. (2010) did evaluations to assess the effectiveness of interventions to improve water quality for the prevention of diarrhea. Apart from two trials said to have taken place in the USA, all trials were undertaken in the developing nations: Bangladesh, Bolivia, Brazil, China, Guatemala, Gambia, Ivory Coast, Liberia, Kenya Malawi, Pakistan, Rwanda, Saudi Arabia, South Africa, Uganda, Uzbekistan and Zambia. The sample population from 19 randomized controlled trials included 29, 920 participants (Clasen et al., 2010). Another 11 quasi-randomized controlled trials included 23, 556 participants. Seven trials of point-of-distribution interventions included 18, 336 participants, and another 23 trials of POU interventions had 35, 140 participants. The trials lasted from 9.5 weeks to 5 years respectively. The overall results of the evaluation suggested that interventions to improve drinking water quality are effective in preventing diarrhea disease for people of all ages and especially for children under five years old (Clasen et al., 2010). Analysis of subgroups showed that household interventions were more effective in preventing the spread of diarrhea disease than interventions at the source of water, although compliance was a necessary condition to ensure success (Clasen et al., 2010).

Another evaluation was undertaken by Cairncross et al. (2010) which focused on other literature reviews about the impacts of improved water quality, quantity, and sanitation on health, especially with regards to diarrhea. Although concerns were expressed about the lack of conclusive evidence associated with the effect of individual projects, the studies confirmed that the interventions had similar effects on disease control (Cairncross et al., 2010). Also, aside from the health benefits, there were also non health benefits that the studies identified such as women's emancipation and the enhancement of human dignity.

Utilizing another approach, Tanko, Musa & Ahiarammunnah (2010) conducted an assessment study of medium scale water and sanitation projects in Adamawa, Gombe, Taraba, and Bauchi states of Nigeria to determine which of the projects was preferred and more beneficial in the selected areas of study. Sixty questionnaires were distributed to personnel who were technically orientated (Tanko et al., 2010). An evaluation of 45 five results from respondents was made based on the objective weight, environmental effects, reliability and how sustainable the projects were. The results of the study revealed the preferential choice of intervention in each sub-area of study. In Adamawa state, rural water and sanitation was of a higher value. In Gombe, Taraba, and Bauchi states, small-scale irrigation projects were indicated to be of higher value (Tanko et al., 2010).

The problems associated with this study included the small number of questionnaires distributed. A study covering four states required more than only sixty questionnaires. Such a small number of available questionnaires limited the sample pool to a small population in each state. What this meant is out of the sixty questionnaires distributed; only fifteen went to each state. The amount of information or data collected

may not have given a fair account of any projects' impact upon which generalizations were made. Additionally, the method of data collection was shown, but how it was analyzed was not shown. Also, adequate explanation of the predictors upon which analyses were made was not given. Furthermore, the extent to which the projects impacted the local communities of the study were not shown. The fact that questionnaires were distributed to technically oriented personnel rather than farmers who were the direct beneficiaries of the projects also raised the possibility of bias and manipulation, undermining the validity and credibility of the results and conclusions.

There are some economic costs associated with poor water quality. These include degradation of ecosystem services, costs related to health, impacts on economic activities such as tourism, agriculture, industrial production, as well as reduced property value and increased water treatment costs (Palaniappan et al., 2010). According to the researchers, these costs in some regions can be substantial. They cited examples of degraded water quality costs in countries of the Middle East and North Africa between 0.5 and 2.5 percent of GDP per year. The overall economic losses due to lack of water and sanitation in Africa was estimated at US$ 28.4 billion or 5 percent of GDP. It was however reported in the study that developing countries that have access to potable water and sanitation services have greater chances to fast economic growth than those without (Palaniappan et al., 2010).

Mathew (2005) assessed the socio economic benefits of water supplies developed in the rural communities of Bikita District in the southeast of Zimbabwe. The people of the district were greatly impacted during the drought of 1991 – 92, and in 2002 they suffered from the general economic meltdown in the country following the general

election of 2000. The Bikita Integrated Rural Water Supply and Sanitation project was to provide water supply from boreholes (Mathew et al., 2005). The indicators used for the program assessment included water, cattle, and other livestock, irrigation of small family gardens, safe domestic water supply, sanitation, and health education, with an emphasis on agriculture. After a seven-year period of the intervention's implementation, the evaluator found that, despite the political and economic challenges the country faced at the time stemming from a standoff between the governments of Zimbabwe and Great Britain, the results showed huge social and economic improvements (Mathew et al., 2005).

The short comings of this study were the lack of information about the sample size and how data was collected. Apart from these, the study outlined the indicators upon which assessments were to be made, but the level of impact of the program on each indicator was not reported. The conclusions about beneficial outcomes centered on one indicator, agriculture. And conclusions were based on observations which may have been biased and manipulated. It is also hard to say how these projects significantly saved time that women had used for water collection and what beneficial activities they were able to engage in due to the time saved such as participation in community gatherings and economic ventures. This raised questions about the validity and reliability of conclusions. The silence concerning some of the outlined indicators may be due to the program's intended impacts not being met because its activities were not implemented as planned.

Another assessment of the socioeconomic benefits of sanitation services was conducted by Rijsberman & Zwane (2008). The researchers criticized the failure of other studies to quantify the externalities associated with these programs and investments

especially the conclusions drawn by those researchers that the benefit cost ratio of investments in the programs were low. (Rijsberman et al., 2008) further argued that such conclusions underestimated the benefits derived from water and sanitation investments which in the long run are qualitatively huge. These benefits according to the study can and should meaningfully contribute to any discussion about how to pay for intervention programs (Rijsberman et al., 2008).

A similar study was conducted about POU water purification and household welfare in Cambodia (Knobloch, 2011). According to the researcher, poor sanitation and water access costs the Cambodian economy $448 million dollars every year, of which $187 million dollars were health related costs. The study sampled participants in a village that received subsidized bio-sand filters and those who did not get the filters (Knobloch, 2011). The objective was to investigate in terms of assets whether those who received the filters were better off than those without. The study revealed that the possession of assets by those who got the filters was greater than those without. This trend was evident in assets such as housing and transportation all of which had the potential to improve rural livelihood and economic wellbeing (Knobloch et al., 2011).

Some shortfalls of this study included the fact that it did not specify the village in Cambodia that was selected for the study. There was no information about the population of participants involved as well as the length of time the study lasted and how data was collected. Other missing information included the measurable variables upon which the data was analyzed. The record of success as the study concluded associated with improved housing and transportation by those who possessed the bio-sand filters told us very little about other assets possessed by some of the participants who could have gotten

fair consideration and judged to be successful or not. More to these was the fact that there was no information about the criteria for sample selection. On this basis, it could be seen that those who received the water filters were members of the village who were already better off; and whose record of success may have origins to their previous status and social standing. All these led to some manipulation of findings and information as well as bias, and hence the question about the validity of the conclusions.

In evaluating the benefits of safe water supplies in rural areas of Guerrero state, Mexico, Dewilde et al. (2008) employed two approaches in their evaluation. The first approach was an extensive review of literature on public health, community-based resource management, and household choices of water source usage. The second approach was based on the many years of field experience. The study was carried out 5 years after the implementation of the programs (Dewilde et al., 2008). From the 60 communities, 31 were selected as study communities based on their population sizes, installation records, and data of weekly health outcomes. Another 44 communities without the purifying systems were selected as comparison villages (Dewilde et al., 2008).

At the end of the study, the program was seen to have had no impact on the target communities, but with a split in the findings. One school of thought was that the systems were, for the most part, highly non-functional and so were greatly under-utilized; (a problem which was attributed to poor maintenance of the systems). The second and more favored school of thought was that the systems were not put to capacity use right from their implementation, which over time led to their becoming non-functional (Dewilde et al., 2008). The study found that for a program to fail or succeed there has to be a link

between household priorities and preferences. These factors would motivate people to get more exposed to safe drinking water sources, as well as experiencing the benefits of convenience or proximity offered by the sources (Dewilde et al., 2008).

From the research about economically sustainable safe drinking water systems for the developing world that focused on Mae Nam Khun, Thailand, Thompson (2010) decried the political void for providing safe water to urban and rural communities that was created for the past 40 years by governments in the developing world. With a few exceptions to governments in developing countries such as India that has made water provision a priority and it is bringing socioeconomic benefits, the researcher assessed the benefits of safe water projects for children's dormitory in Chirundu, Zambia and Mae Nam Khun, in Thailand (Thompson et al., 2010). As a long term socioeconomic benefits, these projects motivated and enhanced school attendance by the children in the target areas. This assertion was confirmed by Snieska & Simkunaite (2009), who in their assessment about the socioeconomic impact of water infrastructure investments revealed that it has positive effects on education of the labor force and has the potential to induce economic growth.

Hygiene interventions, especially those that promote hand washing are reported to be effective. An evaluation study was carried out to ascertain the impact of interventions such as improvement in quality water supply, proper disposal of human excreta and hand washing with soap for the prevention of diarrhea (Cairncross et al., 2010). The results showed that there were considerable reductions in risk of as much as 11%, 26%, and 41% respectively. However, the combined effects of all the interventions were less than 43%.

Oswald et al. (2008) did an evaluation study on the direct observation of hygiene practices by mothers and children in a shantytown in Lima, Peru. The study approach was over three 12 - hour sessions of continuous monitoring of 32 mothers in households without in-house water connections (Oswald et al., 2008). The targets were: observing the use of water and soap for the washing of hands, the number of times hand washing was interrupted after fecal-hand contamination had occurred and the time when it became possible or could be concluded that fecal-hand contamination and disease transmission took place (Oswald et al., 2008).

Within the total of 1008 hours stipulated for observation, the study found that 55% of mothers and 69% of children did not follow the preventive approach of hand washing or bathing within 15 minutes of fecal-hand contamination, which made it possible for transmission to have taken place (Oswald et al., 2008). There was no time difference for possible transmission to occur between mothers and children. The evaluators also found that the direct transmission of faecal material to food or moth occurred frequently within an hour of hand contamination.

There were some flaws with this study. As pointed out by the evaluators, in their study site the shantytown had a population of 450 households, from which 32 participants were selected. Inclusion was based on a household having a youngest child of about 10 years of age, which was not a fair representation of the community. That the study lasted for three months could not have offered the evaluators sufficient knowledge about what was intended to be accomplished. Also, observation days depended on the availability and time of families. Other than mere observation of hygiene practices, there were no other objectives of the study, nor any listing of the indicators upon which the success or

failure of the study could be measured. Whether there were economic or other beneficial outcomes associated with the intervention for the community was not known.

Employing another intervention Clasen et al. (2010), did an evaluation to assess the effectiveness of interventions to improve the disposal of human excreta for the prevention of diarrhea diseases. The evaluation was based on 13 studies from six countries with a total sample population of 33,400 adults and children in rural, urban, and school settings. The evaluators made three selections of randomized, quasi-randomized, and non-randomized controlled trials. All interventions took place in targeted communities (Clasen et al., 2010). According to the evaluators, the results showed variations in effects between the selected groups. Among the 13 study trials, 11 were found effective in preventing the spread of the disease. Aside from these predictors, other baseline sanitation approaches like water and hygiene practices were also assessed. However, comparing the results was difficult due to methodological and logistic constraints (Clasen et al., 2010).

After the evaluation of literature on the benefits of improved hygiene, especially safe disposal of excreta, hand washing and hygiene, Curtis et al. (2011) affirmed that this type of intervention is the most effective and cheapest for reducing infectious diseases. Although it does not require advanced technologies or expensive brands of soap to be used, the evaluators found that there was very little interest and involvement in it from the health, water, and sanitation sub-sectors (Curtis et al., 2011). There is sufficient evidence to suggest that were they to become more involved in providing hygiene and sanitary facilities to homes, schools, and health institutions, governments and donor agencies would bring significant gains to individuals and public health (Curtis et al.,

2011). Data collected based on observed hand washing from six countries: Bangladesh, Ghana, India, Kenya, Peru, and Uganda revealed that implementing the interventions in schools might be an added advantage because school children take what they are taught in schools home and have the potential to share that information and influence their families (Curtis et al., 2011).

## Existing Gaps in the Literature

The preceding section of this study reviewed the existing scientific literature and analyzed the theoretical and practical results of water and sanitation impacts on the social and economic development that focused on the NSD and Benue state in particular. Lack of unique and commonly agreed upon methodology in academic literature hinders evaluation of water and sanitation impacts on socioeconomic development in general. While those researches gave insights on this relationship with a wide methodological background, they however created some gaps in the literature which have to be addressed. These gaps include the exclusion of key players such as the rural people, special stakeholders like decision makers and local government officials, the omission of the twofold level of cost effectiveness and cost-benefit of interventions and an assessment of the water technologies.

### Key Players: the Rural People

A case could be made from the preceding literature review that health impacts were at the heart of most studies. In some of the studies, some of the project staff were technical professionals who supplied information about the results or the outcomes of intervention projects. Those kinds of results and conclusions were open to interpretation and judgment whether they were influenced by the projects' officials or they truly

represented the reality and views of the participants and beneficiaries. Much of the literature did not pay attention to key players: the rural people, their level of knowledge and awareness of the consequences of the issues about which the projects or programs were the main objectives (McGarvey et al., 2008; Tilt et al., 2008). The failures of some intervention projects stem from the exclusion of their beneficiaries who perceived those projects with mixed feelings hence their lack of support towards sustainability and social change. As an effort to fill this gap, these issues were addressed in this study.

With respect to the environment, the literature did not address as sufficiently as it deserved, especially when considered from the perspective of good practices to enhance the environment which is one of the indicators aimed at by rural water supply and sanitary facilities (Emch et al., 2010). In developing countries in particular, demand for environmental quality is often low due to poverty. Little attention is paid to the fact that lack of awareness about the impact to health effects due to environmental pollution especially by rural people does keep the demand low (Jalan et al., 2009).

**Stakeholder Participation**

In a study centered on the themes of stakeholders' participation in greywater management in the rural communities of Jordan, Dalahmeh et al. (2010) pointed out some of the advantages of stakeholders' participation in intervention projects. These include among others the selection of ideal types of technologies, locations of intervention, construction and operation of the units, problem identification, data collection as well as situation analysis. Furthermore, the incorporation of a broad range of sectors and stakeholders' in projects does not only ensure a feeling of ownership for the

projects, it also ensures cooperative management and enhanced quality output and sustainability (Dalahmeh et al., 2010).

Previous studies paid little or no attention to the knowledge and involvement of the stakeholders and local government officials and how important the impacts of programs are to benefiting rural communities (Mahmoodi et al., 2008). From some examples cited in the reviewed literature, in a few places where decision makers were involved at all, that involvement did not go beyond specified sub-sectors at the two tiers of government (national and state). Although the collaborative involvement of local governments and their officials is essential their views in decision making are rarely sought, regardless of the fact that their officials have a more direct relation with both the programs and the intended beneficiaries (Stedman et al., 2009). For any improvement projects to be implemented and expected to achieve their goals, these issues need to be critically considered and, where needed, decisively addressed as a matter of policy or should be included in policy formulation.

**Cost Effectiveness and Cost-Benefit**

A major gap the literature failed to address is the twofold level of cost effectiveness and cost- benefit of water quality interventions which all have a corresponding relationship and benefits to individual and community development as well as social transformation. On the cost effectiveness of interventions or programs, whether it is increasing access to improved water and sanitation for everyone, providing water treatment technologies at the point of use, or providing regulated piped water supplies within homes and sanitary facilities, there are cost variations for each when compared. This factor would have to be considered right from the planning stages in each

given intervention and how appropriate it is to benefiting communities, but also their suitability to the regions or countries that will utilize them (Holland et al., 2011; Magoon et al., 2010).

Hand-dug wells, for example, which are non-piped, have a lower cost compared to boreholes and other standard water projects. In a similar way, the cost of constructing standard toilet facilities is higher than the construction cost of a pit latrine. This assertion was confirmed by Shankar & Singh (2011), with examples from their studies of a rural community, Varanasi in India where such projects were implemented and the costs compared. Aside from this, the cost of household interventions such as chlorination and filtration were also compared and found to be relatively low, especially when considered from the perspective of places and situations where resources are scarce.

It would be hard to argue that the cost of construction of tube-wells in rural Bangladesh and improved pit latrines in Malawi, for example, can be compared with regulated piped water projects or standard sewage facilities elsewhere. This is not to imply that interventions where high costs are required should be avoided. Indeed, if it is projected that the money saved from public health improvement and the benefits of development would offset the cost of implementation, such programs could be executed (Kalulu et al., 2012).

A good starting point for considering the worthiness of the capital costs of water and sanitation programs is the direct economic benefits of such interventions. The point of emphasis here is more on the net rather than gross costs involved in executing projects of social development. There are a number of ways through which direct economic benefits are realized as a result of services from projects or interventions. These include

the expenses saved which would be gone for the treatment of diseases associated with poor water quality and other impacts (Palaniappan et al., 2010). When patients seek medical attention, there are a variety of ways that indirect costs are incurred, and when such services are provided they have direct cost bearing on the patients or the employers who cover such costs. There are also other direct costs incurred by patients such as transport, food, and drinks when they make visits to health care facilities.

There are also some indirect financial benefits due to improvements in health directly associated with projects or programs. Long term economic gains from reducing deaths and physical disabilities of family members, as well as costs saved or avoided from over-all health care and non-health care issues, all have a cumulative link to community development over time (Palaniappan et al., 2010). Other benefits include the time saved which would otherwise be wasted during illness, as well as the number of working days gained from prevented illness. Of equal importance are the consequences of illness for children of school age which adversely impacts their over-all education, which is not good for the future of the society and its social economic development.

The cumulative non-health benefits associated with water and sanitation is time saved. The point was made previously about the considerable amount of time women and children (especially girls) spend collecting water. Such time and the number of days wasted could be reduced if sources of water are brought closer to households and communities. When such time is calculated as per capita gain, it amounts to huge economic benefits which over time could lead to individual and community development (Sigenu et al., 2009).

In developing countries such as Nigeria, for example, if the finances spent daily by the poor on water vendors were invested in standard piped water supplies, apart from being more economical, they would have better water quality and services. It is hoped that those who have access to information, whether as users or decision makers, will share that information to provide insights so that governments and donor agencies will target future programs to the areas and communities that are in most need. Projects should be designed to meet the needs and concerns of benefiting societies who depend on them.

**Human Resources and Water Supply Technologies**

A key gap in the current literature and an important element evaluated in this study was the water supply technologies used in the developing countries such as Nigeria and the quality of services they deliver. From the literature that was reviewed, an understanding emerged that the attention of researchers and evaluators of water and sanitation interventions was always on the kinds of factors identified in the theoretical framework that made the assessments less holistic. In some instances where an assessment of the projects were made the focus was more on establishing the successfulness from their implementation with the aim to justify the projects' costs. This approach in many cases negated other essential components such as the human resources associated with the programs, the effectiveness of the programs, their efficiency and sustainability and how these deficiencies can and do impact the overall goals of the programs. In this study, the factors associated with water supply projects and their technologies such as human resources and infrastructure, documents and records and internal audit among others were evaluated.

I considered the evaluation of these factors to be important and necessary apart from the reasons given above for other reasons as well. It is common for regimes and leaders who have corrupt tendencies and practices to beat public drums about all kinds of socioeconomic development projects that are implemented and the huge finances expended for the said projects. It is also common in a number of cases and instances that those projects are practically none existent. In a few cases where they exist at all, the quality, durability and the standard of services to be offered from what is implemented hardly justifies the public drums and expenditures. Since corruption is the direct intent, there are usually no documents and records for verification or to justify those reports. It is also possible for high capacity water supply technologies for example not to be assigned competent trained personnel. Those appointments are intentionally made so that the lack of skills would lead to incessant break down of the technologies. When this happens, huge "repair expenses" are reported when in fact those resources are again misappropriated. Ultimately, the absence or lack of effective, efficient and sustainable development programs or their failures have direct connections with human resources and the factors evaluated in this study.

## Summary

In this chapter, the literature concerning the impact of portable water availability on the socioeconomic development of the NSD and Benue state was reviewed. Human civilization, development, and survival are closely linked to water and water supply. Potable water supply, sanitary facilities, as well as hygiene practices are necessary, not only for protecting life and the health of people, but also for individual and community productivity, as well as the socioeconomic development and social change. Over 80% of

global sickness and disease are due to the lack of potable water supply, inadequate sanitation, or polluted water (WHO, 2012). It is important therefore that rural communities should not only be provided with potable water supply, also sources of water supply, especially those used for drinking and domestic purposes should be adequately protected in order to prevent their contamination and the outbreak of diseases as well as cases of mortalities resulting from the contamination and poor water quality.

There are great benefits to be derived from potable water supply and sanitary interventions as well as protecting other sources of water supply. Some of the benefits include savings associated with health and medical expenses incurred from services received and fighting disease. Such financial savings can be profitably directed towards development objectives for the good of families, as well as communities. Aside from this, those interventions save the time utilized by women and children who bear the burden of water collection for household and domestic purposes. The time saved from such chores accords women opportunities to engage in productive activities that are financially rewarding that also contribute to their families and communities as well as improve their social standing. Such availability of time can also provide children more time and opportunity to attend school which can improve their future as well as transform their families, communities and the society at large.

While it is possible that water supply and sanitation interventions can enhance the development of rural communities, the failure of such programs in some countries and communities of the developing world are due to the lack of community and stakeholder participation. It is important that such programs should be carried out in collaboration with key stakeholders from the beginning to the final stages of their implementation.

What makes this process so fundamental is the fact that the involvement of stakeholders and the rural people does contribute to increased awareness of the value of such programs and also their implications on the environment and how environmental management is essential for the socioeconomic development of rural communities. Good environmental protection can also guarantee the wellbeing of future generations.

In conclusion, this chapter focused on the theoretical hypothesis that the economic development and social transformation of the rural communities of the NSD and Benue state, Nigeria are impacted due to the lack or inadequate water supply. This framework was supported by three theories: Hugo's theory of population growth and migration (2008) that has close links with the phenomenon of migration and brain drain (Omamegbe et al., 2010). This theory helped in understanding how the absence of basic social amenities in most countries of the Sub-Saharan Region motivates Africa's youth to migrate to the United States of America in search of green pastures (Omamegbe et al., 2010). These two theories have cumulative results in the theory of growing industrialization and overcrowding (Acey et al., 2011). In a number of places such as the NSD of Benue, these factors can and do lead to competing demands for agricultural land and water which is in acute supply in developing countries and rural communities in particular.

