ENVIRONMENTAL ISSUES, ACCESS TO WATER AND QUALITY OF LIFE IN NIGERIA: The Role of Economic Policy

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ABSTRACT

The intricate relationship between the environment and water resources and how access to water affects quality of life have been key development issues at the global level since the turn of this century. Goal 7 of the Millennium Development Goals was meant to ensure environmental sustainability, with Target 7C specifically concerned with reducing by half the proportion of the population without sustainable access to safe drinking water and basic sanitation by the year 2015. While it is true that MDG7, in terms of its targets, was largely achieved at the global level, at the individual country level, many developing countries were still far from meeting the target by 2015. This explains why environmental sustainability is still a core pillar of the post-MDG development agenda, as encapsulated in Goal 6 of the Universal Sustainable Development Goals. This paper examines the link between the environment and water resources in Nigeria. It profiles the country's water resources as well as the various policy measures that have been adopted over the years by the various governments in the bid to broaden access to water for productive and consumptive uses. The effectiveness of the various policy measures was also assessed by using a sub-component of the Africa Infrastructure Development Index within a regional comparative frame. The results suggested that Nigeria still lags behind such ECOWAS countries like Cape Verde, Gambia and Senegal in terms of access to water and sanitation services. The major factors militating against the development of the country's water resources towards the achievement of environmental sustainability and better quality of life for the people were identified, on the basis of

which suggestions were made on the way forward. Key amongst these are the need to encourage private participation in the water resources sector and the adoption of the Integrated Water Resources Planning model as the core planning framework for sensible exploitation of the country's water resources.

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1. General Background

In traditional societies, where water was generally sourced from natural sources such as rivers, streams, brooks, ponds and wetlands, it was generally seen as a free gift of nature and property rights to its ownership were generally not established. It was seen as a common resource, which could be exploited by economic and social agents, without any encumbrance whatsoever, albeit by members of the same community. However, as the traditional society grew and economic activities expanded beyond the local enclave, the setting of water boundary ownership became an issue of concern, as competition between adjoining communities for the use of water resources for domestic consumption, recreational and cultural activities as well as agricultural production increased. Thus, water resources came to be recognized as economic resources for generating community wealth, enhancing quality of life and maintaining the collective cultural beliefs of the people. Contiguous communities were quite ready to pitch themselves against each other in conflict over rightful access to such resources, often leading to violent inter-communal clashes. With the rise in urbanization and public provisioning, access to safe water, particularly for domestic consumption came to be rated and tariffed. However, even at that, in the urban areas, where public schemes for the supply of safe water were available, water remained generally conceived as a semi-public good, being characterized by weak non-rival and non-excludable consumption, by the majority of the people.

From a historical perspective, water resources have always played an important role in the evolution of human societies and civilizations. For example, in Europe, the Rhine valley was recognized as a locus of co-operation, conflict and a veritable nexus of economic activity and growth (Sadoff, Whittington and Grey, 2002). The historic land of Mesopotamia epitomized the

role which the Euphrates and Tigris rivers played in early civilization. In North Africa, early civilizations such as those of the Nile valley and plains provide another classic example of how seasonal flooding provided water and increased soil fertility that encouraged and enhanced agricultural productivity, while the Senegal and Niger rivers played the same role in the West African region.

In Nigeria, basins of the Niger, Benue and other rivers were, and have remained, the greatest centres of agricultural activities, including artisanal fishing. The same goes for the coastal areas of the Niger delta region, where the major occupation of the people is fishing. Coincidentally, the decline of some civilizations has also been closely associated in part with problems of effective water management and utilization (Orubu, 2006). Here again, the old land of Mesopotamia provides a classic case of how the problem of siltation of irrigation canals caused substantial problems in sustaining development in that region. In India, and particularly in the Indus region, there was the problem of salinization, which hampered agricultural development and degraded the quality of life of the people. In like manner, it has been estimated that the Lake Chad, whose basin covers parts of Chad, Cameroon, Niger and Nigeria, has, since the 1960s, shrunk by as much as 90% as a result of several factors, including climate change, population growth and unplanned irrigation, and this is visibly adversely affecting crop farming, fishing and livestock activities (BBC, 2018). Today, there are a number of coastal regions that are threatened by sea encroachment.

Water resources also have political and cultural dimensions that ultimately determine human settlement patterns, economic structures and opportunities that are available to the entire population. In the African continent for example, several migrations of peoples from one region to the other over time were significantly influenced by water availability or its scarcity, with the stronger groups of people generally tending to move towards and settling close to the great rivers and lakes. Water is and should be a critical element in a progressive strategy of economic development in modern society. The lack of access to sufficient quantities of adequate quality water can significantly hinder growth and human development, but improved water management can generate huge benefits for health, agriculture and industrial production providing an opportunity for economic growth, poverty eradication and social fairness (OECD, 2011, 2019).

The World Health Organization (WHO, 2019) has particularly stressed the primacy of water in any meaningful policy effort to improve the quality of life of the people. It specifically noted that at the global level, by the year 2017, about 71% of the world's population, that is about 5.3 billion people, used safely managed drinking water services, either located on premises, available when it is needed, and free from contamination. However, as much as 90% of the world's population used at least a basic service, defined as an improved drinking water source within a round trip of 30 minutes to its collection point. On the other hand, about 785 million people lack even these basic drinking water services, while 144 million people depend on surface water for consumptive and other uses. The worst part of the picture painted by WHO is the fact that 2 billion people globally source their drinking water from sources contaminated with faecal residue, which has the capacity to transmit diseases such as cholera, diarrhoea, dysentery, typhoid and polio, estimated to cause 485,000 annual global deaths. Of particular note is the fact that in the least developed countries, several health care facilities do not have credible water supply and sanitation services, with the proportion of health facilities without safe water, sanitation and waste management services placed at 22%, 21% and 22% respectively. In addition, it has been predicted that by the year 2025, half of the world's population will be living in areas that are water-stressed, and yet the demand for water, particularly in Africa, including Nigeria, is visibly on the ascendant (AfDB, 2018).[1] This is due to a number of factors, including rising population; rising agricultural demand, urbanization and associated water stress, as well as frequent droughts in the arid and semi-arid regions of the continent, where drought-induced water scarcity has brought about social shocks in incipient fragile economies. There is therefore the urgent need to formulate and implement policies that will help to improve water supply and sanitation in least developed and transitional economies like Nigeria.

At the global level, access to water and improved sanitation has been a key development issue, since the turn of this century. For example, Millennium Development Goal 7 is concerned with ensuring environmental sustainability. Under MDG Target 7C, it was envisioned that by the year 2015, developing countries as a collective, would have reduced by half the proportion of the

[1] See Sharma et al., 1996, for a back-view of the situation of rising demand for water for different uses.

population without sustainable access to safe drinking water and basic sanitation (WHO, 2018). In reviewing progress made on this sub-target, the United Nations (UN, 2018) reported that over the period 1990-2015, the proportion of the world's population using water from improved sources and having access to better sanitation facilities increased substantially at the global level, and actually surpassed the global and MDG targets by the year 2010. Progressively, the number of people using improved drinking water sources increased from 76% in 1990 to 91% in 2015, with about 2.6 billion people having gained access to better drinking water. Of these, 1.9 billion had access to piped drinking water on premises, with 58% of the global population enjoying this level of service in 2015. According to the report, in 2015, 147 nations in the world had fulfilled the drinking water target; 95 nations had achieved the sanitation target; and 77 nations had met both the water and sanitation targets.

In the same vein, the quality of lives of slum dwellers improved substantially over the period 2000-2015, with more than 320 million people having gained access to improved water, durable housing, improved sanitation, or less crowded housing conditions, even though more than 1 billion people globally still practised open defaecation. While it could be argued that MDG7, in terms of its targets taken at the global level, were largely achieved; at the individual country level, many developing countries were recorded to be still far from meeting the target by 2015, with progress being generally uneven and dualistic on the comparative scale between different regions, rural and urban areas, and between the rich and the poor. It is this that explains why environmental sustainability is still a core pillar of the post-MDG development agenda, as healthy, diverse, and well-managed ecosystems can play a critical role in improving livelihoods and mitigating future environmental challenges, which, incidentally impact the poor segments of society more adversely (SIWI, 2005). It is this that also explains why Goal 6 of the Sustainable Development Goals (UN, 2016) is concerned specifically with ensuring access to water and sanitation for all by the year 2030.

This paper addresses the link between the environment and water, and the policy strategies that address the problem of access to safe water and improved sanitation services, with particular reference to Nigeria. A number of questions have been raised in the introductory background, which necessarily touch upon the nexus between access to safe water and sanitation and economic progress and

the quality of life. What is the nexus between access to water and sanitation and the quality of life? How do anthropogenic activities impact on the quality of water resources in an economy? What are the efforts that have been made over the years by government in Nigeria to develop the country's water resources? Are there any records of success in terms of investments in water resources with reference to greater access? How has Nigeria fared in this regard in comparison with other countries in the ECOWAS sub-region? Which policy measures can we use best to develop Nigeria's water resources for domestic, industrial, agricultural and other uses and to facilitate greater access to safe water and sanitation services? These are the questions we attempt to answer in this paper.

The remaining part of the paper is therefore structured according these questions, in six broad sections. Section 2 following this introductory background treats the link between access to water, sanitation, and the quality of life. Section 3 examines the interaction between water resources and the environment. Sections 4 and 5 give overviews of Nigeria's water resources and government policies respectively while section 6 presents policy effectiveness and challenges. Recommendations and the conclusion are presented in the final section of the paper.