Aside from the central theories, other important variables associated with the study framework included water and human life, the necessity of potable water supply for community development, water and public health, water pollution, loss of capacity for self-purification, the prevention of disease and mortalities, free time for women and children as well as the role of women in economic improvement. Also included were

enhanced community development, environmental implications, impact of climate change, population growth and migration, growing industrialization and overcrowding, uncontrolled pollution, rural development and environmental implications, investments in water and sanitation for the rural poor as well as rural water program evaluation. Other variables include rural water programs, rural water supply in Benue state as well as rural water programs, an overview of evaluations and the key gaps in the literature. All these theories and variables provided both the breadth and an in-depth understanding to how in combination, they were the root causes and impacted the economic development and social transformation of the NSD and Benue state, Nigeria.

Chapter 3 provides the research design that was employed for this study. It then describes the different instruments that were used in data collection, and the sampling procedure as well as the levels involved. It also provided information about the techniques the researcher used in analyzing the data. Aside from these components, this chapter also discusses the measures that were taken to ensure the validity and reliability of data, as well as the problems that were encountered in the course of field work.

# Chapter 3: Research Method

I designed this research to evaluate how the economic development of the NSD of Benue state, Nigeria is impacted by the lack of water or inadequate potable water availability. I have described the quantitative methodology, the cross-sectional survey, the method of the survey sampling, and the participants who were selected for the study. I have also provided information about data collection and the techniques I used in analyzing the data. In addition, this chapter addresses relevant validity and reliability issues. My goal in this study was to evaluate water supply projects and the kinds of technologies used in the NSD of Benue in order to establish the relationship between lack of water supply and its impact on economic development of the SD and the role Benue state governments played in this economic development process.

I collected quantitative data from additional secondary sources. These data sources included publically available government statistics and surveys that confirmed the number of water supply projects established within the NSD by Benue state governments. The aim of the investigation was to create a model for improving the water supply to the rural communities of the NSD of Benue state, Nigeria. To achieve this objective, the research question I posed was:

**Q1.** What was the nature of the relationship between the lack of potable water availability and the economic development of the NSD district and Benue state Nigeria?

**$H_o1$** There was no correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

**$H_a1$** There was a correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

## Theoretical Hypothesis

I chose the quantitative survey method because it limited the possibility of my influence over the variables (Vogt, 2007). This means that there was a better chance that the results would be very independent. Besides this, according to Black et al. (1999), studies that are conducted independent of researcher's influence are likely to be more objective. I saw this choice of survey method to be an added advantage.

This method of study is valid as a basis for understanding the concrete evidence about the situation by analyzing people who are responsible for decision making (Black et al., 1999). Other advantages of this quantitative study method are that the collection of data is relatively quick and less expensive. Data is more accurate, and it is interpreted quantitatively and numerically. Data analysis consumes less time, especially when a statistical software is used (Black et al., 1999).

## Research Design

There were different study designs reviewed in Chapter 2. While some of the studies were longitudinal, others were case studies. Longitudinal studies were concerned with existing situations prior to the programs' interventions and comparisons made of the conditions after the programs' intervention in the target areas. The focus of most of those studies was water and public health, the prevention of diseases and mortalities, as well as the availability of time for women and children. Other areas of interest included the role of women in economic improvement, enhanced community development, environmental implications, evaluation of rural water, as well as sanitation and hygiene programs and

their impact on rural communities. All these factors can greatly impact individuals and communities and worsen their socioeconomic status and in some cases increase the situation of poverty if not adequately and decisively addressed.

Although numerous studies have been conducted about water problems in Benue state, none of the studies holisitcally evaluated the impact of lack of potable water supply on the economic development, especially of the NSD of the state. Against this background, it was challenging to come up with an idea choice for the design of this study. Every study conducted about the impact of interventions, according to Pattenayar et al. (2009), the validity and verification of the conclusions depend on individual choices of evaluation methods.

I chose the quantitative research method over other methods because of its objectivity; this is especially important when the research is about complex relationships and correlations between different variables (Black et al., 1999). According to Black et al. (1999) this method of survey has the potential to be more practically applied in water supply technologies and in settings wheren authorities/agencies with decision making are invloved. Apart from these advantages, data collection in quantitative research method is quick and relatively less expensive and it provides a more accurate quantitative numerical data (Black et al., 1999).

The advantage of a nonexperimental survey method is that it takes into account the experiences of individuals and their analyses of events (Babbie et al., 2008). These experiences and peoples' analyses of events are more valid as a foundation for understanding a phenomenon and decision making by those in government or authority

(Black et al., 1999). Due to some logistical factors that posed a challenge in conducting this research, such as financial and time constraints, I utilized a cross-sectional approach. Financially, the study was entirely my responsibility financially and otherwise. This made a shorter time frame for its conduct a huge advantage. A cross-sectional approach enabled the research to take place at a single point in time and greatly minimized cost. The size of the participant sample and the instruments of survey both favored a cross-sectional choice of the study. Utilizing this survey method allowed a cross-section sample of the population that nonetheless allowed the generalization of the findings.

I adopted and modified for this study the Uganda MoH and CPHL version of the WHO and AFRO Laboratory Assessment Checklist survey that was tested, approved and has become a well-established tool used for assessing and improving laboratory quality in Uganda (Elbireer et al., 2012). Elbireer et al. (2012) used the instrument for his study in assessing and improving populations of 83 moderate/high complexity level laboratories in Kampala. Although the instrument in its original context was utilized in a different field of study from mine, I considered its use appropriate because I contexually likened the laboratory technologies to those of water supply.

The Uganda MoH and CPHL version of the WHO and AFRO Laboratory Assessment Checklist is a gradual implementation scheme of laboratories quality improvement. The instrument and implementation scheme was in line with international standards of laboratory assessment with scare ratings, starting from zero to five stars (Elbireer et al., 2012). The Uganda MoH effectively modified, tested and approved the survey instrument which is made public, and was used as part of another dissertation research study by Elbireer et al. (2012). In keeping with the use of the survey instrument

by the Uganda MoH, it is my hope as I adopt the isntrument for this study that the outcomes generated would help propose a model for the gradual implementation of new water supply systems in the NSD in order to meet the target of the MDGs by 2015.

I modified the Ugandan Laboratory Assessment Checklist in order to give it contextual bearing to this study. From the 12 sections of the Ugandan modified assessment checklist, I removed section four in my modified version. I also removed or changed some survey questions in other sections of my modified version. The changes or modification that I were made were not substantial; therefore the survey instrument did not need to be revalidated. Utilizing this method, I was able to quantify the kind of water supply technologies used in the NSD of Benue state and evaluated their performance standard as well as the quality of water services they offered.

I obtained a letter of approval for the release of data and information from the Benue state government authorities. As highlighted in the approval letter, that results/outcome and recommendations of this study would enthusiastically received and put into acton by the officials of the Benue state MWRE as well as other related stakeholders.

In order to obtain accurate assessment information about the 43 water supply projects implemented by Benue state governments in the NSD and their impact on the communities, face-to-face contact was made with all the 43 project managers at the different community locations. Five officials of the Benue state MWRE were also contacted. These individuals were professionals in the ministry as well as the technical professionals in charge of the water supply projects whose knowledge and information helped in understanding the quality of water services provided and the ensuing impact on

the SD. This approach enabled me to gain a better understanding about the performance of the technologies and how the basic technology management skills of project managers contributed to the level and quality of services provided to the rural residents of the benefiting communities.

The information that was gathered from the survey data of all the quality standard factors was correlated and compared to the overall quality and standard assessment score from all the water supply projects serving the water needs of the people of the NSD. The information generated from the assessment checklist provided a better understanding of the study outcomes upon which a model is proposed to decision makers and Benue state governments for improving the quantity and quality of potable water supply to the NSD of the state.

Although this quantitative method of research has the advantages highlighted above, according to Creswell et al. (2009) there are also potential weaknesses associated with it. Among these is the fact that it can easily happen for a researcher not to clearly present the experiences of the participants and communities concerning a situation. This scenario can also affect the researcher's judgment to draw correct inferences from the data about the population. I am from the NSD of Benue so I am familiar with the SD well as the lack of potable water availability in the region. While it is possible for this study to provide information that supports the need for improving the supply of potable water to the SD, it is also possible that the results and recommendations of the study may be at odds with the current water development programs. I anticipated that using the already validated WHO-AFRO Laboratory Assessment Checklist survey would reduce the impact of these weaknesses.

Another disadvantage of utilizing the quantitative research method to holistically assess the impact of potable water supply is the excessive time commitment for one researcher (Elbireer et al., 2012). I personally administered the survey in collaboration with three research assistants who were trained by me and they worked closely with me. There were also logistical concerns that posed challenges, such as finances, the limit of time within which the survey was conducted and completed, as well as the required personnel to assist in conducting the research. A non-experimental, quantitative survey was deemed most appropriate because it was the best option for coping with these logistical concerns.

## Research Question

The research addressed a question that focused on the relationship between lack of potable water availability on the development of the NSD and the role Benue state governments played to address this problem.

**Q1.** What was the nature of the relationship between the lack of potable water availability and the economic development of the NSD district and Benue state Nigeria?

## Hypotheses

The main objective of this study was to evaluate if there was a possible connection between lack of potable water availability and its impact on the development of the NSD and Benue state and the impact the Benue state government played in this economic development process. The following hypotheses were presented as specific statements of prediction for the research question. To enable an evaluation of the research question, the null ($H_o$) and alternative ($H_a$) was tested.

**$H_o1$** There was no correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

**$H_a1$** There was a correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

## Setting and Sampling

The study included all the water supply projects implemented by Benue state governments in the NSD of the state that were identified by the Benue state MWRE. These projects included those on the large, medium and small scale. This researcher used "large scale" to describe water projects with technologies that have the capacity output that could sufficiently serve the water needs of at least from 2000-4000 or more residents all year round. "Medium scale" was to denote water projects with motorized pumps that have the capacity output to effectively serve the water needs of at least from 1000-2000 residents all year round. "Small scale" was used to describe water projects that utilize hand pumps that could efficiently serve the water needs of at least from 500-1500 residents all year round (Gleick et al., 2009).

As of May 2013, there were 43 water supply projects in the NSD of the state implemented by Benue state governments. Out of the 43 projects, four were identified as large scale, 10 were identified as medium scale and 29 as small scale. The latter (small scale) were equipped with hand pumps which were small and simple technologies. For this study to make a fair assessment and have a better understanding about how effective and efficient the 43 water supply projects were serving the water needs of the speculated 1,000,000 to 2, 000,000 members of the SD, attempts were made at obtaining accurate figures (if any) of the population of the NSD at the time of this study. This approach was

to help the researcher identify the numeric distribution of the water supply projects in each of the 14 LGs that make up the NSD. This was to further enhance an understanding of the average percentage of the population each of the units were planned to serve. Ultimately, this approach was to help in understanding how apart from the water related issues discussed in the review of literature there were other factors associated with the lack of potable water that impacted the development of the NSD and Benue state, Nigeria.

**Participants**

I utilized the survey assessment checklist and interviewed one manager (key informant) at each of the 43 water supply projects at its respective community location within the NSD (14 LGs). The key informants were for this study defined as the managers (operators) of the water supply projects who had good knowledge about the working system of the technologies and projects they were in charge of. Those also included were five official members of the Benue state MWRE. These were state officials who had good knowledge about water resources development and management as well as good hygiene and environmental practices whose knowledge and information contributed to the objectives of this study.

**Study Units**

The study units in this research were identified as the water supply projects in the NSD of Benue. According to the Benue state MWRE, there were 43 water supply projects in the SD as at May 2013. All the 43 water supply projects were surveyed in this research. While all the 43 water supply projects in the senatorial district were implemented to supply water to the benefiting communities, those identified as large

scare have technologies different from those identified as medium and small scare. Based on the fact that the large and medium scare projects have different and more complex technologies, they required some scientific or technical training for their managers (operators) to more effectively operate them. It was paramount therefore that appropriate measures would be put in place in terms of regulations and principles that required their continuous monitoring to ensure their efficiency, effectiveness and sustainability.

**Sample Size**

A total of 48 participants were included in this study. One manager (operator) at each of the 43 different water supply projects, also included were five officials from the Benue state MWRE. From each of the water supply projects one participant was selected for the study as well as five officials from the state. Small scare water projects especially boreholes that are equipped with hand pumps do not essentially require specified managers (operators) since the technology is simple and easy to operate by the resident members of the benefiting communities. However, in each of these projects a community approved member was trained by the MWRE who served as the project's care taker and liaison between the community and the state ministry. Those designated "managers or operators" in all the locations were also be interviewed.

## Materials and Instrumentation

In preparing for the research instrument with a focus on areas of concern, I collected data from primary and secondary sources. Primary data was collected by conducting face to face interviews with one principal manager of each of the 43 community water supply. Participants were also drawn from those whose knowledge and

experiences contributed to the research; that was, five Benue state government officials in the MWRE. This brought the total number of participants that were interviewed to 48.

Secondary sources included materials that digest, analyze, evaluate, and interpret the information contained within primary sources or other secondary sources such as books, journal articles, and peer-review or research articles related to potable water supply within the African Sub-Saharan Region. Other sources included original written records, statistics, and surveys from government sources that provided direct evidence of firsthand information about the number of water supply projects established within the NSD by Benue state governments and from donor agencies (Waddington et al., 2009). These sources provided information concerning the topic under investigation. They also produced an in-depth understanding about the impact of potable water availability on the economic development of the NSD and state.

**WHO and AFRO Laboratory Assessment Checklist**

For the purposes of collecting the water supply assessment quantitative data, I utilized one instrument, the WHO and AFRO Laboratory Assessment Checklist survey. According to Elbireer et al. (2012), the instrument was used by the Uganda MoH and CPHL to assess the quality of government laboratories and to provide a standard measure by which laboratory services in Uganda were to be strengthened. In this study, I utilized the instrument however with slight adjustments (modification). In the adjustment, from 12 main sections of the original assessment tool, section four was removed and some of the factors for assessment in other sections were also removed (refer to Appendix B). The adjustment was considered necessary so that the factors on the Uganda modified version

and the checklist that had no direct bearing to this study were replaced with those that were in keeping with this study and its objectives.

The WHO and AFRO Laboratory Assessment Checklist tool has a survey structure with 12 sections that are constructed to collect information about the attributes of the quality management systems (QSEs) facilities (Elbireer et al., 2012). The general information section of the tool seeks quantitatively the demographic characteristics of the laboratories' studied with specific attention to areas of interest such as laboratory testing, laboratory affiliation, laboratory testing menu, suitability of staffing and the level of education of the laboratory personnel. The main sections of the survey and the factors that make up the 12 QSE were:

- Documents & Records (six factors were assessed)
- Management Reviews (three factors were assessed)
- Organization & Personnel (five factors were assessed)
- Client Management (one factor was assessed)
- Equipment (eight factors were assessed)
- Internal Audit (one factors was assessed)
- Purchasing & Inventory (eight factors were assessed)
- Information Management (six factors were assessed)
- Process control and Internal & External Quality Assessment (14 factors were assessed)
- Corrective Action (four factors were assessed)

- Occurrence/Incident Management, process Improvement & Customer Service (three factors were assessed)
- Facilities and Safety (21 factors were assessed).

**Research Instrument**

This survey instrument was designed as a simplified accreditation scheme by the WHO-AFRO. The gradual implementation of the scheme was in line with international standards of laboratory assessment with scare ratings from zero-to five-stars. According to this scheme, laboratories that were rated below 55% did not merit a star due to poor standard performance. However, laboratories that scored from 55% and above merited a star and those that scored from 95% and above merited five stars in rating (Elbireer et al., 2012). Utilizing this rating process helped in identifying laboratories with potential limitations and those laboratories were made to know their position from the assessment and the gradual steps they needed to take to improve their quality of services. As stated above, this survey tool was adopted from the WHO and AFRO laboratory assessment with the total score for the Uganda MoH and CPHL of 180 points taking a stepwise scale form first to fifth step marking a gradual implementation of the standard laboratory quality recognized internationally.

Under this structural arrangement, laboratories that performed below 98% score points (that is less than 55%) were categorized below the minimal accepted standard of laboratory quality. Those however that scored 55% or more of the total score were awarded stepwise beginning from the first step (an equivalent of one star) up to the fifth step (an equivalent of five stars) when the total score was above 95% it was considered an equivalent of international standards for accreditation (Elbireer et al., 2012). As the

Uganda MoH used this instrument to assess the quality of laboratory services, this researcher believed the same instrument could be utilized to measure similar constructs which helped in establishing the content validity of the questionnaire (Black et al., 1999; 2009 Vogt et al., 2007).

The failures of many water and sanitation intervention programs in the developing countries including Nigeria and the NSD of Benue state in particular have a lot to do with the lack of or poor assessment of such programs. This problem is further complicated due to the absence of standard assessment tools that could form the basis for such assessments. There are hardly checklists and items upon which prior assessments would be based in order to more holistically identify the key issues associated with the lack thereof or the poor delivery services to address the water needs of communities and peoples. It is my hope that this tool will subsequently become useful to other researchers and evaluators of water programs.

Some of the descriptive terms used in the Uganda modified instrument for example laboratory were replaced with appropriate terms associated with this research such as high capacity pumps, motorized pumps and hand pumps. I defined high capacity pumps as water pumps that are powered electrically and are by capacity designed for large scale water projects that supply water to cities, towns or villages with populations from 2000- 4000 or above. Motorized pumps were those that are powered with the use of gasoline and are by capacity designed for medium scale water projects that supply water to villages and communities with smaller populations than cities and towns. Hand pumps were those technologies that are designed for small scale water projects operated manually and can serve the water needs of small villages and communities. Also

modified were the items assessed in the main sections. While the original (Ugandan modified) assessment tool has 12 sections, some of the sections and items assessed were adopted as are in the survey tool. However, one of the sections was removed (section 4) and some of the items were also removed or changed (Black et al., 1999). (Refer to Appendix B). From the perspective of this understanding, the slightly modified (adjusted) checklist included the following:

- Section 1: Documents & Records (four factors were assessed)
- Section 2: Management Reviews (three factors were assessed)
- Section 3: Organization & Personnel (five factors were assessed)
- Section 5: Equipment (six factors were assessed)
- Section 6: Internal Audit (one factor were assessed)
- Section 7: Purchasing & Inventory (seven factors were assessed)
- Section 8: Information Management (four factors were assessed)
- Section 9: Process Control and Internal & External Quality Assessment (four factors were assessed)
- Section 10: Corrective Action (three factors were assessed)
- Section 11: Occurrence/Incident Management, process Improvement (three factors were assessed)
- Section 12: Facilities and Safety (15 factors were assessed).

The overall assessment of the survey has the total score of 180 points taking a stepwise scale from first to fifth step marking a gradual implementation of the standard laboratory quality recognized internationally (Elbireer et al., 2012). In view of the

objectives of the Millennium Development Goals to reduce to half the world population of those without access to improved water supply and sanitation by 2015 and beyond, I followed the same grading and scoring pattern as utilized by the Uganda MoH and CPHL in assessing the standard and quality of services offered by the water supply programs in the NSD of Benue state, Nigeria. As the Ugandan assessment of laboratory quality of services aimed at a gradual accreditation process and improvement to meet international standards, it is my hope that a similar approach would help to both improve and accelerate the standard and quality of water supply to the NSD of Benue in order to also meet the international standard and quality of the MDGs. Although there was slight modification of the assessment tool for this survey, the total score points were the 180 as shown above (Black et al., 1999).

Under the Ugandan MoH and CPHL assessment structure, laboratories that performed below 98% score points were categorized below the minimal accepted standard of laboratory quality. The laboratories that scored 55% or more of the total score were awarded stepwise beginning from the first step (an equivalent of one star) up to the fifth step (an equivalent of five stars) when the total score was above 95% it was considered an equivalent of international standards for accreditation (Elbireer et al., 2012). As the Uganda MoH used this instrument to assess the quality of laboratory services, this researcher believed the same instrument could be utilized to measure similar constructs which helped in establishing the content validity of the questionnaire (Black et al, 1999; Vogt et al., 2007).

I assumed that based on the similarities of the current research question and hypotheses to the dissertation study conducted by Elbireer et al. (2012) that utilized this

survey tool, there was no need to pilot test the instrument for re-validation (Babbie et al., 1990). I personally administered the survey in collaboration with three research assistants who were properly trained by me and they worked closely with me to ensure the consistency of the survey to the research participants in the same manner. For lack of knowledge about the communities at which the water supply projects were located, the research assistants also served as "tour guides". These assistants were people familiar with all the communities benefiting from the water supply programs including the managers (operators) of those water projects. Their presence was an added advantage for the team to secure the support of village leaders.

**Reliability and Validity**

In order to ensure internal reliability of the instrument, I examined the records of water supply projects to be certain that the records or reports were consistent with the instruments and the causal links of interest to this study (Vogt et al., 2007; Yin, 2014). In like manner, the external validity of the instrument was secured by keeping to the sample units all through the course of the survey. In this way the concerns about other agents having access to the survey that could have otherwise led to little validity and confounding of the results to occur was avoided (Black et al., 1999). Also as an external validation of the instrument, this research generalized about the population the study focused on as well as to other populations. Such generalization showed that the outcomes of the study may be applied to others or similar situations in Benue state, Nigeria and other countries in the African Sub-Saharan Region (Vogt et al., 2007). For the fact that it was crucial for me to find a baseline survey that holistically evaluated water supply

programs upon which this study was to rely, this study may serve as a tool for similar researches in the future.

## Operational Definitions of the Variables

The research about the impact of potable water availability on the development of the NSD and Benue state, Nigeria was conducted using the quantitative research method. Taking a moment of departure from the quite familiar factors upon which water and sanitation impacts have been evaluated in many researches such as health and diseases, in this study data was collected on other aspects of water supply projects' impacts with the use of well-structured questionnaires (refer to Appendix B). The information collected was helpful in understanding the underlying factors responsible for the lack of or poor accessibility of potable water to the NSD of the state. With the help of three research assistants, I collected data on the research sites from respondents within a specified frame of time.

### The Quality of Water Systems Variable

Among the many factors or reasons responsible for the failures of many intervention programs/projects in the developing nations is the choice and quality of the technologies (Magoon et al., 2010). Weak economic status of many developing nations and individual states within nations often leads to the choice of technologies of lower economic value and hence poor (fragile) quality as well. Such technologies often times do not deliver the quality services expected and are generally not durable (Magoon et al., 2010). There are also situations where the problem is poor or improper implementation process that results to unsuccessful outcomes. The general quality of the water systems (high capacity pumps, motorized pumps and hand pumps) were therefore assessed in this

study. This over all systems' quality assessment helped in understanding the factors responsible for poor outcomes of programs or their out-right failures to meet the goals of implementation.

This quality assessment was based on the standard scoring procedure as adopted from the Uganda MoH and CPHL for each of the factors in the sections of the survey. In order to meet the gradual implementation quality standards of laboratories recognized internationally, the Uganda MoH and CPHL utilized a stepwise scare which I also used. Although modifications were made to the assessment checklist, the total scores for this survey were 180 as in the Uganda 180 points. This total score was maintained in order not to create problems at the end of data collection and differences in statistical analysis.

The intent here was similar to that of the Uganda laboratory assessment: to identify the water supply programs in the NSD of Benue with weak performances and let them know so that improvement efforts would be made in order to meet both the implementation objectives and the MDGs by 2015 and beyond in what was described as "dynamic operation" (Montgomery et al., 2009). In the grading scheme, the water projects that were rewarded below 98 points (less than 55%) were marked as performing below the minimal expectation. The water projects that scored 55% or above the total score were awarded the stepwise system beginning from the first step (an equivalent of one star), up to the fifth step (an equivalent of five stars). By a water project achieving 95 % or more of the total scores was considered meeting the goal of their implementation (refer to Appendix B).

**The Resources Capacity of the Water Projects**

The success or failures of many intervention projects have close links with the knowledge and skills of the staff or technology managers (operators). If a high quality technology for water supply project for example is purchased, properly installed but the skills and ability of a manager (operator) are lacking such a technology and project would fail to deliver even if there is effective community demand (Montgomery et al., 2009). The hiring, training and retaining of skilled technicians alongside the entire process of the projects' implementation are critically important if such projects are to succeed and meet their set objectives. The assessment of human resource capacity was important for understanding how the knowledge and skills (quality) of managers (operators) can and does affect the quality and delivery of services to meet the water needs of communities.

The evolution of technology has grown so much that no matter how simple or small some technologies are, they may however be complex to operate. Against this development it is essential that technicians should have a certain level of education and skills appropriate for their use of designated technologies. This survey variable was assessed based on the level of education and qualifications of the water managers (operators) especially for projects with high and medium capacity pumps and hence their competence to operate the equipment to offer the required services. In this section of the survey, the factors assessed included personnel files containing vital information about staff levels of education, documented job orientation/description, clearly defined lines of authority and responsibility, personnel training policies and procedures as well as records of competency assessment.

Together, the quality of water systems and the resources capacity variables were related to and helped in answering the research question about how these factors have a relationship to lack of potable water availability and the development of the NSD of Benue state, Nigeria. In this section, from the factors that were quantitatively assessed, if all the information concerning organization and personnel (resources capacity variable) were all marked correct, a total of 14 pints were to be awarded. If the four factors for assessment in the quality of water systems variable were all marked correct, a total of 8 points were to be awarded bringing the total points in the section to 22 scored.

**The Records and Documents Variable**

One of the many challenges evaluators of water and sanitation programs have faced in the developing countries is the lack of data and information concerning those projects and the activities related to them. The point was made in a previous section of this research about how the lack of adequate or total absence of records and documents about programs have frustrated evaluation efforts or led to inaccurate and misleading information, results and conclusions by evaluators (Nadeem & Hameed, 2008; Quinn, 2010). It is absolutely important that there should be records and documents associated with water programs whether they are about high, medium or small capacity pumps. To make an objective assessment about the water supply projects and their related activates, this research assessed whether there were records and documents associated with water supply projects implemented by the Benue state governments or not. It is essential and records should be available to show that individual employees' read, understood and signed accepting their responsibility for the projects and the tasks associated with them.

This records and documents variable was related to and helped answer the second part of the research question about the role Benue state governments played to address the problem of lack of potable water availability on the development of the NSD. At the end of the assessment of the factors in this section there were 16 points to be awarded. Well organized records and documents are vital for all organizations apart from keeping track of their activities, they are also vital for auditing by stakeholders and donor agencies. The data that were collected quantitatively from all the survey sections was processed and their analysis helped significantly for developing strategies that would bring about improvements in the provision of potable water to the NSD of Benue state and ultimately bring about development and social change.

## Data Collection

The collection of quantitative data for this research was done using the WHO and AFRO Laboratory Assessment Checklist tool (refer to Appendix A). Data collection was coordinated and participated in by me in collaboration with three research assistants. The selection of the assistants was done in consultation with the Benue state officials at the MWRE. This choice was carefully thought because I did not know some of the communities at which water supply projects were located. The assistants knew all the communities and water projects' locations including each manager (operator) who participated in the survey, thus they also served as "tour guides". Those assistants were selected on the bases of education background, a bachelor degree and a minimum work experience in the water sub-sector of two to three or more years. A prior knowledge in research was an added advantage.

The research assistants were properly trained by me in order to have good knowledge about the survey as well as the objectives of the study and were able to relate well to each of the research participants. Key aspects of their training included consistency with data collection, observance of research ethics, informed consent, participants' right as well as an overview of the research. I documented the training of the research assistants. Before administering the survey tool, each participant of a water supply project was served with a letter of informed consent (refer to Appendix C) in which the topic and purpose of the study was introduced. Each participant's questions and issues of concern were addressed and their written consent provided before administering the survey. For purposes of quality assurance, I had weekly meetings with the research assistants and reviewed the survey and other matters of concern.

**Processing of Data**

Black et al. (1999) mentioned that one of the greatest challenges researchers face especially in quantitative studies is communicating their research findings to others. While using statistical tools may not pose a problem to readers who are familiar with what is being described, many readers who may not be familiar with the filed in which the research is conducted or may not be sophisticated in the use of statistical tools but will nonetheless need to understand the outcomes of the study as policy or decision makers (Black et al., 1999). It was therefore important for the purposes of professionalism, accuracy and understanding of this quantitative survey, for data entry to be done by a well-trained competent data technician using a double entry technique and was validated by me. The data entry technician did not need to be trained by me because there were those kinds of individuals who have undergone such professional training of

their own and who do such jobs for a living. For me to find a competent technician was therefore not problematic.

Prior to the data entry, data checks and controls were put in place to ensure their accuracy, detection of potential errors as well as consistency and validation of the entry. Aside from these methodological approaches, with the permission of research participants, their contact phone numbers were obtained at the time of the survey for callbacks in situations where clarifications were needed. For confidentiality of the research participants, special codes were used in cases of unidentified survey forms. Finally, I had a meeting with the research assistants and thoroughly went over each of the survey variables in the questionnaire and data entry and arrived at a consensus that all matters of concern associated with the survey were correctly and appropriately addressed. The training of the research assistants was thoroughly done by me and the format documented.

**Techniques of Data Analysis**

With the use of an internet based software, "R" statistical software ®, and Microsoft Excel® the data was analyzed with the use of statistical graphs and computations including the summation of scores in each of the survey sections and the variables. The modified and adopted laboratory assessment tool by the Uganda MoH and CPHL that was utilized for this survey comprised of three major components: a section on general information, the 12 QSE sections and two short questions that were responded to by the "key informants" about any other concerns, comments or suggestions they had for improving the standard and quality of water supply in the SD. From the slight modification (adjustment) made by me for the survey, section 4 was removed from the 12

QSE sections which brought the sections to 11. Furthermore, some factors for assessment in the 11 sections were either removed or changed to be in line with this study. In a few sections the factors for assessment were adopted as reflected in the original survey tool due to their contextual relevance to this study.

In order to assure consistency of data collection, I and the research assistants agreed on some characteristics that distinguished the water supply projects. The 43 water supply projects as at May 2013 were reported to be implemented by the Benue state governments and were identified as high, medium and small capacities respectively. This identification was clear and except if any water projects were discovered to be implemented by local governments or donor agencies with capacities different from those by the state government proper identifications were to be labeled as such. These identifications were to help in the course of quantitatively analyzing the data.

**The Statistical Approach**

In order to answer the research question, the nature of the relationship between lack of potable water availability and the economic development of Benue state, Nigeria, the statistical approach employed was Pearson product-moment correlation coefficient to ascertain whether there was correlation between the variables. By its design, this approach enables researchers to establish whether there is a correlation between the variables investigated and the degree to which that relationship exists (Rodgers & Nicewander, 1988). The Pearson product moment correlation is a parametric method that requires some assumptions concerning that data associated with the variables that are measured. Among the expected assumptions in this method is that the correlation between the variables has to be measured by intervals or ratio and should be normally

distributed with minimum outliers as well as a linear relationship between two or multiple variables and the data must reflect a random sample of the population studied (Black et al., 1999; Rodgers et al., 1988).

To test the hypotheses of the research question in relation to correlations for statistical significance, the *t*-test was used to evaluate if there was a significant difference from zero indicative of association between variables. All these assumptions I hoped would be met in this study and were evaluated by making scatter-plots and observations about the different factors that were assessed. In the end, there were no violations observed in the data analysis from the scatterplots observation, a re-assessment of the correlation was made as verification with the use of Spearman's Rank Correlation which is a non-parametric method that does not take into account any assumptions especially when parametric assumptions are not met (Rodgers et al., 1988).

**Assumptions**

I assumed that there would be at least one water project in all the 14 LGs of the NSD of Benue so that the research could cover the entire area and population as intended for the study. I also assumed that while it is possible over time that changes may take place as a result of improvements in the number of potable water supply projects along with some of the essential concepts, the standard and quality assessment of water programs would be maintained as foundation for future purposes. I also assumed that water projects' managers (operators) especially those with the high and medium capacity technologies would have sufficient knowledge about the working systems of the technologies in order to deliver high quality services to benefiting communities.

Each participant had enough time with and to respond to the assessment survey, it was also assumed therefore that their responses would be truthful and unbiased. It was also assumed that their responses would be devoid of fears about apprehensive measures that could be taken regarding the poor image (if any) of state leadership their responses may have portrayed. In order to ensure the confidentiality of the survey participants, they were given enough time to read carefully the letter of consent and ask questions of concern and sign them before completing the assessments. I also assumed that the survey process, data collection, processing and analyzing would be conducted with absolute integrity to the ethics and research requirements.

**Limitations**

As it is the case sometimes with many policies that no matter how well intended they might be in their formulation, it is another thing however for them not to be implemented. It was a limitation of this research for the findings to suggest that more efforts should be made by increasing water supply programs in the NSD of Benue yet for the need to be at variance with the water development agenda and priorities of the state. It is also common in politics and among political leaders some times that no matter the urgency of a situation or the needs of the governed, political leaders view them differently. Once programs that were designed by a particular government in power were not implemented (or fully) before the expiration of its tenure those programs are abandoned. An incoming government especially if from an opposing party appears to be reluctant to give a score point to the opposition by not following the policies or programs proposed prior to their coming into office to their logical implementation.

**Delimitations**

The study was limited to the communities of the NSD of Benue state, regardless of the existence of the situation in other parts of the state. Also excluded in the study were people from the NSD of Benue who migrated to other neighboring states even if their experiences about the impacts of lack of potable water availability were the same or similar to those who resided in Benue within the study period. In like manner, water projects that were not within the NSD were not included in the survey even though they may have been implemented by Benue state governments. The review of literature included some of the well-known factors that other evaluators of water and sanitation intervention programs normally focus on such as the prevention of common causes of water related diseases and death like malaria, diarrhea, trachoma and guinea worm among others with observations about a before and after intervention outcomes. Since those factors were already examined in the review of literature, they were not directly included in the survey as it is commonly done by other evaluators.

**Ethical Protections**

I complied fully with the Institutional Review Board (IRB) requirements. No data was collected before Walden IRB approval. In keeping with the requirements, the title or topic of the research was introduced to all the participants and the objectives of the study as well as its procedures were also explained to them before the commencement of the survey. All questions and other concerns related to the study were fully addressed from the onset. The letter of informed consent was given to all the participants, and all emerging questions were answered. Consent forms were signed prior to commencing

interviews, and participants were assured they could exit the interview at any time if they wanted to. I also ensured that the privacy protection of all participants was guaranteed.

Physical risks seem to be rare in social and behavioral research. However, I ensured that all potential risks associated with the study were adequately addressed so that the study was conducted in a safe and peaceful atmosphere. Any inappropriate conduct displayed by a participant or an unauthorized person(s) or member of a study area depending on the magnitude and need, law enforcement officers were to be promptly contacted so that appropriate actions could have been taken. Apart from these measures, the privacy protection was ensured by crating processes that maintained the confidentiality of data provided by participants. Specific survey data were available only to those involved in the study. Data and research findings were made available to officials of the MWRE and Benue state government that could not be identified with water supply managers (operators) to ensure their anonymity. Their names were not used in the survey other than a code number (water supply project). The data was stored with a code number and a computer protected with a password that was known only by the researcher.

## Summary

Potable water availability is essential for the development and social change of individuals, rural communities, states and nations. It is imperative to develop practical models for improving on and expanding potable water supply programs in the developing nations especially Nigeria and the NSD of Benue state in particular. Chapter 3 described the quantitative methodology including the cross-sectional survey, method of the survey sampling, and the participants who were drawn for the study. It also provided information

about data collection and the techniques I used in analyzing the data. In addition, this chapter also addressed relevant validity and reliability issues as well as the protection of research participants. The research was focused on evaluating water supply projects in the NSD in order to understand the factors responsible for the lack or poor water supply services in the SD and how this lack impacted the economic development of the SD and state. Relevant data were analyzed and from the perspective of the outcomes, areas that would serve as great opportunities for developing and improving the sub-sector services were identified.

I utilized a quantitative, non-experimental, cross-sectional method. The evaluation of high, medium and small capacity water supply projects implemented by Benue state governments in the NSD was an important part of this research. I assessed water supply projects in the NSD and by using this study method was able to quantify the quality management systems of the projects. I obtained a letter of approval for the data collection from authorities of the Benue state government, and the study was conducted in full observance of research ethics as well as complying with the IRB requirements and standards. The reliability of the study depended upon the breadth and depth of secondary literature and its ability to address the impacts of lack of potable water availability on the NSD of Benue state. The validity of the outcomes compared decision makers as well as Benue state government acceptance to pursue water programs that would meet water needs of the NSD as well as the MDGs and beyond.

Chapter 4 presents the results of the research findings. In doing so, the Chapter describes how the data were processed. It also provides the different techniques that were used to analyze the data. Additionally, it provides the statistical approach that was

employed to answer the research question as well as how the hypotheses of the research question were tested.

# Chapter 4: Results

The purpose of this quantitative research study was to evaluate the impact of lack of potable water availability on the economic development of the NSD and Benue state, Nigeria. I aimed to examine the causes of lack of potable water availability and how it impacted the economic development of the NSD and Benue state in general. This non-experimental study utilized questionnaires that were distributed to water supply managers at 43 different locations in the NSD and five officials of the MWRE to explore whether water supply technologies contributed to lack of potable water supply to the NSD and therefore impacted their economic development. I evaluated possible water supply problems that could be addressed by the MWRE and Benue state governments to provide insight and potentially improve potable water supply services to the NSD in the future. The following research question and hypotheses guided this study.

**Q1.** What is the nature of the relationship between the lack of potable water availability and the economic development of the NSD and Benue state, Nigeria?

**$H_o1$** There was no correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

**$H_a1$** There was a correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

This chapter provides the results of the analyses carried out using the internet based software, "R" ® and Microsoft Excel® as well as Pearson product-moment correlation coefficient. These approaches were helpful in presenting the descriptive analyses as well as *t*-test graphs and computation of the different scores in the survey

sections and the variables. I organized the results of the study in keeping with the research hypotheses and research question and are as follows: descriptive analysis of the variables on the checklist, statistical analysis, regression model, correlation analysis, hypothesis testing, statistical testing, scatter plot graph, and the summary of the results.

## Data Collection

I collected primary data from original written records, statistics, and surveys from government sources that provided direct evidence or firsthand information about the number of water supply projects established within the NSD by Benue state governments and related agencies. An email was sent to 43 water supply managers and five officials of the MWRE with a request to participate in the study. The email also included a request for times they were available for me to meet them at their various locations with the checklists. The five officials responded the same day the email was sent. Eight participants responded three days after the email, five participants responded after seven days, 10 participants replied after 10 days, and then five participants replied after 13 days; 15 days; 17 days and 20 days respectively. There were no reminder e-mails as all the responses were provided in relation to the initial e-mail. From the responses of the participants, there were days and dates when I was able to meet with one or two participants per day, there few cases however when I met with three participants a day at their various locations respectively. The recruitment of participants and data collection lasted two and half months.

I met them at their locations at the time they requested. They were provided the assessment checklist and allowed ample time to read through it and ask questions if clarifications were needed. The questions were answered, and participants were

subsequently allowed the privacy and time needed to complete the checklists and hand them back. With the use of an internet based "R" statistical software ® and Microsoft Excel®, the data were analyzed in keeping with the WHO international quality standard.

Additionally, I also used Pearson product-moment correlation coefficient to determine whether there were correlations between the variables and the degree to which that relationship existed. This was measured by ratio/intervals distributed with minimum outliers as well as a linear relationship between two or multiple variables that reflected the population that was studied. To test the hypotheses of the research question in relation to correlations for statistical significance, the *t*-test was used to evaluate if there were significant differences from zero that indicated the association between variables.

As shown in Table 1 below, the scoring criteria of this survey for each water supply project was measured on a zero to five-step scale respectively (refer to Appendix B, the survey tool). The 48 participants in the study gave their responses to each of the 11 questions variables of the assessment checklist, The step ranges assigned to each variable were determined in relation to the sum total of those responses. Furthermore, the scale and measure were designed to reflect the quality standard score from the 180 total points assigned to the 11 factors (questions) regarding the overall quality of services offered by each water supply project. From these criteria, water supply projects that obtained from 0 to 55% representing no step were considered to offer poor quality services below the international standard requirement developed by the WHO. The water supply projects that obtained the assessment score of 55% to 64% correspondingly attained step 1 and were considered to offer better quality services. Any factor that scored from 65% to 74% correspondingly attained step 2. From 75% to 84% the factor accordingly attained step 3

as well as from 85% to 95% step 4 and from 95% to 95% attained step 5 according to WHO's international standard.

Table 1

*Water Supply Assessment Grading Scheme Table*

| None (0) | 1 Step | 2 Step | 3 Step | 4 Step | 5Step |
|---|---|---|---|---|---|
| (0- 98 pts) | (99-115pts) | (116-133pts) | (134-151pts) | (152-169pts) | (170-180pts) |
| 55% | 55% - 64% | 65% - 74% | 75% - 84% | 85% - 95% | 95% |
| Poor Quality standard | | Better Quality Standard | | | WHO International Quality Standard |

The questions were grouped into 11 variables to evaluate the impact of lack of potable water, if any, on the economic development of the NSD of Benue State. To all the 11 factors of the assessment checklist, specific questions were asked in each section (refer to Appendix B). The total points of responses by the 48 participants to the questions were added according to the 11 factors. The overall score of the variables were determined and awarded appropriate steps. The 11 factors/questions on the assessment checklist are important for this study. First because enhanced a better understanding about the factors associated with lack of potable water availability to the NSD of Benue state. Second because they helped to answer the research question about the nature of the relationship between lack of potable water availability and the economic development of the NSD. Third because they also helped in establishing the role Benue state governments have played to address the water needs of the communities of the NSD since the creation of the state in 1976.

From the analysis of responses received as presented in Table 2 below, none of the variables received 152 points or up to 85% of the assessment score. Five question variables (i.e., equipment, internal audit, purchasing/inventory, information management and corrective action) received less than 98 points which was not up to 55% of the total score. This indicated that rural water supply in the NSD of Benue is far below the WHO standard and expectation for 21st century society. Table 2 below identifies the 11 quality of service variables for all 43 water supply projects assessed using the 48 respondents.

As shown in Table 1 above, the overall percentage score for each of the 11 factors of assessment were awarded corresponding standards of quality in steps. As pointed out earlier, the steps served as criteria for ascertaining if the factor(s) met the quality standard or not. The grading scheme was from 0 step to step1. Then from step 2 to step 3 as well as step 4 to step 5 respectively. According to this grading scheme, any factor of assessment that scored from 0 to 55% did not attain a step. Any factor that scored from 55% to 64% attained the 1 step; from 65% to 74% 2 step; from 75% to 84% 3 step; from 85% to 95% 4 step and from 95% to 95% 5 step.

Table 2

*Descriptive Analysis of the 11 QSE Variables for the 43 Water supply Projects from 48 Respondents*

| | TOTAL | MEAN | SD | QUALITY % | STEPS | N |
|---|---|---|---|---|---|---|
| Documents and Records | 16 | 11.96 | 2.44 | 75 | 3 | 48 |
| Management Reviews | 6 | 4.02 | 1.77 | 67 | 1 | 48 |
| Organization and Personnel | 15 | 11.04 | 2.28 | 74 | 2 | 48 |
| Equipment | 17 | 8.69 | 3.11 | 51 | 0 | 48 |
| Internal Audit | 3 | 1.40 | 1.20 | 47 | 0 | 48 |
| Purchasing and Inventory | 22 | 11.67 | 4.22 | 53 | 0 | 48 |
| Information Management | 12 | 6.35 | 3.04 | 53 | 0 | 48 |
| Process Control and Internal/ External Assessment | 24 | 16.52 | 5.09 | 69 | 2 | 48 |
| Corrective Action | 10 | 4.63 | 3.68 | 46 | 0 | 48 |
| Occurrence/Incident Management, Improvement and Customer Service | 10 | 5.69 | 3.59 | 57 | 1 | 48 |
| Facilities Safety | 45 | 29.98 | 10.17 | 67 | 2 | 48 |
| CUM | 180 | 112 | 2.44 | | | |

**Documents and Records**

There were six questions on the documents and records factor with a total of 16 points value. This factor was important because while it is easy for some governments and their related agencies to make public claims of development projects they have established, they may not actually exist. The goal of this study was to assess if the 43 water supply projects that the Benue state governments stated to exist had verifiable documents and records to support those claims. As shown in Table 2, the majority (i.e., over 60%) of the large, medium, and small capacity water supply projects in the NSD had good documentation and record-keeping practices that were awarded 75%, representing step 3 (refer to Table 1 above). All the percentage scores awarded to this factor/variable were based on the same calculation of the responses by participants to each variable of the assessment checklist for all the water projects assessed during this study (refer to Table 1 above for the grading scheme). It is therefore important to note that

documentation and good record keeping practices do not necessarily mean good water quality offered by those supply projects since both documents and records and water supply represent two different realities. Water supply projects were considered to have offered Poor quality services if the project's overall assessment score was not above 55%.

**Management Reviews**

Management reviews had three specific questions that were asked with a toal of six points value. The management reviews' factor in the questionnaire was designed to identify how frequently management reviews of the 43 water supply projects were conducted, and how the lack of reviews impacted the quality and delivery of water supply services. It is possible that well intended rural development projects that are not reviewed for many years fail.

My goal was to ascertain if there was a need to develop policies that would support more effective and efficient water supply to the NSD. According to the data results shown in the table above, all the water supply projects assessed scored 67% representing step 1 in the overall assessment. The result of the study showed there were poor management reviews of the projects. It is also clear from the results that over 50% of water supply projects had maintenance issues that were addressed. Those issues invariably impacted the overall quality of water supply services.

**Organization and Personnel**

Organization and personnel factor had five questions and I designed it to identify the issues related to human resources in the supply of potable water to the NSD and how the issues, if any, impacted the overall quality of services. For rural development projects, especially those for dealing with water supply, it is important to have both

organized and skilled personnel. This is because technological malfunctions and breakdown can be the result of unskilled and unorganized personnel. This factor was important to this study because it established how personnel issues are connected to lack of potable water in the NSD. The result of the survey showed that organization and personnel had statistical correlation with the other 10 variables from all the 43 water supply projects and scored 74%, representing step 2, which was the second best score in the overall quality standard. The strength of this correlation was calculated using the Pearson's product-moment correlation and Spearman's ranking correlation analysis. What the organization and personnel factor showed was a statistically positive correlation between the 11 factors assessed in this study as well as the water supply projects and lack of potable water availability. Similarly, there is also a correlation between lack of potable water supply and its impact on the economic development of the NSD.

**Equipment**

The equipment factor in the QSE of the survey had eight subquestions with a total point value of 17. It was designed to examine the standard or quality of water supply equipment that were used. This variable is key in the assessment process and for the study because a better understanding of the water supply technology types enhanced a deeper understanding about the relationship of technologies used and lack of potable water supply to the communities of the NSD. This further identified the issues associated with the equipment and how they impact the overall quality and delivery of water services to the NSD. Apart from two water supply projects/equipment located in Makurdi the state capital, those installed for water supply in the SD scored (51%) of the total 180 points representing no step in the overall assessment of the survey. The equipment factor

was important because it clearly showed the efforts of Benue state governments to address water supply needs of the communities of the NSD since the creation of the state in 1976. The equipment factor did not attain a standard score in the overall assessment and confirms the reality about lack of potable water supply to the NSD.

**Internal Audit**

There was only one specific question on the variable with a three point value. The factor evaluated how frequent internal audit of water supply projects were conducted for the purposes of accountability and transparency of the ministry's activities. The researcher considered this variable to be important because for any ministry such as the MWRE not to conduct frequent internal audits, it would be hard for its officials to identify culprits responsible for certain material loses and projects/work failures. The goal here was to ascertain the level to which this lack, if any, impacted the quality and delivery of water supply services to the NSD. During the survey, the results showed that internal audit scored only 47% of the 180 points representing no step in the overall QSE assessment. What the data supported is that problems associated with water supply projects and what was needed at a given point in time to resolve them was not identified early enough. By the time some of the problems were eventually identified, the damage was huge that led to the total abandonment of those projects. This was largely because; internal audits were not carried out frequently.

**Purchasing and Inventory**

There were seven questions with a total of 22 points value in this section. The variable examined stock taking about the procurement of spare parts as well as new equipment that were needed. The importance of this variable is that it has direct

connection with the variable just discussed above (internal audit). Again, it can happen if the purchasing or supply of equipment/spare parts are done by different people, it could be hard to keep track of what is purchased or supplied and by who as well as what went out, when and by who, if inventories are not taken or kept. The goal here was to establish if claims were made that spare parts or new equipment were purchased for water projects; there were records to justify the claims. The results of the survey showed that this factor scored 53% which represented no step (below quality standard) in the overall assessment. What this indicated is that there were no purchases of spare parts to rehabilitate broken down equipment as much as there were no new equipment purchased for back-up measures. What the result further showed is the degree of association of this factor with the impact it has on the overall quality and delivery of potable water supply services.

**Information Management**

This factor had six questions with point's value of 12. It evaluated how the activities of the ministry with specific reference to information were shared or communicated. The researcher considered this variable to be important because the NSD comprises of 14 local government areas that are separated by a driving distance of two to three hours from each and a little more to Makurdi the state capital and headquarters of the MWRE. Those distances could potentially hamper the activities of the ministry especially in relation to the projects and water supply managers at their respective locations and how it accounted for water supply problem to the NSD. Throughout the NSD, the results of the study showed that from the 180% of the overall assessment, information sharing managed to score only 53% that represented no step form the quality standard. For an organization that should be well structured and collaboration clearly

defined, what this result showed is that some members of the ministry, especially water supply managers at community locations had limited/partial access to information about what goes on at other water supply locations as well as at state headquarters.

**Process Control and Internal/External Quality Assessment**

In this section of the study, there were eight sub-questions with a total point value of 24. The goal of this variable was to assess if out of control water runs from water supply projects were checked, accurate and documented regularly, as well as equipment stipulations for in-range and out of range for gas/engine oil dependent technologies. This was to see the measures that were taken when the technologies went out of range. This variable was important because, water supply pipe lines that are old could lead to water leakages during transmission/delivery; or cases of broken pipes could led to loss of substantial amount of water that could potentially impact beneficiaries as a result of supply shortages. Additionally, depending on the magnitude of leakages/pipe break down, those problems could lead to water contamination and environmental nuisance. Although the assessment variable obtained 69% representing step 2, in practical terms, this did not reflect the overall environmental conditions of water supply projects as well as the technologies, especially for some that during the survey were found to have obtained a low percentage score of quality standard if taken on case by case bases. It could well be concluded that if the key points in the variable showed water supply projects were all maintained and in standard working conditions, the result would have also amounted to better quality of water supply services delivered.

**Corrective Action**

This variable has connections among other variables with the one just discussed above and had three specific questions with a total points value of 10. It was designed to help examine whether the environments of the small, medium and high capacity water projects were in acceptable or unacceptable conditions. The aim here was to assess how these lacks, if any hampered the overall water supply and its quality to the NSD. The data showed this variable obtained the lowest score 46% representing no step of the 180% overall assessment. The researcher found out that over 70% of the 43 water supply projects and equipment were not in working conditions due to breakdown or some malfunctions that led to unacceptable environmental conditions of the projects.

**Occurrence/Incident Management, Process Improvement and Customer Service**

On this factor, there were three specific questions awarded 10 points in value. It also has interconnection with the two just discussed above as well as other variables for the study. An evaluation of this factor was to identify whether cases, reports and frequency of technology breakdown or malfunctions were completed with causes identified, corrective actions were taken on all reports to avert re-occurrence in order to improve supply quality. Another aim was to verify if there were tools for evaluating the satisfaction of communities with water supply services they were offered. It was additionally to establish how those process or their lack contributed to lack of potable water supply to the NSD and hence the collective impact of the factors on economic development. The result of the data showed that this factor scored only 57% that represented step 1 of the assessment grading. What this data result meant is that this variable fell below the quality standard of the assessment.

**Facilities and Safety**

There were 15 sub questions in this section and had a total points value of 45. Among key issues evaluated in this variable were the layout of water supply units, the suitability of their locations to communities and supply managers, the safety of their environment, water treatment chemicals, waste disposals, vaccination of personnel and records of injuries. The researcher considered this factor to be important precisely in view of the questions generated and how deficiencies in the components could lead to catastrophic damage to equipment, environmental contamination as well as loss of lives and the impacts of water supply to benefiting communities. Although the result showed a 67% score representing step 2, the factor of its own does not transcend the other variables of the study discussed above that did not meet the quality standard of the overall assessment; hence the reality of the general impact of lack of potable water availability.

The mean is one of the most useful and widely used methods to find out the average in statistics. It is calculated by adding up all the data values and dividing that sum by the total number of data items in sample. It is represented by X

The formula for mean is as stated below:

$$\overline{X} = \frac{\sum x}{N}$$

Where $\sum x$ is sum of all data values

*n* is number of data items in sample

Standard Division: The standard deviation of a sample is known as S and is calculated using:

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$$

Where **x** represents each value in the data, **x** is the mean value of the sample, **Σ** is the summation (or total), and **n-1** is the number of data items in the sample minus 1.

**Statistical Analysis**

The objective of this study was to evaluate the impact of lack of potable water availability on the economic development of the NSD and Benue state. The statistical analysis employed the use of linear regression analysis/least square method to illustrate the model of water supply quality. There were two important variables involved- the controlled factors which were independent in nature and could be influenced by the opinions of participants; and the overall quality which is direct response of the independent factors. It is believed that the resultant linear equation would lead to addressing the problems associated with the supply of potable water if the controlled factor can be manipulated in a way that it would improve the overall quality assuming the opinions of participants are not biased. Table 3 shows in details the outcome of the survey. From Table 3, the number of those who participated in the study was 48 in total. Out of 48 participants, 43 were managers of water supply units located at different communities/local governments of the NSD. The information they provided was first-hand based on their years of service and experience with the ministry and as managers who liaised between the ministry/government and the local communities they served.

Apart from the water supply managers, five participants were the officials of the MWRE who worked at the state headquarters. They too provided first-hand information from their years of service and experience. Additionally, they served as direct liaison between state governments, water supply managers and their various communities.

**Independent Variables**

All the factors of assessment (refer to Table 2 above) were in relation to the quality of potable water supply also identified as an independent variable that the overall quality is denoted in Table 3 above by Yi. They are direct presentation of the opinions of participants about the factors in Table 2 above that could lead to lack of or improvement to potable water availability to the rural areas under investigation. The point values attached to those variables are derived from the summation of participants' views on the checklist. For instance, a "yes" response as indicated by the letter Y in the assessment checklist (confer Appendix B) is equivalent to 2 or 3 points depending on the section of the checklist.

Table 3

*The Survey Outcome Table*

| No of particip | Factors (X) | Overall Quality(Yi) | $X^2$ | $Y^2$ | XY |
|---|---|---|---|---|---|
| **1** | 89 | 49.4 | 7921 | 2440.36 | **4396.6** |
| **2** | 101 | 56.1 | 10201 | 3147.21 | **5666.1** |
| **3** | 117 | 65 | 13689 | 4225 | **7605** |
| **4** | 111 | 61.7 | 12321 | 3806.89 | **6848.7** |
| **5** | 110 | 61.1 | 12100 | 3733.21 | **6721** |
| **6** | 95 | 52.8 | 9025 | 2787.84 | **5016** |
| **7** | 104 | 57.8 | 10816 | 3340.84 | **6011.2** |
| **8** | 91 | 50.6 | 8281 | 2560.36 | **4604.6** |
| **9** | 99 | 55 | 9801 | 3025 | **5445** |
| **10** | 91 | 50.6 | 8281 | 2560.36 | **4604.6** |
| **11** | 101 | 56.1 | 10201 | 3147.21 | **5666.1** |
| **12** | 107 | 59.4 | 11449 | 3528.36 | **6355.8** |
| **13** | 99 | 55 | 9801 | 3025 | **5445** |
| **14** | 130 | 72.2 | 16900 | 5212.84 | **9386** |
| **15** | 129 | 71.7 | 16641 | 5140.89 | **9249.3** |
| **16** | 143 | 79.4 | 20449 | 6304.36 | **11354.2** |
| **17** | 113 | 62.8 | 12769 | 3943.84 | **7096.4** |
| **18** | 117 | 65 | 13689 | 4225 | **7605** |
| **19** | 138 | 76.7 | 19044 | 5882.89 | **10584.6** |
| **20** | 105 | 58.3 | 11025 | 3398.89 | **6121.5** |
| **21** | 90 | 50 | 8100 | 2500 | **4500** |
| **22** | 123 | 68.5 | 15129 | 4692.25 | **8425.5** |
| **23** | 146 | 81.1 | 21316 | 6577.21 | **11840.6** |
| **24** | 76 | 42.2 | 5776 | 1780.84 | **3207.2** |
| **25** | 130 | 72.2 | 16900 | 5212.84 | **9386** |
| **26** | 131 | 72.7 | 17161 | 5285.29 | **9523.7** |
| **27** | 142 | 78.9 | 20164 | 6225.21 | **11203.8** |
| **28** | 133 | 73.9 | 17689 | 5461.21 | **9828.7** |
| **29** | 91 | 50.6 | 8281 | 2560.36 | **4604.6** |
| **30** | 91 | 50.6 | 8281 | 2560.36 | **4604.6** |
| **31** | 92 | 51.1 | 8464 | 2611.21 | **4701.2** |
| **32** | 94 | 52.2 | 8836 | 2724.84 | **4906.8** |
| **33** | 85 | 47.2 | 7225 | 2227.84 | **4012** |
| **34** | 150 | 83.3 | 22500 | 6938.89 | **12495** |
| **35** | 129 | 71.7 | 16641 | 5140.89 | **9249.3** |
| **36** | 86 | 47.8 | 7396 | 2284.84 | **4110.8** |
| **37** | 87 | 48.3 | 7569 | 2332.89 | **4202.1** |
| **38** | 150 | 83.3 | 22500 | 6938.89 | **12495** |
| **39** | 84 | 46.7 | 7056 | 2180.89 | **3922.8** |
| **40** | 83 | 46.1 | 6889 | 2125.21 | **3826.3** |
| **41** | 111 | 61.7 | 12321 | 3806.89 | **6848.7** |
| **42** | 122 | 67.8 | 14884 | 4596.84 | **8271.6** |
| **43** | 114 | 63.3 | 12996 | 4006.89 | **7216.2** |
| **44** | 142 | 78.9 | 20164 | 6225.21 | **11203.8** |
| **45** | 126 | 70 | 15876 | 4900 | **8820** |
| **46** | 114 | 63.3 | 12996 | 4006.89 | **7216.2** |
| **47** | 131 | 72.8 | 17161 | 5299.84 | **9536.8** |
| **48** | 163 | 90.6 | 26569 | 8208.36 | **14767.8** |
| **Total** | **5406** | **3003.5** | **631244** | **194849.2** | **350709.8** |

**Dependent Variables**

As shown in the table above, the responses of participants to the overall quality of the factors/variables (refer to table 2 above) are identified as the dependent variables that could be affected by changes from the other variables. The Overall Quality of potable water was to be determined by the summation of the total point values attached to the participants' opinions. There were also assessment percentage of dependent variables ($X_i$) under investigation divided into 180 points that made up the overall assessment score {Independent variables ($X_i$)/180 *100%}. $X^2$ and $Y^2$ as well as $X_i Y_i$ are necessary for the theoretical build-up of the least square method.

It is good to note that the $X_i$ (dependent variables in table 2 above) and the $Y^2$ responses of participants (Table 3 above) concerning the independent variable (quality of potable water supply) are important for this study. First because they are key to a deeper and better understanding about the issues associated with lack of potable water availability to the NSD. Second, not only do they enhance a better understanding of the issues, a discussion of the participants' responses about all the factors/variables also helped in answering the research question about the nature of the relationship between lack of potable water availability and the economic development of the NSD. Furthermore, the $X_i$ (11 factors/variables in Table 2 above) together with the $Y^2$ (response variables in Table 3 above) by study participants also helped in understanding the efforts/role played by Benue state governments since the creation of the state in 1976 to address water supply problems to the NSD.

**The Answer to Research Question**

The research question is answered based on the findings of the study (refer to Tables 1-3) as follows: First, the data supported the fact that the role/efforts of Banue state governments to address the water supply needs of the communities of the NSD since the creation of the state in 1976 are inadequate. Second, that the inadequacy of the role/efforts of state governments and a combination of the factors assessed in this study have significantly contributed to lack of potable water availability to the NSD of the state. Aside from the fact that the factors have significantly contributed to lack of water supply, the lack has direct relationshp with the lack in economic development. In Makurdi and Katsina Ala (LGs) where farmers have better access to water supply, they heve higher crop/food production as well as better economic development opportunities than other farmers within the SD who have less or no access to water supply. Given that all the communities of the NSD had good access to water supply like those of Makurdi and katsina-Ala, they would have the same economic developemnt opportunities.

Third, there is ultimately a direct connection between lack of potable water availability and its impact on the economic development of the NSD and Benue state at large. Conversely, improvement of the role/efforts by state governments would bring about improvements to the factors assessed in this study; and that would ultimately change or bring about improvement in the quality of water supply services to the NSD. This will in turn bring about improvement in the economic development of the people and communities of the SD and Benue state in general. What has been accomplished

here is the application of the theory derivatives to design the regression model that follows shortly.

**Hypothesis Testing**

According to Udom (2005), a hypothesis or assumption can be subjected to statistical investigation especially when the test of the hypothesis can be carried out. The null hypothesis ($H_0$) will thus be accepted if the evidence provided by the sample observation is sufficient to prove that the null hypothesis ($H_0$) is true. However, if there is lack of satisfactory evidence from the sample to prove that the null hypothesis ($H_0$) is true, it is rejected. This means the alternative hypothesis($H_1$) is supported as true. Taking this background into perspective, to test the hypotheses of the research question in order to ascertain the correlations for statistical significance, the t-test was used to evaluate if there was a significant difference.

**Q1.** What was the nature of the relationship between the lack of potable water availability and the economic development of the NSD district and Benue state Nigeria?

**$H_o1$** There was no correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

**$H_a1$** There was a correlation between the quality of potable water supply services to the NSD of Benue state Nigeria and its economic development.

The hypotheses are:

$$H_0: \rho = 0,\ H_1: \rho \neq 0$$

$$H: \rho = 0 \begin{pmatrix} \text{there is no correlation between the quality of potable} \\ \text{water supply services to the NSD of} \\ \text{Benue state Nigeria and its economic development} \end{pmatrix}$$

$$H_1: \rho \neq 0 \begin{pmatrix} \text{there is a correlation between the quality of potable} \\ \text{water supply services to the NSD of} \\ \text{Benue state Nigeria and its economic development} \end{pmatrix}$$

The level of significance is $\alpha = 0.05$. This will ensure that at $95\%$ confidence, a right decision will be made.

**The Statistical Test**

$$t_{(n-2)} = \frac{r}{\sqrt{\frac{(1-r^2)}{(n-2)}}}$$

$$\textit{where } r \textit{ is the coefficienct and } n \textit{ is the number of data}$$

*Decision:* Reject $H_0$ if $t_{cal} > t_{tab}$ otherwise we accept $H_0$ which indicates that there is no correlation

*Calculation*

$$t_{(46)} = \frac{0.999995014}{\sqrt{\frac{(1-0.99995014^2)}{46}}} = 2147.67$$

$$t_{tab}^{0.05} = 2.01$$

*Conclusion*

We reject $H_0$ since $t_{cal} = 2147.67 > t_{tab}^{0.05} = 2.01$. Therefore, it can be concluded that the two variables: dependent and independent are linearly related. In other words, the quality standard factors and the overall quality standard assessment score from the water supply projects are said to be linearly correlated. What this means is that there is a correlation between the lack of potable water availability and its impact on the

economic development of the NSD and Benue state, Nigeria. What this means by implication is that, an improved/increased quality of water supply services to the NSD will boost its economic activities which will ultimately affect its development and Benue state in a positive manner.

**The Regression Model**

The term regression is generally used to describe or help explain relationships among multiple variables X and the other variable Y (Black et al., 1999; Vogt et al., 2007). From the perspective of the knowledge of such relationships, one is enabled to predict and control events. In this study however, the researcher focused on a model that will perfectly serve or fit the situation at hand.

Table 4 has shown that out of 43 water supply projects implemented in the entire NSD since the creation of the state in 1976, only 18 of them representing 42% of the total water supply projects were established by the Benue state governments, while 25 water supply projects representing 58% are provided by donor agencies. (Prior to the study/data collection, the researcher thought all the 43 water supply projects in the NSD were established by Benue state governments. The information therefore that 25 water supply projects representing (58%) of all the water supply projects were by donor agencies was new as provided by the MWRE in the course of data collection)

Table 4

*Distribution of Water Supply Projects in NSD*

| | Donor Agencies | State Governments | | |
|---|---|---|---|---|
| Status | Hand Pumps | Motorized | Total No | Percentage |
| Functioning | 13 | 5 | 18 | 42% |
| Not Functioning | 12 | 13 | 25 | 58% |
| Total | 25 | 18 | 43 | 42% |
| % | 58 | 42 | 80 | |

The table also shows that only five water supply projects representing 42% provided by Benue state governments are in good working conditions. What is remarkable however is the fact that from the total number of 18 water supply projects established in the entire NSD by Benue state governments, only five were motorized/high capacity equipment representing 27.78% in good working condition. Giving that in the whole NSD there were only five high capacity water supply technologies in good working conditions to supply water to the citizens, the result revealed how grossly inadequate potable water is supplied to meet the water needs of the communities for domestic purposes as well as their agricultural needs especially for people who are skilled farmers.

Based on this understanding, a linear regression formula from which the proposed statistical model for the water supply assessment projects will be derived is as follows:

$Y_i = \beta_0 + \beta_i X_i$ where

$Y_i$ is the dependent variable which is the overall quality factor

$\beta_0$ $\beta_i$ are the partial regression coefficient or the regression parameters while $X_i$ is the observed values of the independent variables.

$$\beta_1 = \frac{n\sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i}{n\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2}, \qquad \beta_0 = \frac{\sum_{i=n}^{n} Y_i}{n} - \beta_1 \frac{\sum_{i=n}^{n} X_i}{n}$$

$$\sum_{i=1}^{n} X_i Y_i = 10617.198 \qquad \sum_{i=1}^{n} X_i = 5406 \quad \sum_{i=1}^{n} Y_i = 3003.5 \quad \left(\sum_{i=1}^{n} X_i\right)^2$$

$$= 29224836 \quad \sum_{i=1}^{n} X_i^2 = 631244 \quad \sum_{i=1}^{n} Y_i^2 = 194849.23 \quad \left(\sum_{i=1}^{n} Y_i\right)^2$$

$$= 37966222432$$

$$\frac{\sum_{i=n}^{n} Y_i}{n} = \frac{3003.5}{48} = 62.572917 \qquad \frac{\sum_{i=n}^{n} X_i}{n} = \frac{5406.5}{48} = 112.625$$

$$\beta_1 = \frac{48 * 10617.198 - 5406 * 3003.5}{48 * 631244 - 29224836} = 0.5555519$$

$$\beta_0 = 62.572917 - 0.5555519 * 112.625 = 0.0038844$$

From the above calculation, the Regression Model that was used is:

$$Y = 0.0038844 + 0.5555519X$$

It is worthy of note that the result of any analysis that forces the sample data into a model that is not applicable could be worthless. In order therefore to test the adequacy of the proposed model above, a sample of 114 from the factor X was utilized for prediction.

At $X = 114$, $Y = 0.0038844 + 0.5555519(114) = 63.3$. From the estimate of 63.3 derived above, when the factor X is 114, it can be statistically inferred that a high factor such as 114 will produce overall high quality of potable water supply up to the level of more than 60 percent. What this means is that, going by the grading scheme (refer to table 1 above), if each of the 11 factors/variables of the assessment checklist

obtained 114 points of the total 180 points, that would have placed the variables between 55% to 64% representing at least step 1 (the minimum) of the overall quality standard. Additionally, going by the WHO standard, such percentages would not have been high enough; however, they would nonetheless be better than a 0 step (below acceptable quality standard).

**Correlation Analysis**

The correlation coefficient was also used to determine the relationship between two random variables (dependent and independent variables). Furthermore, it also provided a measure of the strength and direction of the correlation varying from -1 to +1. Positive values indicate that the two variables are positively correlated meaning that a perfect direct linear correlation exists between the variables. Negative value (-1) indicates that the two variables are negatively correlated meaning a perfect inverse correlation exists between the variables. To obtain the nature of the relationship between the variables and the degree to which it exist, the Pearson Product Moment Correlation Coefficient was employed and is presented thus:

$$r = \frac{n\sum_{i=1}^{n} X_i Y_i - \sum_{i=1}^{n} X_i \sum_{i=1}^{n} Y_i}{\sqrt{[n\sum_{i=1}^{n} X_i^2 - (\sum_{i=1}^{n} X_i)^2][n\sum_{i=1}^{n} Y_i^2 - (\sum_{i=1}^{n} Y_i)^2]}}, 1 \leq r \leq -1$$

$$r = \frac{48 * 10617.198 - 5406 * 3003.5}{\sqrt{(48 * 631244 - 29224836)(48 * 194849.23 - 37966222432)}} = 0.999995$$

Therefore r = 0.999995.

Since the correlation coefficient r is 0.999995, this has proved that there is a strong positive linear relationship between the independent factors and the overall quality standard assessment scores from the water supply projects. Recall as stated above that the

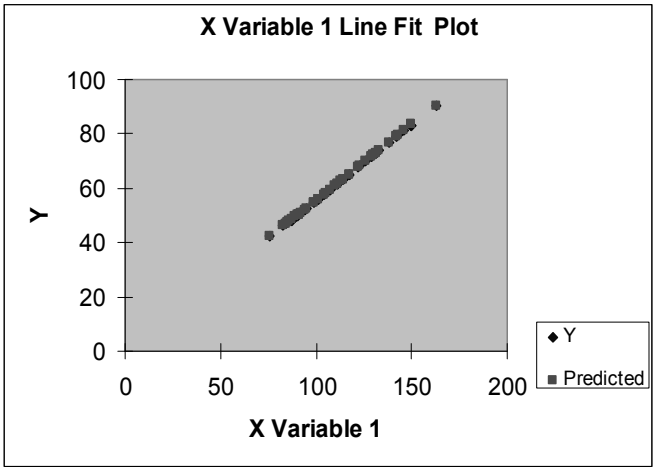
independent and the overall quality scores are X and Y respectively. In other words, an increase/improvement in X variable will proportionately lead to an increase in Y variable and vice versa.

**Scatter Plot Figure**

In this study, the graph below helped to determine the level or degree of the relationship between two variables (independent variable X and dependent variable Y). Conventionally, the dependent variable (Y) is placed on the vertical axis while the independent variable(X) is on the horizontal axis.

Figure 3

*X and Y Variables' Scatter Plot Graph*




It could be concluded from the above graph that as X, (i.e. the 11 dependent factors/variables of the assessment checklist) increases or are improved upon, Y which stands for the overall quality of potable water supply (independent variable) will also increase or be improved upon. Recall that based on the findings, the 11 variables/factors assessed in this study have a positive (or direct) linear connection with the overall quality of water supply or its lack; i.e. a correlation between (X and Y) variables. Recall also that

the opinions of study participants: the 48 water supply managers and officials of the Benue state MWRE are derived from the X variables as factors that could, or do lead to lack of potable water availability to the rural areas under investigation. Conversely, when the X factors responsible for lack of potable water supply are improved upon or decisively addressed, there will also be an improvement or increase in the Y factor/variable. Ultimately, changes or improvements to X and Y variables will have a positive impact on the economic development of the NSD and Benue state in general.

## Study Findings: An Evaluation

In this study I assessed the quality of potable water supply projects in the NSD of Benue based on the information provided by 43 water supply managers at different locations in the NSD and five officials of the Benue state MWRE at the state capital, Makurdi. Ialso examined how lack of potable water and its poor quality supply services have impacted the economic development of the NSD and Benue state in general. A brief overall summary of the data presented here precedes a more detailed explanation of the research question.

From the perspective of this research hypothesis, I have from the findings identified in the scatter plot that there is a positive (direct) linear relationship between the X, the dependent factors/variables (documents and records, management reviews, organization and personnel, equipment, internal audit, purchasing and inventory, information management, process control and internal and external quality assessment, corrective action, occurrence/incident management, process improvement, and customer service and facilities safety) which are the 11 questions of the assessment checklist (that the 48 participants gave their opinion about) and the Y, independent factor/variable (the

overall quality of water supply) upon which those opinion were centered. The result provided from the findings has shown that all the X factors are highly connected with the poor quality and services of the water supply projects.

What was identified as a fundamental or starting point of the problem is that rural water supply policies in the state are loosely enforced by state governments (Chukwu, 2015). Even though each government may understand the water needs of the people, if priority attention is not given to the need, it will remain unattended to for a long time as is the current situation in the NSD. This lack of political good will has negatively affected the water sub-sector, overall water supply and the quality of services offered as well as its impact on the economic development of the communities of the NSD. The focus of the 11 sections of the survey was to help ascertain the quality of services offered and the level of connection between the quality services variables and how relevant they are to the anticipated outcomes of this study. In the course of the study, I identified the relevant factors that helped to answer the research question.

## Summary

The purpose of this quantitative study was to evaluate the impact of lack of potable water availability on the economic development of the NSD of Benue. All the 43 i.e. 100% of the high, medium and low capacity water supply projects in the NSD of Benue state, Nigeria were assessed by me and the null hypothesis for the research question was rejected. The design of the research question was to assess/identify those water supply projects that offered poor quality of water supply services to the NSD.

The results of the study revealed that 75% that is the majority of water supply projects in the NSD offer poor quality of water supply services. Out of a total number of

18 functional water supply projects, only 5 are implemented by Benue state governments since the inception of the state in 1976. None of the water supply projects scored 98 points or above 55% of the overall quality assessment. This shows how far behind potable water supply to the NSD of Benue is from meeting international standards as well as the MDGs of reducing to half by 2015 the world population of those who do not have access to potable water supply. This also highlights the degree of impact this lack has on the economic development of the NSD as well as the low standard of living of people in the rural communities. It is exactly for these reasons that Hevty & Carlitz (2008), Pattenayar et al. (2009), Prokopy et al. (2009), Richards et al. (2011), and Woolcock et al. (2009) emphasized and encouraged the idea and need for the evaluation of projects.

As shown and discussed in previous sections of the study findings, these five question variables (Equipment, Internal Audit, Purchasing/Inventory, Information Management and Corrective Action) out of the 11 questions on the assessment checklist received 51%, 47%, 53%, 53% and 46% respectively. These are less than 98% points, which is not up to 55% (below minimum WHO quality standard) according to the quality assessment grading scheme (refer to Table 1 above). What this indicates by implication is that the efforts of state governments are inadequate, and therefore that rural water supply in the NSD of Benue is far below the WHO standard and expectation for the 21$^{st}$ century society.

These are the overall results of the study. This research study showed that predictability and replication is possible. In Chapter 5, an interpretation of the findings is presented. In addition, the implications for social change, recommended actions, and opportunities for future research are provided

# Chapter 5: Summary, Conclusion, and Recommendations

## Introduction

The purpose of this quantitative study was to evaluate the impact of lack of potable water availability on the economic development of the NSD and Benue state, Nigeria. This was the first study about water supply problems in Benue state and the NSD in particular that evaluated more holistically the factors that contribute to lack of potable water availability. I used secondary sources provided by the Benue state MWRE in this quantitative study. These sources were associated with 43 water supply projects established by Benue state governments since the creation of the state in 1976. In addition to these sources, I also utilized a modified water supply assessment checklist to gather information from study participants.

The people of the NSD are predominantly farmers who depend on annual rain falls for their farming activities. Recently, shortages in annual rain fall due to the impact of climate change and the lack of potable water supply to irrigate farms and crops, has made produce seasonal rather than continuous. The "Food Basket of the Nation" is experiencing shortages in food production. Poor water quality results in multiple health issues and water related challenges as well as lack of economic development.

I conducted a qualitative study utilizing an assessment checklist to identify the factors associated with lack of potable water supply. Improvements in the quality of water supply services depend on those factors identified in the study, identified as the dependent variables and good quality of potable water services was thus the independent variable. Once the issues associated with such factors are decisively addressed, there will be improvements in the quality of potable water supply.

A review of the problems and findings from this study are presented in this chapter include the summary and interpretation of findings. Also included in this chapter are the limitations of the study, recommendations for action, implications for social change, and the conclusion.

## Summary of Findings

The findings of this study were analyzed and discussed in the previous chapter in keeping with the modified water supply assessment chacklist. The factors included: documents and records, management reviews, organization and personnel, equipment, internal audit, purchasing and inventory. Also icluded were information management, process control and internal and external quality assessment, corrective action, occurrence/incident management, process improvement, and customer service and facilities safety.

The overall percentage score for each of the 11 factors of assessment were awarded corresponding standards of quality in steps. The steps served as criteria for ascertaining if the factor(s) met the quality standard or not, from 0 step to 1 step; 2 step; 3 step; 4 step and 5 step respectively. According to this grading scheme, any factor of assessment that scored from 0-55% did not attain a step (none or 0). Any factor that scored from 55% to 64% attained the 1 step; from 65% -74% 2 step; from 75% -84% 3 step; from 85% -95% 4 step and from 95% - 95% 5 step. Assessment factors that scored below 55% were considered to have obtained poor standard quality.

**Documents and Records**

As stated in the previous section, the goal of this study was to assess if the 43 water supply projects said to be established by Benue state governments had verifiable documents and records to support those claims. The results of this study showed that the majority (i.e. over 60% of the large, medium, and small capacity water supply projects in the NSD had good documentation and record-keeping practices pertaining to all the projects assessed during this study. Documents and records therefore scored 75% representing the 3 step which was the highest percentage among all the factors. Whether those documents/records amount to the standard or quality of water supplied by those projects remained a big question as they represent two different realities.

**Management Reviews**

The management reviews factor in the questionnaire was designed to identify how frequent management reviews of the 43 water supply projects were conducted and how the lack of reviews impacted the quality and delivery of water supply services. Well-intended rural development projects that are not reviewed for many years sometimes fail. The evaluation of this factor was important because, oftentimes issues relating to water supply projects as well as water quality can go unidentified or unattended to and may invariably impact the quality of water or its supply services in general. Lack of work plan and budget can also impact the delivery of water services if the water supply managers cannot identify issues or undertake performance improvement to the units. It was found that the majority of water supply projects scored 67% representing the 1 step, which was one among the lowest percentage score in the overall assessment. This shows that were poor management reviews of the water supply projects.

**Organization and Personnel**

For rural development projects such as water supply projects to succeed and meet their objectives, it is important to have both organized and skilled personnel. Organization and personnel factor was important to this study because it helped to establish how personnel issues such as untrained personnel are connected to lack of potable water to the NSD. Other points of interest about organization and personnel were the existence and availability if any, of personnel chart as well as personnel files. Also of interest were documents of job description/orientation of personnel as well records of competency assessment of personnel, training policies/training plans and records of staff meetings/minutes of those meetings.

The data supported the fact that organization and personnel QSE factors have statistical correlation with the other 10 QSE as well as the overall quality scores 74% representing the 2 step from all the 43 water supply projects. The strength of this correlation was calculated using the Pearson's product-moment correlation and Spearman's ranking correlation analysis. What the data on organization and personnel showed was a statistically positive correlation between this factor and other 10 factors judging from the overall scores of water supply projects assessed during this study.

**Equipment**

This variable was key in the assessment process and for this study because a better understanding of the water supply technology types enhanced a deeper understanding about the relationship of technologies used and their association with lack of potable water supply to the communities of the NSD. It identified issues associated with the equipment and how they impact the overall quality and delivery of water

services to the NSD. This factor examined whether there were backup procedures for equipment failures. It also examined whether repair orders were monitored to ensure repair services were completed. Additionally, it examined whether the supply units provided uninterrupted services since projects' inception. This reflected the efforts of Benue state governments to supply potable water to the NSD and what those efforts mean in practical terms. According to the data examined, apart from two water supply projects in Makurdi the state capital and katsina Ala, those installed for water supply at community locations in the SD scored (51%), representing no step of the overall assessment of the survey. The data supports the assumption that there is a lack of potable water supply to the NSD.

**Internal Audit**

I considered internal audit to be important because for any ministry such as the MWRE not to conduct frequent internal audits would be hard for ministry officials to identify those responsible for missing spare parts as well as failures of projects. Internal audit factor was to show how frequent internal audit of the projects were conducted, and if so whether the audits were documented. I also intended to establish if there were annual water supply assessments as well as follow-up recommendations and corrective actions. I considered internal audit to be important for purposes of accountability and transparency of the MWRE. Additionally, it was also important to ascertain the level to which lack of internal audit had impacted the quality and delivery of water supply services to the NSD. The data supported the assumption that internal audit scored only 47% of the 180 points, representing no step in the overall QSE assessment. Based on the evidence that there are no frequent audits, it was hard if not impossible for the officials of

the MWRE to discover what was needed to support water supply projects at any given point in time.

**Purchasing and Inventory**

The importance of this variable is that it has a direct connection with the variable discussed above (internal audit). If the purchasing of equipment, spare parts, or supplies are done by different agents, it could be difficult to keep track of what was purchased or supplied. If there are no inventories to purchases of spare pasrt as well as no forecasting of what needs to be supplied these can lead to serious problems. Similarly, if there is no system of control, orders are not tracked until delivery or inspected and receipted, these can lead to accusations, blame, distrust and friction among employees as well as governments especially, when confronted with projects' failures. The end result to these issues is that communities suffer the lack of water when broken down equipment is not fixed or replaced with new technologies. The data findings supported the fact that this factor scored 53% which represented no step (poor standard) in the overall assessment. What this data supported was the close association of this factor with the overall lack of quality and delivery of potable water supply services to the NSD.

**Information Management**

I considered this variable to be important because the NSD is composed of 14 local government areas that are separated by a driving distance of between 2 to 3 hours to and from the state capital and the headquarters of the MWRE. The activities of the ministry can be hampered due to poor information management especially when considered in relation to project managers at community locations. My interest in information management was to establish easy access to information was by personnel of

the ministry, and if not, how this lack contributed to water supply problem to the NSD. The assessment of this factor included information about how the activities of the MWRE were shared or communicated from the headquarters to community locations and vice versa. The result of the study showed there were communication issues between personnel at community locations and officials at the ministry headquarters and vice versa. The result of the data supported the assumption that information management only scored 53% of the assessment which represented no step of the expected 180% of the overall assessment. I discovered that some members of the ministry, especially water supply managers, had partial access to information about what went on at other water supply locations and at the headquarters.

**Process Control and Internal/External Quality Assessment**

This variable was important because water supply pipe lines that are old could lead to water leakages during transmission/delivery and result in supply shortages. Additionally, depending on the magnitude of leakages/pipe breakdown, these events could lead to water contamination and environmental nuisance. Additionally, this factor examined whether environmental checks were accurate and reviewed regularly; were there defined ranges for in-range and out of range for gas/engine oil dependent equipment and what to do when they were suddenly out of range. It also examined whether there were designated officials to be contacted immediately when water supply technologies in rural areas had sudden malfunction, or who addressed those complaints: the MWRE or the local communities. Also included in the factor was whether internal quality control preformed, documented and reviewed. Were there procedures for reporting unsatisfactory performance of the supply systems? Whether the MWRE participates in external quality

assessment with other states for comparison. Although the data showed that this factor obtained 69%, representing step 2 of the general assessment, at more than 20 of the 43 water supply projects it was evidently clear that the water supply projects were in deplorable conditions. For example, some of the equipment were found to have been in poor/none working conditions such that they could have scored a zero percent meaning, they did not meet any quality standard.

**Corrective Action**

As indicated in one of the sections above, corrective action variable has inter connection with other variables such as the variable just discussed above. This factor examined whether environmental checks around or within the small, medium, and high capacity water supply projects were in acceptable or unacceptable conditions; it also examined if out of control water runs were reviewed and corrective actions taken. The aim was to ascertain how these issues, if any, impacted the overall supply and quality of water to the NSD. The data showed that this variable obtained the lowest score of 46%, no step, from the 180% of the overall assessment. At some water supply units that were in working conditions, the environments were unclean with out of control water runs form the activities of children.

**Occurrence/Incident Management, Process Improvement and Customer Service**

Again, this factor has interconnection with the two just discussed above as well as other variables for the study. An evaluation of this factor was important to identify whether cases, reports and frequency of equipment breakdown or malfunctions were completed with causes identified, how prompt those reports were attended to, corrective and preventive actions were taken or not on all reports to avert re-occurrence in order to

improve quality. Another aim was to verify if there were tools to evaluate how satisfied or not the communities were with the water supply services they were offered. It was additionally to establish how those processes or their lack contributed to lack of potable water supply to the NSD and hence the collective impact of the factors on economic development. The data results showed that this factor scored only 57% which represents the step 1of the overall assessment score. Invariably, this was below the standard requirement of the assessment and further supports the factor on corrective action just discussed above.

**Facilities and Safety**

This factor like every factor was important for variety of reasons. Among key issues evaluated in this variable were the layout of water supply units, the suitability and accessibility of water supply projects to their benefiting communities as well as the supply managers. The safety of the water supply managers and the public and the environment, water treatment chemicals, waste disposals, vaccination of personnel and records of injuries. The researcher considered this factor to be important precisely in view of the questions generated. For example, if the originating points of distribution are not environmentally clean they could potentially serve as sources of bacterial transmission with their attendant water contamination and health issues to consumers. Besides these issues, deficiencies in the components could lead to catastrophic damage to equipment, environmental contamination as well as loss of lives and other impacts to benefiting communities. Although the data showed a 67% score which represented the 2$^{nd}$ step of the overall assessment, it still measured below high quality standard. Again, the researcher found during physical visits to the water projects that while some were accessible and

suitable to communities, some were not and their environments were not secure and well kept.

## Interpretations of Findings

The purpose of this study was to evaluate the impact of lack of potable water availability on the economic development of the NSD and Benue state. In this section of the chapter, I attempted to analyze and interpret the findings of this study in relation to the scholarly literature presented previously on the value and importance of potable water to human life and the development of communities, states and nations. Additionally, I also attempted to analyze and interpret the findings of this study in relation to the 11 questions/factors of the assessment checklist. This study both confirms and extends on the scholarly literature written about water supply problems in Benue state and the issues associated with water quality as well as its lack and the need to make improvements towards its constant availability and better quality supply especially to the NSD of Benue (Isikwue et al., 2009; Kughur et al., 2012; Maitera et al., 2011; Ocheri et al., 2010; & 2012; Odiaka et al., 2008; Okoye et al., 2009; Tse et al., 2009).

### Documents and Records

In the review of literature, it was noted that water projects that were implemented years ago were not working effectively due to poor maintenance or their lack or due to other logistic issues (Ocheri et al., 2010). Documents and records, one of the factors assessed in this study is among logistic problems associated with lack of potable water especially in the NSD of Benue state. Several key statistically significant correlations were found. The data supported a strong correlation between documents and records that obtained 75% representing step 3 which indicated that they somehow met the required

standard. This outcome was however prominent in the state headquarters of the MWRE than it was the case at the projects and locations within the NSD. While at most of the community locations standard operating procedures [SOPs] were available for all supply units; they were not easily accessible to all staff due largely to authority and control. Additionally, there were no records to show that all staff read and understood the SOPs related to their responsibilities in service delivery. It could well happen that some managers were not knowledgeable and skilled for the responsibilities they assumed that could potentially damage the technologies and interrupt water delivery to the communities.

**Management Reviews**

The "unconstitutional war on poverty" declared by President Lyndon Johnson in 1964 focused on social problems and evaluation of programs that were designed to ease them (Zuccala et al., 2010). The necessity of evaluation/management reviews is for reasons of accountability as well as improving the working of the programs from inputs to outcomes, (Brown et al., 2009; Estache et al., 2010; White et al., 2009). The data presented on this factor supported that there were poor management reviews of water supply projects. There was lack of work plan as such projects in the NSD were implemented without sustainability plans. There were also no budgets in place as such the water supply managers had no funds to purchase gas when and at locations it was needed. Subsequent to these developments, it was also difficult for water supply managers to identify and undertake performance improvement of the units neither could they purchase water treatment chemicals.

In some cases including Makurdi the state capital, the chemicals needed for water treatment were not supplied on regular bases. This was not due to its lack or availability in the markets; the lack was majorly due to lack of political good will on the part of government by delayed disbursement of funds including bureaucratic process that delayed quick action. Furthermore, only few water supply projects offered skeletal services due to lack of public electricity supply or only periodic (occasional) supply of diesel to run the pumping machines. Potable water supply became intermittent depending on the availability of diesel. There were no documented reviews of quality records by the ministry's supervisors or its representatives for performance improvement.

**Organization and Personnel**

Although in the assessment, this factor managed to score 74% representing step 3, data findings revealed that this was more evident in the MWRE's administrative headquarters. Things were different at the water supply projects and locations within the NSD. The study identified that some water supply units were under staffed or the personnel were not qualified. There was inadequate training and re-training of water projects' staff. Some personnel lacked the basic skills, lost motivation due to lack of political good will that dampened their spirits and job effectiveness. There was lack of interest by the personnel to participate and learn (know) more about their job responsibilities. The example in Uganda by the Katoki Women Development Trust attests to the fact that, good organization and personnel would bring beneficial outcomes to projects and communities, (Payne et al., 2008). What this means in practical terms is that lack of skilled manpower can lead to poor maintenance and the failure of water supply systems. Olaniyan et al. (2008) highlighted the necessity and value of sound education

with high quality skills for economic growth and development as well as meeting the skill-demands of the economy.

**Equipment**

In the data presented above, this factor scored 51% which represented no step in the quality standard, (i.e. below the required standard) (refer to table 1above). This factor was very critical because it has strong ties with the subject under investigation of this study. No matter how well-meaning water supply projects may be, if the tools for water delivery (equipment) are of poor qualities resulting to constant malfunctions, the benefitting community will go without water supply (Ocheri et al., 2012). The data on this factor showed that over 70% of water supply projects in the NSD were not high quality equipment hence the lack of potable water supply to the communities. Additionally, the assessment also showed that the poor quality of technologies was exacerbated by poor maintenance culture. Some of the equipment including boreholes had broken down for more than ten years and were not re-habilitated if not all together abandoned.

There were also substantial cases of pipe leakages again including Makurdi that threw away water during the distribution process leading to massive waste and shortage of water supply to residents. Most of those pipes were too old and should have been replaced to ensure effective and sustainable supply. Invariably, the benefitting communities have gone for that length of time without water supply. Gboko, the headquarters of the NSD (the Tiv people), was a stark example of such cases due to lack of back-up procedures.

Profoundly, if the qualities of technology are poor and there is poor maintenance culture, these issues complicate or further demonstrate the magnitude of lack of water supply services to the NSD and its impact on their economic development. In their analysis of the poverty status determinants among smallholder farmers in Nigeria Asogwa et al. (2012) postulated that improvements in efficiencies of farms and farmers which includes among other things water supply will boost the agricultural sub-sector and the economic growth of rural communities such as those of the NSD, states such as Benue as well as Nigeria. Furthermore, it will greatly stimulate productivity levels as well as economic growth and per capita of rural communities such as those of the NSD of Benue which will ultimately reduce the level of poverty in Nigeria.

**Internal Audit**

This factor examined how frequent internal audit of water supply projects were conducted or if not any at all; the findings of the data supported that this factor scored only 47% representing no step in the overall assessment. As stated before, apart from the purposes of accountability and transparency on the part of governments and the activities of the MWRE, lesson learning and the ability to implement strategy made this factor of assessment important (Crawford et al., 2008; Estache et al., 2010). The failure of projects left in the hands of local governments and community partners to achieve their objectives are sometimes due to lack of internal audits (Holzer, 2012). It was also important to ascertain if the projects had attained their objectives or whether there were malfunctions in the process of operation and what, if any, needed to be improved or changed to ensure their efficiency for the good of the benefiting communities (Flynn et al., 2009). Based on the data evidence, the rural water supply units lacked regular audits that could have

helped to ascertain if the projects were in working conditions or not. It was therefore difficult if not impossible to identify what was needed at a given point and which water supply unit needed it.

**Purchasing and Inventory**

Investments in water services for rural communities such as those of the NSD could bring higher socioeconomic benefits and development as noted by UNICEF (2012). The result of the data collected showed that this factor scored 53% representing no step in the overall assessment. As stated above, lack of purchasing and inventory of spare parts; no forecasting of needs for supplies; no inventory control system in place; orders not tracked until delivery, inspected and receipted as well as complete and accurate inventory records can lead to accusations, blame, distrust and friction among employees as well as governments especially, when confronted with projects' failures. What this data showed was that there were no purchases of new equipment or spare parts for the technologies that were broken down for years (poor investment). This impacted water supply to the communities affected by equipment breakdown. Among some of the personnel constrains were bottle-neck bureaucracy and lack of freedom for administrators who had responsibilities to use their initiatives. These were at the heart of lack or poor quality of water supply to the NSD and its attendant impact on the economic development of the SD and Benue state at large.

**Information Management**

How information about the activities of the MWRE were communicated from the headquarters to community locations and vice versa was key to this factor's assessment. Its importance laid in the fact that the 43 water supply projects were spread across 14 local governments of the NSD. Some of the community locations and projects are far from Makurdi, the ministry's headquarters. It was as challenging for water supply managers to communicate with the main office problems encountered at their locations as much as it was difficult for the main office to communicate with them. In both cases information sharing was only partial. Throughout the NSD, the data supported that information management was only 53% which represented no step of the expected overall quality assessment. Apart from these, there were no systems for reviewing staff and technology errors as well as lack of documented procedures for the preservation of data.

**Process Control and Internal/External Quality Assessment**

This factor examined whether environmental checks were reviewed regularly and found to be accurate or not. It also examined if gas/engine oil dependent equipment had clearly marked indicators for in-range and out of range. In the given that an equipment was suddenly discovered to be out of range, were mechanisms in place for what could be done. The factor also examined if officials were designated to be contacted immediately in situations where water supply technologies in rural areas have sudden malfunction. Additionally, the factor sought to know who addressed those complaints: the MWRE or the local communities. Aside from these, the factor also examined if internal quality control of water projects were routinely performed, documented and reviewed. Were

there established procedures for reporting cases of unsatisfactory performance of water supply systems? Additionally, it also sought to know if the MWRE in collaboration with key players and stake holders participate in external quality assessment of water supply projects and compare notes with other states to identify areas of weakness and improvements. Although the data supported the fact that this factor obtained 69% representing the 2 step of the general assessment, it did not reflect the reality of things at more than 20 of the 43 water supply projects. For example, if taken on case basis at those locations some equipment could have obtained a lower percentage score due to lack of internal quality control and frequent technology checks.

**Corrective Action**

This factor examined whether environmental checks around water supply projects were in acceptable or unacceptable conditions; it also examined if causes of out of control water runs were reviewed and corrective actions taken. Previous literature did not pay much attention to environment that is one of the objectives of water supply projects (Emch et al., 2010). The aim was to ascertain how these lacks, if any impacted the overall supply and quality of water to the NSD. The findings of the data supported that this variable obtained the lowest score 46% no step from the 180% points of the overall assessment. At some water supply units the environment were in unacceptable conditions; out of control runs of water pipes were not controlled, not documented for troubleshooting and cause analysis performed (Jalan et al., 2009). As one might be right to wonder why the gross lack of attention, one might also be right to assume that the answer has ties to corruption, lack of transparency and political good will which Agba et

al. [2010] described as a major impediment to sustainable economic and developmental growth in Nigeria.

**Occurrence/Incident Management, Process Improvement and Customer Service**

This examined cases of equipment breakdown and how frequent they occurred; whether reports about such cases were completed and the causes identified; were the corrective measures taken or not as well as how prompt maintenance measures were taken in order to avert re-occurrence. It further examined if there were tools/ways to evaluate the satisfaction of communities with the quality of water supply and services they were offered. This was considered important as a major step towards getting key players: the rural people as well as special stakeholders such as local government officials involved in the intervention projects (Mahmoodi et al., 2008). The honest feedback of participating teams could help state governments, officials of the MWRE and other decision making bodies to make changes and improvements towards efficiency and sustainability of the water supply projects (Stedman et al., 2009).

Subsequently, this could also be an avenue to discuss the cost and cost benefits of projects with participating teams as well as to seek communities' support right from the planning of projects (Halland et al., 2011; Magoon et al., 2010). The data results showed that this factor scored only 57% which represents the 1 step of the overall assessment score. What this meant is that although there were frequent equipment break down, authorities did not bother to identify the causes as such no management and improvement measures were taken. The data finding also supported that tools for evaluating the satisfaction of communities were not put in place. Projects were planned and implemented without the involvement of key players that could help promote ownership.

Therefore, there were no discussions about the cost and cost benefits of projects with their host communities. Invariably, this factor further supported the reality of lack of potable water supply and its impact on the NSD.

**Facilities and Safety**

As stated above, this factor was important for variety of reasons. It examined how suitable and accessible water supply projects were to their benefitting communities as well as the safety of water supply managers and the public (Holland et al., 2011; Magoon et al., 2010). Another reason was that unclean water supply sources could potentially serve as sources of bacterial transmission with their attendant water contamination and health issues to consumers. Although the data showed a 67% score which represented the 2 step of the overall assessment, this was not the case for all the supply units. During physical visits to the water projects for data collection, the researcher found that while some projects were accessible and suitable to communities, some were not secure and well kept.

Data findings showed that safety cabinets for the storage of water treatment chemicals and gas were lacking in more than 30 of the projects. These were risky to water supply managers and the public in an event of fire outbreak. Also lacking was lack of provision for safety records of personnel especially in cases of work related injuries; both at the state headquarters and water supply locations within the NSD. Keeping track of medical bills and compensations due could be difficult if there were no safety records. This can lower the morale of personnel and lead to poor job performance.

Of vital importance is the fact that the assessment checklist utilized for this study, based on the responses of the 48 study participants has helped in answering the research

question about the nature of relationship between lack of potable water availability and the economic development of the NSD and Benue state. It also provided a deeper and better understanding of the role played by Benue state governments since the creation of the state in 1976 to address water supply needs to the communities of the NSD.

Overall, the results of the study revealed that over 68%, that is the majority of high and medium capacity water supply projects offered poor quality of water services. The outcomes of this data are in consonant with this research hypothesis. According to Biswas et al. (2009), the future social and economic development of the world would be seriously limited or even substantially impacted without sufficient and sustainable water supply. Adamgbe &Uno (2013) have therefore advocated for the implementation of irrigation technologies that will ensure improved crop species as well as yields for communities such as those of the NSD of Benue state. Ultimately, this may stimulate the creation of a model for improving and sustaining more effective and efficient potable water supply to the NSD of Benue state, Nigeria.

## Relation of Findings to Current Literature

While there was a substantial amount of literature concerning water and water problems in Nigeria (Chudi et al., 2010; Kolawole et al., 2012; Nwajei et al., 2012; Offem et al., 2011; Olajide et al., 2011) and some specifically on Benue state, Nigeria (Maitera et al., 2011; Ocheri et al., 2010; Ocheri et al., 2012), little was known about water problems in the NSD of Benue state as a whole; a gap this study has attempted to fill. Furthermore, little was known regarding factors such as documents and records, management reviews, organization and personnel, equipment, internal audit, purchasing and inventory, corrective action, occurrence/incident management, process improvement

and customer service as well as facilities and safety. This is one among the gaps in those literatures this study has attempted to fill by showing from the data how the 11 factors can lead to lack of potable water supply to communities such as the NSD of Benue state as well as how invariably, this lack can and does hamper economic development of communities as is the case with the NSD and states such as Benue.

Apart from these, another important gap this study has attempted to fill in literature and in practice is the possible relationship between lack of potable water availability and its impact on the economic development of the NSD as well as the impact Benue state governments have played in this development since the creation of the state in 1976. The data for this study supported that the 43 water supply projects implemented by Benue state governments throughout the 14 local government areas that make up the NSD are not adequate which confirms previous literature about lack of potable water supply to the NSD (Aper et al., 2011; Terngu et al., 2010; Utsev et al., 2012). This condition was exacerbated by poor technology qualities; malfunctions, total breakdown and lack of rehabilitation out of poor maintenance culture that have a direct relationship with lack of potable water availability and its impact of the economic development of the NSD and Benue state.

As noted in the review of literature, much of the literature on water problems in Nigeria and Benue state did not pay attention to key players such as rural people, special stake holders like decision makers or government officials who must be involved in the planning and implementation of projects to promote ownership; a gap this study tried to fill. Although the result of the data showed that water supply projects in the NSD did not have tools put in place to involve key players and special stake holders including their

feedback through evaluation, this study adds to literature that they are essential in projects' planning, implementation and evaluation (McGarvey et al., 2008). In a related development, officials of the MWRE who have administrative responsibilities were not given free hands to use their initiatives due to bottle-neck bureaucracy.

Another major gap this study attempted to fill was cost effectiveness and cost benefits of potable water supply projects. Consideration to this was not so much on the net than the gross costs of the projects. However, as stated above, lack of planning; involvement; implementation; claim of ownership by the communities of the NSD and a combination of other factors militated against the derivation of cumulative cost benefits of the water supply projects. Direct economic benefits could have been realized from expenses saved for health treatment and other indirect costs incurred as well as direct costs like transportation, food and drinks. These benefits, cumulatively with non-health benefits could greatly enhance economic development and growth of the NSD and Benue state.

An important question to ask at this juncture is, in view of this background development, where do the people of the NSD of Benue go from here? This research study has postulated that the quality of technologies implemented for potable water supply projects and the factors assessed are important for realizing efficient and effective delivery of water supply services. No doubt, there is link between this scholarly work that may serve as a model to help Benue state governments, law makers; policy makers and stake holders to improve the quality and availability of potable water supply services to the NSD. The study also adds to the body of knowledge by providing outcomes to the assessment of the quality of technologies used for water supply in the NSD of Benue. The

results of this research confirm my assumption that lack of potable water availability has impacted the economic development of the NSD and Benue state. Examples abound in other parts of world such as North America and Europe where both water supply technologies and skilled personnel have significantly contributed to the effective, efficient and sustainable supply of potable water to the citizens even those in rural areas (Solomon et al., 2010).

## Limitations of the Study

Apart from the limitations of the study discussed in Chapter 3, other limitations were also identified in the process of data collection. These included but were not limited to the fact that the water supply assessment was primarily focused on the NSD of Benue. The selection of sample may therefore have been skewed towards a predominantly rural and agricultural setting when compared with other communities in the African Sub-Saharan Region with better living standards than those of the NSD. It is important against this background that the interpretation of the results of this study would need to be done with caution, especially when generalizing to other communities in the African Sub-Saharan Region.

Furthermore the closed-ended questions in the water supply assessment checklist may have prevented the participants from providing more in-depth information. Additionally, the researcher discovered that many of the participants were not quite familiar with the evaluation of water supply that was done utilizing an assessment checklist and the factors this study focused on. This may have led to some miscommunication or miss-representation of information by the participants. However, to minimize this limitation and its impact on the study, during data collection I went through

the checklist with all the participants individually and their pertinent questions were adequately answered and clarifications made to all aspects of the checklist in order to avert miscommunication and ensure compliance to the ethics of the study.

## Recommendations for Action

This research study showed that the NSD of Benue state lacks potable water supply. The goal of this research was to evaluate the impact of potable water availability on the economic development of the NSD and Benue state. The outcome was to propose a model that will help Benue state governments and its related agencies improve the quality and delivery of potable water supply services to the SD. The communities of the NSD are the largest sub-group in agriculture and food production in the whole of Benue state. Improvements in potable water supply would bring beneficial outcomes such as boost its potential towards food production, economic activities/development and ultimately, the development of the state [Okpoko et al., 2008; Solomon et al., 2010].

### Practical Recommendations

There is a serious need to strengthen the supply of potable water to the rural communities of the NSD as this will enhance their economic development and ultimately, Benue state in general. The Benue State governments, the MWRE and their related agencies could be led based on the results of this study to develop a state model to strengthen the supply of potable water to the citizens, especially the communities of the NSD. As a reference point, the literature presented in Chapter 2 could be used to support the model as well as the outcomes of the study and the recommendations by this researcher. In order that all water supply projects enjoy maximum benefits from the model that would be developed, its gradual application shall be desirable. From the

perspective that the majority of water supply projects will be implemented by state governments, a gradual approach will facilitate the long-term sustainability of the model and projects financially.

**Developing a State Model**

The proposed model would be developed in relation to the WHO-AFRO stepwise (laboratory) water supply process towards improvements to meet the WHO standard to reduce to half the world population of those without adequate supply of potable water by 2015 and beyond. Additionally, by utilizing the results of this study as a baseline, the proposed model would from a small scale that will gradually establish water supply quality assessment scores which may eventually become a step-wise expanded assessment survey nationally. Furthermore, from the assessment of documents and record's outcomes of this study, the proposed model's water quality assessment scores could be drawn directly from the records of respective water supply units/projects. Although at the state headquarters I noted that there were better ways of records' keeping that were not the same at the water supply stations/locations within the NSD. It would therefore be helpful to create a standardized mechanism (computerized) of records' keeping at all the supply units to keep track of all water supply registries.

Involving benefiting communities, stake holders, policy/decision makers and the MWRE in the planning and implementation of all water supply projects will be helpful (Tilt et al., 2008). It will enable administrators and local communities to have a better understanding about how well their respective water supply projects are functioning or not. Aside from serving as a motivation towards improvement to serve their water needs

better, it may also encourage the communities to take ownership of the projects and contribute to their efficiency and sustainability.

As noted in the results of the data, technology malfunctions and breakdowns and lack of maintenance left many communities without access to potable water. Rehabilitation of those equipment will place the projects on the path to realizing the objectives for which they were implemented. In addition to this, the old and rusty water pipes need to be replaced. There is also need for leaders to change their lack of political good will to good civic responsibility and good leadership. Along this path, the water subsector needs to be adequately funded. There should be early release of funds budgeted for the water sector that will assure regular supply of water treatment chemicals. Governments should be more proactive in tackling water supply problems which may require reorganization of the water sector to enhance efficiency and accountability. Furthermore, there should be regular evaluation and environmental checks on water supply units. There should be provision of safety cabinets for water treatment chemicals and other hazardous materials; proper documentation of personnel injuries and illnesses as well as regular or periodic checks on rural water supply units.

Lack of skilled manpower and safety plans often lead to poor maintenance and failure of water supply systems. From the findings of the study with regards to human resources, it was found that there were personnel shortages at some supply stations. Apart from this, opportunities for training and continuing education of water supply personnel were lacking. There is a created need to improve on water supply in-service training programs at least which will improve the skills of water supply personnel to all the water projects within the NSD and ultimately improve the quality of services. What this would

imply is to establish a state qualification and certification examination for water supply personnel that could form a basic requirement and would be updated annually. Closely connected to this is the need to encourage personnel by giving awards as recognition for work excellence. These approaches will subsequently go a long way towards the general improvement of potable water supply services within the NSD, other parts of Benue state as well as to other parts of Nigeria and beyond.

**Academic Recommendations**

For practical purposes to expand research on assessment of water supply programs as well as building the capacity of programs and studies, this research study may serve as a baseline for future research and can be replicated. It is also important for future research to expand and include a holistic assessment of all the water supply projects in Benue state. To utilize the assessment checklist used for this study as a tool to identify other issues not included in the checklist, it is recommended that future research allocate adequate funds as well as increase the time to be spent at each supply project. This will enhance an in-depth evaluation of each water supply project.

Furthermore, while this research utilized a quantitative method, this may have prevented other contextual understandings of the theory and praxis of the problems. It may therefore be helpful for future research to include other research methods such as mixed and qualitative methods in the design of those studies. While the research method used for this study may have prevented the participants from providing in-depth information on the subject under investigation, utilizing other methods for a single study may cover more aspects there by increase the amount of information participants may provide. This may also increase the possibility for generalization of results.

Additionally, the fact that this study focused on a particular sub-group, the NSD of Benue it may have been skewed as such would limit the possibility of generalization when applied to other sub-groups in Benue state, Nigeria and beyond. That the communities of the NSD are majorly farmers also poses another challenge to generalization, especially when applied to communities whose living standards are better than those of the NSD. The researcher recommends that future research expand its scope in order to have a better picture of the issues of investigation and hence the generalization of the results.

Although this study is recommended as a base line for future research, since it is the first to evaluate more holistically the factors associated with lack of potable water availability and its impact on the NSD and Benue state, there may be other factors/aspects of investigation not yet addressed. Future researchers may do well by adding other factors if considered necessary on the assessment checklist utilized for this study before using it in order to expand investigations.

## Implications for Social Change

We are in the 21st century and yet in Nigeria and other countries within the African Sub-Saharan Region, the population of people without adequate supply of quality water is still very alarming (WHO, 2012). Governments of these countries and regions are facing the challenge and are under intense pressure to implement and improve the quality and effectiveness of potable water availability not just to towns and cities but most importantly to the rural areas such as those of the NSD of Benue state.

It is clear from the results of this study that the majority i.e., 68% of low, medium and high capacity water supply projects in the NSD of Benue do offer poor quality of

water services. This finding and conclusion is in consonant with many of the previous articles that are published concerning lack of water supply and its poor quality to rural communities. In most cases and places, those communities are neglected with no serious measures taken to improve their water supply, economic development and standard of living. It is worthy to note that many of the past research and publications concerning rural water supply focused mostly on rural water development, diseases and health implications associated with poor water quality as well as the implications of water collection by women and children on education, households and communities. In few occasions when lack of rural water supply on economic development was mentioned in those publications, it was simply as an additional factor. Ultimately, existing literature does not take into account holistically other factors that contribute to lack or poor water quality and their impact on people in rural communities.

Although there is literature concerning lack of water supply and its related problems in Benue state and some parts of the NSD in particular, this is the first study to provide a holistic assessment of the quality of all the water supply projects and types of technologies used in the NSD of Benue. With regards to the results of this study, I discovered that water supply projects in the NSD implemented by Benue state governments since the inception of the state in 1976 constitute only a fractional percentage of about or less than 10%. From the empirically based evidence of this study, its outcomes can be presented to the Benue state government and related stakeholders as well as decision makers in the MWRE to help in the implementation of future water supply improvements especially in the NSD. Again, based on the empirical evidence, the outcomes of the study will point out the different levels and water supply areas that need

more support so as to enhance an effective, efficient and sustainable potable water supply services to the SD.

From the outcomes of the study, there were strong and positive correlation between personnel and organization factors from the overall water supply assessment score. The importance of human resources and organization as essential factors to effective supply of potable water has been highlighted by Olaniyan & Okemakinde (2008). According to the authors, human resources are the pivot around which the economic development and functioning of communities, states and nations revolve. It is precisely the investments people make for the training and organizational aspects of human resources that brings about their economic development and productivity. What this directly means is that the training and skills development of human resources are essential to the MWRE and the supply of potable water to the NSD. Every conscious effort to improve the professionals of water supply is necessary and central to the overall improvements in water supply, productivity and economic development.

Agba et al. (2010) addressed a major challenge related to the effectiveness of potable water supply and sustainable developmental growth such as corruption. The author postulated that for sustainable development to take place in communities, states and nations especially of the developing countries, attention must be paid to the training of skilled staff as well as organizational and systems' developments. An investigation of the factors associated with personnel that affect the supply of potable water is crucial for understanding and ensuring better outcomes of the quality supply.

Furthermore, by assessing the factors that make up the personnel and organization of water supply projects, this study intended to evoke the training as well as improving

the efforts and limitations of the human resources. It was also important looking at the outcomes of this study and the degree of correlation between personnel and organization (human resource factors) that the other factors in the assessment checklist must be implemented in order to ensure an excellent water supply quality management.

The outcomes of the study also showed that there was positive and strong correlation between documents and records factors from the overall assessment score. In order to maintain an effective and efficient quality management of water supply projects, it is imperative for documents and records control to be created. I hope that a better understanding of the existing situation of documents and records of the water supply projects in the NSD will help the Benue state governments as well as the officials of the MWRE and stake holders in their policy and decision making to improve the quality of water supply services to the NSD.

Adenugba (2013) made a strong case about good governance and accountability in Nigeria's developmental dilemma with specific emphasis to documents and records of programs/projects. In a good number of instances according to the author, programs/projects are loudly proclaimed to have been implemented when in reality those governments or their associates do not have records to show and explain to the masses what is achieved with huge expenditures. Ensuring therefore that there are adequate documents and records for water supply projects in the NSD of Benue is critical, a practical evaluation which this research outcomes provided. The provision and availability of documents and records especially those that show standard operating procedures may be helpful in evaluating the competency of water supply managers (operators).

## Conclusion

The socioeconomic development of a nation, state or communities depends largely on the development and management of its water resources, (Flynn et al., 2009). Lack of potable water availability has impacted the economic development of the NSD and Benue state (Okpoko et al., 2008). Studies have found that access to potable water supply can solve societal problems of hunger and poverty, promote gender equality, reduce child mortality rates, combat water-borne diseases, improve maternal health, ensure a healthy environment and allow orderly social change (Kolawole et al., 2012). Hugo's theory of population growth and migration (2008) and Omamegbe's model (2010) were used as theoretical basis for understanding how the absence of basic social amenities in most countries of the Sub-Saharan Region motivate Africa's youth to migrate to the United States of America in search for greener pastures as well as Acey's theory of growing industrialization and overcrowding (2011) as a result of migrations.

The study's problem statement is that water is the most basic of human needs without which human existence would be impossible (Aremu et al., 2011). The reality however is that some members of the Nigerian society for example the rural communities of the NSD of Benue state do not have adequate access to potable water. The WHO quality standard of a minimum of 55% of water supply deemed potable is the global standard (WHO, 2010). The need existed against this background to see the connection between lack of potable water availability and the economic development of the NSD and Benue state; and what role Benue state governments played in addressing the problem of potable water availability (applying the WHO quality standard of water supply services

of 55% or greater) in order to enhance individual, community and state development. This study was conducted utilizing data that was publically available.

This study was the first in Benue state and the NSD in particular that using secondary data and a modified version of the HWO-AFRO Laboratory Assessment Checklist by the Uganda MOH and CPHL Elbireer et al. (2012) holistically evaluated the impact of lack of potable water availability in the NSD. From these sources, descriptive, statistical measurements, regression model, correlation, hypothesis testing and scatter plot were performed that identified 11 factors that contributed to lack of potable water supply to the communities of the NSD of Benue and their economic development.

The UN's General Assembly (2012) recognized that potable water availability has the potential to enhance the social enjoyment of life by individuals and produce decent standards of living, as well as improving the mental and physical health of people. While these human conditions can substantially facilitate the economic growth and development of individuals, communities, states and nations (Ajao et al., 2011), the NSD of Benue state is an example of potable water lack. As identified in this research study, lack of potable water supply to the NSD is also an example of lack of economic development. The conclusions for this study have indicated that improvements in potable water availability to the NSD could improve their economic development and Benue state at large.

This research study has added this new tool for evaluating water supply projects to the body of knowledge for the NSD and Benue state. If Benue state governments, stake holders and other relevant agencies can increase and strengthen the effectiveness and efficiency of potable water availability to the communities of the NSD, then the results

would benefit individuals, families, communities by improving mental and physical health of people; and reducing direct and indirect costs, boosting agriculture and food production as well as a sustainable environment (Ajao et al., 2011). Additionally, by reducing migrations by the teeming youths of the NSD from villages and communities to cities and towns as well as a reduction in overcrowding and its related impacts on environment. As documented very well by several researchers, efficient, effective and sustainable potable water supply to communities such as those of the NSD of Benue state will no doubt, have a positive economic and social impact.

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## Appendixes

Appendix A

Uganda MoH/CPHL Laboratories Assessment Checklist

# Laboratory Assessment Checklist

***A modified version of the WHO Laboratory Evaluations Criteria*** *By CPHL/MoH for conducting a Laboratories Assessment survey in the Kampala, Uganda.*

THE REPUBLIC OF UGANDA

| ASSESSMENT SCORING |
|---|
| This laboratory strengthening checklist contains 80 items worth 180 points. Each item has been awarded a point value of either 2 or 3 points— based upon relative importance and/or complexity. Responses to all questions must be either, "yes", "partial", or "no". Items marked "*yes*" receive the corresponding point value. **All** elements of a question must be present in order to indicate "yes" for a give item and thus award the corresponding point. Items marked "*partial*" receive less than the assigned point (based on compliance level)<br>Items marked "*no*" receive 0 points. |

**Assessment Score Sheet**

| Sections. | *Total Points* | *Assessed Score* |
|---|---|---|
| **General Information** | **4** | |
| **Section 1:** Documents & Records (6 items) | **16** | |
| **Section 2:** Management Reviews (3 items) | **6** | |
| **Section 3:** Organization & Personnel (5 items) | **14** | |
| **Section 4:** Client Management (1 item) | **3** | |
| **Section 5:** Equipment (8 items) | **17** | |
| **Section 6:** Internal Audit *(1 item)* | **3** | |
| **Section 7:** Purchasing & Inventory *(8 items)* | **16** | |
| **Section 8:** Information Management *(6 items)* | **12** | |
| **Section 9:** Process Control and Internal & External Quality Assessment *(14 items)* | **30** | |
| **Section 10:** Corrective Action *(4 items)* | **10** | |
| **Section 11:** Occurrence/Incident Management, Process Improvement, & Customer Service *(3 items)* | **7** | |
| **Section 12:** Facilities and Safety *(21 items)* | **42** | |
| **TOTAL SCORE *(80 items)*** | **180** | |

| **None** (0 — 98 pts) <55% | **First Step** (99 – 115 pts) 55% - 64% | **Second Step** (116 – 133 pts) 65% - 74% | **Third Step** (134 — 151 pts) 75% - 84%) | **Fourth Step** (152— 169 pts) 85% - 95% | **Fifth Step** (170— 180 pts) >95% |
|---|---|---|---|---|---|

| GENERAL INFORMATION | | |
|---|---|---|
| **Date of Assessment:** | **District/Division:** | |
| **Facility Name/Address :** | | **Project Code:** |
| **Lab Name:** | **Laboratory Contact Name** *(Key Informant)*: | **Phone#:** |

| **Laboratory Affiliation** (check all those that apply) | | **Laboratory Level** (check those all that apply) | | |
|---|---|---|---|---|
| Public | Academic | Hospital Laboratory | Clinic Laboratory | 24Hr Clinic laboratory |
| Private | NGO/Religious Institution | National Level Laboratory | District Level Laboratory | Standalone Laboratory |

**AVAILABLE LAB TESTS - *List of Tests performed in this Lab (may attached lab testing menu if available )* 2 Points *For each Test indicate lab personnel competency , instrument preventative Maintenance (PM) , Quality Control (QC), & EQA -If Done Yes (Y) Or No(N)***

| Test Name | Competency | PM | QC | EQA | Test Name | Competency | PM | QC | EQA |
|---|---|---|---|---|---|---|---|---|---|
| **1.** | | | | | **10.** | | | | |
| **2.** | | | | | **11.** | | | | |
| **3.** | | | | | **12.** | | | | |
| **4.** | | | | | **13.** | | | | |
| **5.** | | | | | **14.** | | | | |
| **6.** | | | | | **15.** | | | | |
| **7.** | | | | | **16.** | | | | |
| **8.** | | | | | **17.** | | | | |
| **9.** | | | | | **18.** | | | | |

**Average total Number of tests performed in the lab per day: _____**

**Temperature Sensitive Equipment** Available (e.g., Refrigerators, incubators,.. etc) **Yes / No ||**
If Yes - is ***Daily*** Temp log Completed **Yes / No**

| **Laboratory Complexity/Type** (check all those that apply) – this to be completed by the surveyor based on list of test above | | | | |
|---|---|---|---|---|
| POC Labs | One step Testing Kits (e.g., HIV, Syph) | Moderate/High Complexity Labs | Multiple Tests Instrument (e.g., CBC) | |
| | Microcopy (e.g.,Malaria, UA, Stool,..etc) | | Multiple steps testing kits (e.g., RPR, ELIZA, …) | |
| | One Test Instrument (e.g., Hg test) | | PCR and Other High Complexity Tests (e.g., VL, flow..) | |
| | Other _____ | | Micro- Culture.. | Histo/cyto Pathology |

| LABORATORY STAFFING INFORMATION<br>2 Points | | | |
|---|---|---|---|
| **Category of Lab staff** | **Number** | **Education Qualifications** | **Professional Certification (if any)**<br>*Medical Board or AHP Certification (specify)* |
| Pathologists/MD/PhD | | Medical Degree / PhD in Lab related discipline | |
| Lab Technologists/Scientists | | Higher Diploma or 3- 4 Year BSc in lab Technology Degree (need at least one for each Hi/Moderate complexity lab) | |
| Lab Technician | | 1-2 Year Laboratory Technology Certificate (need at least one for each Hi/Moderate complexity labs) | |
| Lab Assistant/Microscopy | | High School Diploma /on-the-job Training | |
| Phlebotomists | | | |
| Healthcare staff (e.g. Nurse) | | | |
| Other: | | | |

| 1.0 DOCUMENTS & RECORDS | | | | |
|---|---|---|---|---|
| **1.1. Are there Standard Operating Procedures (SOPs) current and available for all laboratory tests & functions?** *(i.e., Safety, Maintenance, samples collection, QA Manual/SOP)* | **Y** | **P** | **N** | 3 |
| **1.2. Are SOPs easily accessible / available to all staff?** | **Y** | **P** | **N** | 3 |
| **1.3. Is there a system or procedure for document & record control and retention?** | **Y** | **P** | **N** | 2 |
| **1.4. Is there documentation that all staff have read and understood SOPs that relate to their responsibilities in the laboratory?** | **Y** | **P** | **N** | 3 |
| **1.5. Are procedures dated when put into use and when discontinued?** | **Y** | **P** | **N** | 2 |
| **1.6. Are results archived and can be retrieved in reasonable time** | **Y** | **P** | **N** | 3 |
| **SECTION 1: DOCUMENTS & RECORDS Subtotal** | | | | **16** |

| 2.0 MANAGEMENT REVIEWS | | | | |
|---|---|---|---|---|
| **2.1. A work plan and budget in place for the laboratory?** (i.e., does the lab have a budgetary authority?) | **Y** | **P** | **N** | 2 |
| **2.2. Does the laboratory supervisor routinely perform a <u>documented</u> review of quality records?** | **Y** | **P** | **N** | 2 |
| **2.3. The laboratory identifies and undertakes quality improvement projects?** | **Y** | **P** | **N** | 2 |
| **SECTION 2: MANAGEMENT REVIEW** | | | **Subtotal** | **6** |

| 3.0 ORGANIZATION & PERSONNEL | | | | |
|---|---|---|---|---|
| **3.1. Are lines of authority and responsibility clearly defined for all lab staff, including the designation of a supervisor? (i.e., LaboratoryOrganizational chart available)** | **Y** | **P** | **N** | **3** |
| **3.2. Are Personnel Files present? Including Orientation/CE/Job Description/ educations certificates. Vaccination, annual competency evaluations.** | **Y** | **P** | **N** | **3** |
| **3.3. Is there a documented system for competency assessment of staff** | **Y** | **P** | **N** | **3** |
| **3.4. Does the laboratory have adequate training policies, procedures, and/or training plan** | **Y** | **P** | **N** | **3** |
| **3.5. Are Lab staff meetings held regularly (minutes documented)** | **Y** | **P** | **N** | **2** |
| **SECTION 3: ORGANIZATION & PERSONNEL Subtotal** | | | | **14** |

| 4.0 CLIENT MANAGEMENT | | | | |
|---|---|---|---|---|
| **4.1. Is there a laboratory handbook for clinicians' use that includes instruction on specimen collection, test information, and expected turnaround times (TAT)?** | **Y** | **P** | **N** | 3 |
| **SECTION 4: CLIENT MANAGEMENT** | **Subtotal** | | | **3** |

| 5.0 EQUIPMENT | | | | |
|---|---|---|---|---|
| **5.1. Is equipment installed and placed as specified in the operators' manuals and uniquely labeled or marked? And operator manuals are readily available to all testing staff?** | **Y** | **P** | **N** | 3 |
| **5.2. Is current equipment inventory data available on all equipment in the laboratory?** | **Y** | **P** | **N** | 2 |
| **5.3. Is non-functioning equipment removed from the laboratory and storage area?** | **Y** | **P** | **N** | 2 |
| **5.4. Is routine calibration of laboratory equipment – including pipettes, centrifuges, ba lances, and thermometers – scheduled, indicated on the equipment, and verified?** | **Y** | **P** | **N** | 2 |
| **5.5. Is routine preventive maintenance performed on all equipment and recorded according to SOPs?** | **Y** | **P** | **N** | 2 |
| **5.6. Are there back-up procedures for equipment failure** (including SOPs for handling specimens during these times, identification of a back-up lab for testing, referral procedures)**?** | **Y** | **P** | **N** | 2 |
| **5.7. Are repair orders monitored to determine if the service is completed?** *(review document)* | **Y** | **P** | **N** | 2 |
| **5.8. Has the laboratory provided uninterrupted testing services** | **Y** | **P** | **N** | 2 |
| **SECTION 5: EQUIPMENT** | **Subtotal** | | | **17** |

| 6.0 INTERNAL AUDIT | | | | |
|---|---|---|---|---|
| **6.1. Is an internal audit routinely conducted?** Is there documented annual laboratory assessment and follow-up recommendations /corrective actions? | **Y** | **P** | **N** | 3 |
| **SECTION 6: INTERNAL AUDIT** **Subtotal** | | | | **3** |

| 7.0 PURCHASING & INVENTORY | | | | |
|---|---|---|---|---|
| **7.1. Is there a documented system for forecasting needs for supplies and reagents?** | **Y** | **P** | **N** | 2 |
| **7.2. Is an inventory control system/SOP in place?** | **Y** | **P** | **N** | 2 |
| **7.3. Are all orders tracked until delivery and inspected, receipted, and labeled with date of receipt when checked in?** | **Y** | **P** | **N** | 2 |
| **7.4. Are inventory records complete and accurate, with minimum and maximum stock levels denoted?** | **Y** | **P** | **N** | 2 |
| **7.5. Are stock counts routinely performed (documented)?** | **Y** | **P** | **N** | 2 |
| **7.6. Is First-Expiry-First-Out (FEFO) practiced?** | **Y** | **P** | **N** | 2 |
| **7.7. Are storage areas set up and monitored appropriately?** Temp Control/ security | **Y** | **P** | **N** | 2 |
| **7.8. Are all reagents/test kits in use (and in stock) currently within the manufacturer-assigned expiry dates.** *(physical check)* | **Y** | **P** | **N** | 2 |
| **SECTION 7: PURCHASING & INVENTORY** **Subtotal** | | | | **16** |

| 8.0 INFORMATION MANAGEMENT | | | | |
|---|---|---|---|---|
| **8.1. Are test results format legible, technically verified, and confirmed against patient identity?** | **Y** | **P** | **N** | 2 |
| **8.2. Are testing personnel identified on the requisition &/or testing records?** | **Y** | **P** | **N** | 2 |
| **8.3. Are test results recorded in a logbook or electronic record in a timely fashion?** | **Y** | **P** | **N** | 2 |
| **8.4. Is there a system for reviewing for clerical errors** (i.e., second check)**?** | **Y** | **P** | **N** | 2 |
| **8.5. Are archived results stored in a secure location accessible only to authorized personnel?** | **Y** | **P** | **N** | 2 |
| **8.6. Are there documented procedures for the preservation of essential laboratory data in the event of hardware/software failure, theft, or an unexpected destructive event (e.g., fire, flood).** | **Y** | **P** | **N** | 2 |
| **SECTION 8: INFORMATION MANAGEMENT** **Subtotal** | | | | **12** |

| 9.0 PROCESS CONTROL and INTERNAL & EXTERNAL QUALITY ASSESSMENT | | | | |
|---|---|---|---|---|
| **9.3. Are guidelines for patient identification, specimen collection** (including client safety)**, labeling, and transport readily available to persons responsible for primary sample collection** my)**?** | **Y** | **P** | **N** | 2 |
| **9.4. Are adequate specimen collection and receiving procedures in place?** Specimens Labeling, & 2 identifiers on each tube and acceptance/rejection criteria documented | **Y** | **P** | **N** | 2 |
| **9.5. Are specimens stored appropriately?** | **Y** | **P** | **N** | 2 |
| **9.6. Are specimens packaged appropriately and transported to referral laboratories** | **Y** | **P** | **N** | 2 |

| | | | | |
|---|---|---|---|---|
| **within acceptable timeframes?** | | | | |
| **9.7. Is there a reagent logbook for lot number and dates of opening that reflects verification of new lots?** | **Y** | **P** | **N** | 2 |
| **9.8. Is internal quality control (IQC) performed, documented, and reviewed prior to release of patient results? –** *Review QC records to confirm* | **Y** | **P** | **N** | 2 |
| **9.9. Are QC results monitored for biases, shifts, and trends, i.e. Levy-Jennings charts? And are violations followed by timely troubleshooting/corrective action** | **Y** | **P** | **N** | 2 |
| **9.10. Are test results validated & interpreted by appropriately authorized personnel?** | **Y** | **P** | **N** | 2 |
| **9.11. Are test Requests crosschecked with test Results thereby assuring completion of all tests?** | **Y** | **P** | **N** | 2 |
| **9.12. Is there a procedure for result reporting, critical results, handling corrected /amende laboratory results, and reporting unsatisfactory samples?** | **Y** | **P** | **N** | 2 |
| **9.13. Are graphical tools (charts and graphs) used to communicate quality findings and identify trends?** | **Y** | **P** | **N** | 2 |
| **9.14. Does the laboratory participate in an External Quality Assessment (EQA) scheme or inter-laboratory comparison – for ALL tests done in the lab?** | **Y** | **P** | **N** | 3 |
| **SECTION 9: PROCESS CONTROL and INTERNAL & EXTERNAL QUALITY ASSESSMENT Subtotal** | | | | 30 |
| | | | | |
| | | | | |

| **10.0 CORRECTIVE ACTION** | | | | |
|---|---|---|---|---|
| **10.1. Do the environmental checks / temperature logs <u>document</u> action taken on unacceptable results?** | **Y** | **P** | **N** | 3 |
| **10.2. Are out-of-control runs reviewed and submitted for troubleshooting and cause analysis?** | **Y** | **P** | **N** | 2 |
| **10.3. Is corrective action taken on out-of-control runs documented in the occurrence log, with results withheld, if indicated by the level of control violated?** | **Y** | **P** | **N** | 3 |
| **10.4. Are discordant results tracked and appropriate corrective action taken?** | **Y** | **P** | **N** | 2 |
| **SECTION 10: CORRECTIVE ACTION** | **Subtotal** | | | **10** |

| **11.0 OCCURRENCE / INCIDENT MANAGEMENT, PROCESS IMPROVEMENT, & CUSTOMER SERVICE** | | | | |
|---|---|---|---|---|
| **11.1. Are laboratory occurrence reports completed and cause analysis performed, corrective and preventive action taken on all reports to avoid recurrence?** | **Y** | **P** | **N** | 3 |
| **11.2. Are quality indicators (TAT, rejected specimens, stock outs, etc.) selected, tracked, and reviewed regularly to monitor laboratory performance and identify potential quality improvement activities?** | **Y** | **P** | **N** | 2 |
| **11.3. Is there a tool for regularly evaluating client satisfaction?** | **Y** | **P** | **N** | 2 |
| **SECTION 11: OCCURRENCE/INCIDENT MGT, PROCESS IMPROVEMENT, & CUSTOMER SERVICE** | **Subtotal** | | | **7** |

| **12.0 FACILITIES & SAFETY** | | | | |
|---|---|---|---|---|
| **12.1. Is the layout of the laboratory, as a whole, organized so that workstations are positioned for optimal workflow?** | **Y** | **P** | **N** | 2 |
| **12.2. Are the client area and the testing areas of the laboratory distinctly separate?** | **Y** | **P** | **N** | 2 |
| **12.3. Is each individual workstation maintained free of clutter and set up** | **Y** | **P** | **N** | 2 |

| | | | | |
|---|---|---|---|---|
| **for efficient operation?** | | | | |
| **12.4. Is the physical work environment appropriate for testing?** *AC Ventilation, safety, lighting, wiring clutter?* | **Y** | **P** | **N** | 2 |
| **12.5. Is the laboratory properly secured from unauthorized access with appropriate signage?** | **Y** | **P** | **N** | 2 |
| **12.6. Is major safety signage posted and/or SOP enforced in the laboratory, prohibiting eating, drinking, smoking, and storing food/drink in laboratory refrigerators, etc.?** | **Y** | **P** | **N** | 2 |
| **12.7. Are patient samples stored separately from reagents and blood products in the laboratory refrigerators and freezers?** | **Y** | **P** | **N** | 2 |
| **12.8. Is the work area clean, free of spills, and properly disinfected daily?** *See documentations* | **Y** | **P** | **N** | 2 |
| **12.9. Is a certified and maintained biosafety cabinet used for all specimens or organisms considered to be highly contagious by airborne routes?** | **Y** | **P** | **N** | 2 |
| **12.10. Is waste disposal separated into infectious & non-infectious waste, with infectious waste autoclaved, incinerated, or buried?** | **Y** | **P** | **N** | 2 |
| **12.11. Are 'sharps' handled & disposed of properly in 'sharps' containers that are appropriately utilized?** | **Y** | **P** | **N** | 2 |
| **12.12. Are all electrical cords, plugs, and receptacles used appropriately and in good repair?** | **Y** | **P** | **N** | 2 |
| **12.13. Is an appropriate fire extinguisher available, in working condition, and routinely inspected?** | **Y** | **P** | **N** | 2 |
| **12.14. Are safety inspections or audits conducted regularly and documented?** | **Y** | **P** | **N** | 2 |
| **12.15. Is personal protective equipment (PPE) easily accessible at the workstation and utilized appropriately and consistently?** | **Y** | **P** | **N** | 2 |
| **12.16. Is standard safety equipment available and in use in the laboratory?** Including Eye wash stations, hand washing, spill kit, | **Y** | **P** | **N** | 2 |
| **12.17. Are laboratory personnel offered appropriate vaccination/s?** HepB**?** | **Y** | **P** | **N** | 2 |
| **12.18. Are post-exposure prophylaxis policies and procedures posted and implemented after possible and known exposures?** HIV? | **Y** | **P** | **N** | 2 |
| **12.19. Are occupational injuries or illnesses documented in the safety / occurrence log?** | **Y** | **P** | **N** | 2 |
| **12.20. Are drivers/couriers <u>and</u> cleaners working with the laboratory trained in biosafety practices relevant to their job tasks?** | **Y** | **P** | **N** | 2 |
| **12.21. Is a safety officer designated to implement and monitor the safety program in the laboratory?** | **Y** | **P** | **N** | 2 |
| **SECTION 12: FACILITIES & SAFETY Subtotal** | | | | **42** |

| **Additional Comments/Observations** | |
|---|---|
| **Point #** | **Comment/Observation** |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

| SUMMARY/RECOMMENDATIONS |
| --- |
| **Noted Commendations** |
| |
| **What would you consider are the 3 top Challenges for this Water Supply Project?** |
| |
| |
| |
| |
| **What Could be done to overcome the challenge(s) listed above?** |
| |
| |
| |
| |

Appendix B

## My Modified Laboratories Assessment Checklist

# Water Supply Units' Assessment Checklist

THE REPUBLIC OF UGANDA

***A modified version of the WHO Laboratory Evaluations Criteria By CPHL/MoH for conducting a Laboratories Assessment survey in the Kampala, Uganda.***

| ASSESSMENT SCORING |
|---|
| This water supply strengthening checklist contains 65 items worth 180 points. Each item has been awarded a point value of either 2 or 3 points—based upon relative importance and/or complexity.<br>Responses to all questions must be either, "yes", "partial", or "no".<br>Items marked "*yes*" receive the corresponding point value. **All** elements of a question must be present in order to indicate "yes" for a given item and thus award the corresponding points.<br>Items marked "*partial*" receive less than the assigned point (based on compliance level)<br>Items marked "*no*" receive 0 points. |
| **Assessment Score Sheet** |

| *Section* | *Total Points* | *Assessed Score* |
|---|---|---|
| **General Information** | **4** | |
| **Section 1:** Documents & Records (6 items) | **16** | |
| **Section 2:** Management Reviews (3 items) | **6** | |
| **Section 3:** Organization & Personnel (5 items) | **15** | |
| | | |
| **Section 5:** Equipment (8 items) | **17** | |
| **Section 6:** Internal Audit *(1 item)* | **3** | |
| **Section 7:** Purchasing & Inventory *(7 items)* | **22** | |
| **Section 8:** Information Management *(6 items)* | **12** | |
| **Section 9:** Process Control and Internal & External Quality Assessment *(8 items)* | **24** | |
| **Section 10:** Corrective Action *(3 items)* | **10** | |
| **Section 11:** Occurrence/Incident Management, Process Improvement, & Customer Service *(3 items)* | **10** | |
| **Section 12:** Facilities and Safety *(15 items)* | **45** | |
| **TOTAL SCORE** ***(58 items)*** | **180** | |

| | | | | | |
|---|---|---|---|---|---|
| **None**<br>(0 — 98 pts.)<br><55% | **First Step**<br>(99 – 115 pts.)<br>55% - 64% | **Second Step**<br>(116 – 133 pts.)<br>65% - 74% | **Third Step**<br>(134 — 151 pts.)<br>75% - 84%) | **Fourth Step**<br>(152— 169 pts.)<br>85% - 95% | **Fifth Step**<br>(170— 180 pts.)<br>>95% |

| GENERAL INFORMATION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Date of Assessment:** | | **District/Division:** | | | | | | |
| **Facility Name/Address :** | | | | | | | **Project Code:** | |
| **Water supply Unit Name:** | | | | **Manager (operator) Contact Name** *(Key Informant)*: | | | **Phone#:** | |
| **Water Supply Unit** (check the one that apply) | | | | **Water Supply Unit Level** (check the one that apply) | | | | |
| | | | | Water Supply Unit | Water Supply Unit | Water supply Unit | | |
| | | | | High Capacity Supply Unit | Medium Capacity Unit | Small capacity | | |

| AVAILABLE IMPLEMENTATION TESTS - *List of Tests performed if available)* 2 Points *For each Unit indicate unit personnel competency , Unit Maintenance (UM) , Water Quality Control (WQC) ,If Performed Yes (Y) Or No(N)* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **When the Test Carried out** | **Competency** | **UM** | **QC** | **EQA** | | **Competency** | **PM** | **QC** | **EQA** |
| **1.** | | | | | **10.** | | | | |
| **2.** | | | | | **11.** | | | | |
| **3.** | | | | | **12.** | | | | |
| **4.** | | | | | **13.** | | | | |
| **5.** | | | | | **14.** | | | | |
| **6.** | | | | | **15.** | | | | |
| **7.** | | | | | **16.** | | | | |
| **8.** | | | | | **17.** | | | | |
| **9.** | | | | | **18.** | | | | |
| **Average total Number of times water is supplied per day: _____** | | | | | | | | | |

| **Water Supply STAFFING INFORMATION** | | | **2 Points** |
|---|---|---|---|
| **Category of ministry staff** | **Number** | **Education Qualifications** | **(Professional Certification (if any)** |
| Pam Secretary | | Degree, MA / PhD in Water Eng./related discipline | |
| Director Admin & Finance | | Degree, MA / PhD in Water Eng./related discipline | |
| Director Urban Water Supply | | Degree, MA / PhD in Water Eng./related discipline | |
| Director Dams & Hydrology | | Degree, MA / PhD in Water Eng./related discipline | |
| Director Rural Water Supply | | Degree, MA / PhD in Water Eng./related discipline | |
| Water Managers (Operators) | | 1-2 Year Water Technology certificate (need at least one for each Hi/Medium capacity Pump) | |
| Other: | | | |

| 1.0 DOCUMENTS & RECORDS | | | | |
|---|---|---|---|---|
| Are there Standard Operating Procedures (SOPs) current and available for all supply units & functions? *(i.e., Safety, Maintenance, Manual/SOP)* | **Y** | **P** | **N** | 3 |
| **1.2. Are SOPs easily accessible / available to all staff?** | **Y** | **P** | **N** | 3 |
| **1.3. Is there a system or procedure for document & record control and retention?** | **Y** | **P** | **N** | 2 |
| **1.4. Is there documentation that all staff have read and understood SOPs that relate to their responsibilities in service delivery?** | **Y** | **P** | **N** | 3 |
| **1.5. Are procedures dated when put into use?** | **Y** | **P** | **N** | 2 |
| **1.6. Are delivery results archived and can be retrieved in reasonable time** | **Y** | **P** | **N** | 3 |
| **SECTION 1: DOCUMENTS & RECORDS** **Subtotal** | | | | **16** |

| 2.0 MANAGEMENT REVIEWS | | | | |
|---|---|---|---|---|
| **2.1. A work plan and budget in place for water units?** (i.e., does the water unit have a budgetary authority?) | **Y** | **P** | **N** | 2 |
| **2.2. Does the Ministry supervisor routinely perform a <u>documented</u> review of quality records?** | **Y** | **P** | **N** | 2 |
| **2.3. The water operator identifies and undertakes performance improvement projects?** | **Y** | **P** | **N** | 2 |
| **SECTION 2: MANAGEMENT REVIEW** **Subtotal** | | | | **6** |

| 3.0 ORGANIZATION & PERSONNEL | | | | |
|---|---|---|---|---|
| **3.1. Are lines of authority and responsibility clearly defined for all ministry staff, including the designation of a supervisor?** (i.e., Ministry Organizational chart available) | **Y** | **P** | **N** | 3 |
| **3.2. Are Personnel Files present?** Including Orientation/CE/Job Description/ educations certificates. Vaccination, annual competency evaluations. | **Y** | **P** | **N** | 3 |
| **3.3. Is there a documented system for competency assessment of staff** | **Y** | **P** | **N** | 3 |
| **3.4. Does the Ministry have adequate training policies, procedures, and/or training plan** | **Y** | **P** | **N** | 3 |
| **3.5. Are Ministry staff meetings held regularly (minutes documented)** | | | | 3 |
| **SECTION 3: ORGANIZATION & PERSONNEL** **Subtotal** | | | | **15** |

| 5.0 EQUIPMENT | | | | |
|---|---|---|---|---|
| **5.1. Is equipment installed and placed as specified in the operators' manuals and uniquely labeled or marked? And operator manuals are readily available to all staff?** | **Y** | **P** | **N** | 3 |
| **5.2. Is current equipment inventory data available on all equipment in the Ministry?** | **Y** | **P** | **N** | 2 |
| **5.3. Is non-functioning equipment removed from the water supply site?** | **Y** | **P** | **N** | 2 |
| **5.4. Is routine calibration of water supply equipment – including change of spare parts, change of oil, filters, scheduled, indicated on the equipment, and verified?** | **Y** | **P** | **N** | 2 |
| **5.5. Is routine preventive maintenance performed on all equipment and recorded according to SOPs?** | **Y** | **P** | **N** | 2 |
| **5.6. Are there back-up procedures for equipment failure** (including SOPs for handling water supply during these times or a backup plan**?** | **Y** | **P** | **N** | 2 |
| **5.7. Are repair orders monitored to determine if the service is completed?** *(review document)* | **Y** | **P** | **N** | 2 |
| **5.8. Has the water supply unit provided uninterrupted services since project's inception?** | **Y** | **P** | **N** | 2 |
| **SECTION 5: EQUIPMENT** **Subtotal** | | | | **17** |

| 6.0 INTERNAL AUDIT | | | | |
|---|---|---|---|---|
| **6.1. Is an internal audit routinely conducted?** Is there documented annual water supply assessment and follow-up recommendations /corrective actions? | **Y** | **P** | **N** | 3 |
| **SECTION 6: INTERNAL AUDIT** | **Subtotal** | | | **3** |

| 7.0 PURCHASING & INVENTORY | | | | |
|---|---|---|---|---|
| **7.1. Is there a documented system for forecasting needs for supplies?** | **Y** | **P** | **N** | 3 |
| **7.2. Is an inventory control system/SOP in place?** | **Y** | **P** | **N** | 3 |
| **7.3. Are all orders tracked until delivery and inspected, receipted, and labeled with date of receipt when checked in?** | **Y** | **P** | **N** | 3 |
| **7.4. Are inventory records complete and accurate, with minimum and maximum stock levels denoted?** | **Y** | **P** | **N** | 3 |
| **7.5. Are stock counts routinely performed (documented)?** | **Y** | **P** | **N** | 3 |
| | **Y** | **P** | **N** | |
| **7.6. Are storage areas set up and monitored appropriately?** Petrol or Fire Control/ security | **Y** | **P** | **N** | 3 |
| **7.7. Are all the service/maintenance kits in use (and in stock) as prescribed by the manufacturer?** *(physical check)* | **Y** | **P** | **N** | 3 |
| **SECTION 7: PURCHASING & INVENTORY** | **Subtotal** | | | **22** |

| 8.0 INFORMATION MANAGEMENT | | | | |
|---|---|---|---|---|
| **8.1. Are test results format legible, technically verified, and confirmed against patient identity?** | **Y** | **P** | **N** | 2 |
| **8.2. Are testing personnel identified on the requisition &/or testing records?** | **Y** | **P** | **N** | 2 |
| **8.3. Are test results recorded in a logbook or electronic record in a timely fashion?** | **Y** | **P** | **N** | 2 |
| **8.4. Is there a system for reviewing for clerical errors** (i.e., second check)**?** | **Y** | **P** | **N** | 2 |
| **8.5. Are archived results stored in a secure location accessible only to authorized personnel?** | **Y** | **P** | **N** | 2 |
| **8.6. Are there documented procedures for the preservation of essential laboratory data in the event of hardware/software failure, theft, or an unexpected destructive event (e.g., fire, flood).** | **Y** | **P** | **N** | 2 |
| **SECTION 8: INFORMATION MANAGEMENT** | **Subtotal** | | | **12** |

| 9.0 PROCESS CONTROL and INTERNAL & EXTERNAL QUALITY ASSESSMENT | | | | |
|---|---|---|---|---|
| **9.1. Are environmental checks accurate, and regularly reviewed?** | **Y** | **P** | **N** | 3 |
| **9.2. Have acceptable ranges been defined for all gas/engine oil dependent equipment with procedures that detail what to do when they are out of range?** | **Y** | **P** | **N** | 3 |
| | | | | |
| **9.3. When a water supply technology in the rural areas has a sudden malfunction, is there an official designated to be contacted immediately?** | **Y** | **P** | **N** | 3 |
| | | | | |
| **9.4. Are those kinds of issues and complaints addressed by the state ministry or** | **Y** | **P** | **N** | 3 |

| | | | | |
|---|---|---|---|---|
| **the local communities?** | | | | |
| | | | | |
| **9.5. Is internal quality control (IQC) performed, documented, and reviewed?** *– Review QC records to confirm* | **Y** | **P** | **N** | 3 |
| | | | | |
| **9.6. Are the water supply technologies frequently checked, serviced/maintained?** | **Y** | **P** | **N** | 3 |
| | | | | |
| **9.7. Is there a procedure for reporting unsatisfactory performance of the supply systems?** | **Y** | **P** | **N** | 3 |
| | | | | |
| **9.8. Does the MWRE participate in an External Quality Assessment (EQA) scheme or inter-water resources comparison – with other states?** | **Y** | **P** | **N** | 3 |
| **SECTION 9: PROCESS CONTROL and INTERNAL & EXTERNAL QUALITY ASSESSMENT** | | | **Subtotal** | **24** |

| **10.0 CORRECTIVE ACTION** | | | | |
|---|---|---|---|---|
| **10.1. Are the environmental checks around or within the water supply units in unacceptable conditions?** | **Y** | **P** | **N** | 4 |
| **10.2. Are out-of-control runs reviewed and submitted for troubleshooting and cause analysis?** | **Y** | **P** | **N** | 3 |
| **10.3. Is corrective action taken on out-of-control issues documented?** | **Y** | **P** | **N** | 3 |
| **SECTION 10: CORRECTIVE ACTION** | | | **Subtotal** | **10** |

| **11.0 OCCURRENCE / INCIDENT MANAGEMENT, PROCESS IMPROVEMENT, & CUSTOMER SERVICE** | | | | |
|---|---|---|---|---|
| **11.1. Are laboratory occurrence reports completed and cause analysis performed, corrective and preventive action taken on all reports to avoid reocurrence?** | **Y** | **P** | **N** | 4 |
| **11.2. Are quality indicators (TAT, rejected specimens, stock outs, etc.) selected, tracked, and reviewed regularly to monitor laboratory performance and identify potential quality improvement activities?** | **Y** | **P** | **N** | 3 |
| **11.3. Is there a tool for regularly evaluating client satisfaction?** | **Y** | **P** | **N** | 3 |
| **SECTION 11: OCCURRENCE/INCIDENT MGT, PROCESS IMPROVEMENT, & CUSTOMER SERVICE** | | | **Subtotal** | **10** |

| **12.0 FACILITIES & SAFETY** | | | | |
|---|---|---|---|---|
| **12.1. Is the layout of the water supply unit, as a whole, well located so that workstations are positioned for optimal workflow?** | **Y** | **P** | **N** | 3 |
| **12.2. Is each individual workstation maintained free of clutter and set up for efficient operation?** | **Y** | **P** | **N** | 3 |
| **12.3. Is the physical work environment appropriate for testing?** *AC Ventilation, safety, lighting, wiring clutter?* | **Y** | **P** | **N** | 3 |
| **12.4. Is the laboratory properly secured from unauthorized access with appropriate signage?** | **Y** | **P** | **N** | 3 |
| **12.5. Is major safety signage posted and/or SOP enforced within the facility prohibiting smoking and any other safety measures?** | **Y** | **P** | **N** | 3 |
| **12.6. Is the work area clean, free of collected water to prevent bacteria sources?** *See documentations* | **Y** | **P** | **N** | 3 |
| **12.7. Is there a safety cabinet used for water treatment chemicals considered to be highly contagious if not properly stored?** | **Y** | **P** | **N** | 3 |

| | | | | |
|---|---|---|---|---|
| **12.8. Is there a waste disposal container for waste products and are they usually well disposed of?** | **Y** | **P** | **N** | 3 |
| **12.9. Are all electrical cords, plugs, and receptacles used appropriately and in good repair?** | **Y** | **P** | **N** | 3 |
| **12.10. Is an appropriate fire extinguisher available, in working condition, and routinely inspected?** | **Y** | **P** | **N** | 3 |
| **12.11. Are safety inspections or audits conducted regularly and documented?** | **Y** | **P** | **N** | 3 |
| **12.12. Is personal protective equipment (PPE) easily accessible at the workstation and utilized appropriately and consistently?** | **Y** | **P** | **N** | 3 |
| **12.13. Is standard safety equipment available and in use at water supply unit such as hand washing?** | **Y** | **P** | **N** | 3 |
| **12.14. Are ministry/water supply personnel offered appropriate vaccinations?** | **Y** | **P** | **N** | 3 |
| **12.15. Are occupational injuries or illnesses documented?** | **Y** | **P** | **N** | 3 |
| **SECTION 12: FACILITIES & SAFETY** | **Subtotal** | | | **45** |

| Additional Comments/Observations | |
|---|---|
| **Point #** | **Comment/Observation** |
| | |
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| **SUMMARY/RECOMMENDATIONS** |
|---|
| **Noted Commendations** |
| |
| **What would you consider are the 3 top Challenges for this Water Supply Project?** |
| |
| |
| |
| |
| **What Could be done to overcome the challenge(s) listed above?** |
| |
| |

Appendix C: Water Supply Assessment Questionnaire Consent Form

*Name of the Study:* A Quantitative Study of the Impact of Lack of Potable Water Availability on the Economic Development of the North Senatorial District (NSD) and Benue State, Nigeria *Researcher:* Stephen Akange

*Purpose and Description:* I have invited you to participate in a research study that is conducted to fulfill the requirements for a doctoral degree at Walden University, USA. The objective of this study is to examine the factors responsible for lack of or poor quality water supply services in the NSD of Benue state. This research will be conducted by utilizing an assessment checklist which you will read carefully and answer Yes, Partial or No to all the questions that apply in each of the 11 sections of the checklist. The results of this study would lead to developing a model for implementing and sustaining effective and efficient water supply systems in the senatorial district (SD). There is nothing deceitful in and about this study. The researcher's interest is in evaluating our water supply systems and to get your opinions about what is and what can be done or improved upon.

*Participation Requirements:* First, you are asked to read carefully this assessment consent form and are very free to ask any/all questions and concerns you have and I will endeavor to adequately answer them and ensure you understand what I am requesting from you, and that based on that understanding, you have therefore agreed and then will sign the consent form. Secondly, you will also be allowed adequate time to read the assessment checklist carefully and ask any/all questions and I will again endeavor to respond to them sufficiently before you give your opinion as a response to the survey questionnaire. The filling out of the survey tool will take approximately 30 minutes of your time. Remember, this is voluntary and by no means require no force of any kind. Your inclusion for and in this study is not limited to individual status, office positions, economic factors, gender barriers or other social factors. This open inclusion the researcher hopes will be very rewarding form the perspective of a broad based knowledge and information relevant to this study.

*Potential Risks/Right to Withdraw:* Although there are rare but perhaps minimal physical risks known or associate with this study, common risks could be pressure/stress due to your work schedule and the time to fill out the checklist as well as psychological stress associated with mental work on how best to answer a/some question(s). Again remember your participation in the study is certainly voluntary. You may choose to not answer any question(s) you feel uncomfortable answering. You may also withdraw from the study at any time you do not want to continue. Be assured that you will not be reported or victimized because of your withdrawal as no legal or office case shall be constituted against you.

*Potential Benefits:* It is my hope that the results of this study will have social benefits that may eventually improve the supply and quality of water services in the NSD of Benue, or

serve as a tool for future research about water supply services in other parts of Benue state, Nigeria and beyond. There are no direct benefits to you for participating in this research. However, you will be offered token fee as a sign of appreciation for your time in the amount of 5,010.00 Naira (which is about $3.4 US Dollars).

*Anonymity/Confidentiality:* The data that will be collected in this study is confidential. Your privacy and confidentiality will be treated as a matter of top priority. I will ensure that no personal name will be associated with any information provided. In this way, no responses shall be traced back to individual participants or water supply units by government officials when the results of the study shall be made available. All the data sheets will be coded in a way that you will not be associated with them. In like manner, the data will be made available only to me the researcher. It is good to note however that for legal and ethical reasons, the researcher is expected to secure your signature of agreement to participate in this study. You are also free to keep or print a copy of this form for yourselves.

*Participant's Consent:* I have read the above purpose and description of study: A Quantitative Study of the Impact of Lack of Potable Water Availability on the Development of the North Senatorial District (NSD) and Benue State, Nigeria. My signature indicates that I have agreed to participate in the study.

Participant's Name:_____Water Supply Unit:_____

Participant's Signature:_____Date:_____

Researcher's Signature:_____Date:_____

Appendix D: Approval Letter from Benue State

# GOVERNMENT OF BENUE STATE OF NIGERIA

Telephone: 044-532436, 044 532975
EMail:mwremkd@yahoo.com

Ref. No: MWRE/WAT/4/I/591

Ministry of Water Resources and Environment.
P. M.B. 102132
Makurdi, Benue State, Nigeria

Date: 4th April, 2013

Stephen Akange
5913 Spring Run Dr
Columbus Ohio 43229
USA

**A.**

REQUEST FOR ACCESS TO RELEVANT WATER PROJECTS, DOCUMENTS AND WATER ACTIVITIES IN BENUE STATE, NIGERIA FOR DISSERTATION RESEARCH

I am directed to acknowledge receipt of your letter of 2nd April, 2013 requesting for assistance on the above subject matter and inform you that access will be granted to you as requested on relevant water projects, documents and water activities in Benue State, Nigeria to assist you in your PhD dissertation research with the topic: "The impact of lack of potable water availability on the development of the North Senatorial District (NSD) and Benue State, Nigeria".

I am further to inform you that the access being granted is on the condition that the information will be used exclusively for the research only and no other purpose. Wishing you success in your studies, please.

**A.ASHIEKAA**
**For: Permanent Secretary**

**DR. JOHN**