2. The Link between Access to Water and Sanitation and Quality of Life

In times past, economists traditionally measured economic progress with reference to how the output of the economy was growing over time, and how this was reflected in secular improvement in per capita income, which implicitly increased human welfare. Revolutionary thinking, which started more visibly in the late 1960s, led to a widening of the definition of welfare, ultimately leading to the development of several complementary measures of the quality of life, such as the Human Development Index and the Human Poverty Index, amongst others, and most recently, the Multi-Dimensional Poverty Index.[2] Suffice it to say, for the purpose of this paper, that quality of life has many parameters on the basis of which it can be measured. Critical factors for consideration in assessing the quality of life include attainments in income, health, education (captured in the Human Development Index) and other basic needs of life, which help to enhance human welfare and productivity. There is an incontrovertible visible

[2] For a review of chronological developments in measures of quality of life, see Orubu, 2004.

link between the availability of water for household consumption and other productive uses on the one hand, and the issues of health and disease, poverty reduction, food security, productivity, and hence the quality of life. The link between access to water and sanitation and human productivity, and hence the quality of life will be discussed under the following five broad headings:

a. Access to water and sanitation, and health
b. Water access, industry, agriculture and service sectors
c. Water access and livelihood systems of the poor
d. Other macroeconomic consequences of impaired access to water
e. The empirical linkage

2.1 Access to water and sanitation, and health

Water in inadequate quantity and quality and lack of access to basic sanitation services lead to several health diseconomies. Incidentally, it is the health of the poor that is most disproportionately affected by unsafe drinking water and poor sanitation services. The most obvious adverse consequence is health diseconomy for both children and adults, but particularly debilitating for children who may suffer from a host of water-borne diseases such as diarrhoea, dysentery and cholera (in extreme cases), water-related diseases such as malaria, dengue fever, schistosomiasis, and so on, with dire implications for reduction of life expectancy and heightened poverty for vulnerable households. Health diseconomies have manifest macroeconomic consequences that may be reflected in reduced national productivity as a result of decreased effective labour input by those who are sick as a result of drinking unsafe water and poor sanitation practices (Orubu, 2017). The production capacity and productivity of economic sectors depend critically on the health of the people, which in turn depends significantly on access to safe water and sanitation practices. Improved access to safe water is therefore a necessity in the design of policy frameworks that will engender sustainable development and enhanced quality of life for the people.

2.2 Water access, industry, agriculture and service sectors

The performance of the industrial sector of an economy is highly dependent on the availability of water. There is hardly any industrial process that does not require water as an input. Particularly in manufacturing, the entire chain of the

production process largely depends on water. Agriculture is also essentially a hydro-centred economic activity, be it in crop- or cash-crop farming, animal husbandry and livestock, poultry farming or fishery. Other than human beings, plants and animals (including fish) require access to safe water for optimal growth. Emerging problems such as deforestation, groundwater depletion, droughts of prolonged duration as well as climate change are among the critical factors responsible for the migration of large farming populations, which in most recent times have caused great regional conflicts, particularly in West Africa, including Nigeria, a situation that has heightened both human and food insecurity. In arid and semi-arid areas, inadequate rainfall and absence of irrigation facilities reduce agricultural production and threaten food security, and both factors work to intensify the problem of poverty. Health, safety and aesthetics are also critical considerations in the choice of holiday destinations, worldwide. Only safe water is healthy; this explains why the tourism industry thrives more in places with good sanitation and water supply services (UN, 2008).

2.3. Water access and livelihood systems of the poor

The livelihood systems of the poor are generally more rural-centred and more dependent on environmental and natural resources. Sustainable development of the rural economy is therefore a critical factor of any long-term growth strategy. Consequently, more efficient and equitable management of common resources such as rivers, lakes, ground water and coastal zones will translate directly into more income, time, food, and generally a better quality of life for the poor. It is important to note that vulnerability is one of the critical dimensions of poverty, as the poor are those that are more at risk from environmental shocks and episodes and more disproportionately affected by water services inefficiency, and this in itself has other macroeconomic consequences.

In many African countries, including Nigeria, and particularly in rural areas, poor people, including men and women spend substantial time in gathering water wherever it is not available within a short distance. Improved access to water and modern sanitation services will help to save time, which could be applied to other more productive activities. People without toilets or taps at home spend a lot of time each day queuing up at public toilets or seeking secluded spots for open defaecation, or for collecting water for consumptive and

other uses. Improved access to water and sanitation services would therefore give households additional hours over a given period to work, study, care for children, engage in other productive activities, collective efforts, or rest.

2.4 Other macroeconomic consequences of impaired access to water

Macroeconomic diseconomies are implicated as water-induced ill-health reduces physical vibrancy, production and productivity, with the potential to reduce gross domestic product at the national level, if such diseconomies occur on a large scale. There is the adverse effect on school attendance, which is reduced particularly by illness, lack of sanitation services and time spent on collecting water and related duties, all of which work to intensify poverty multi-dimensionally. There are also gender and social inclusion implications of lack of access to water and sanitation services, as the relative burden tends to be more on women, thereby restricting the benefits they may have gained by entrance into the cash economy (Orubu, 2018a). Consumption and income implications are also noticeable, particularly at the household level for the poor, who tend to spend more out of their income to procure water for domestic and other uses.

Time use studies in a number of the least developed countries reveal that women spend substantial time in fetching and gathering water, particularly in sub-Saharan Africa. Furthermore, research has shown that households in rural Africa typically spend one fourth of their day fetching water, with about 40 billion working hours spent carrying water each year in sub-Saharan African countries (UN, 2008). In traditional national income accounting, such activities may be regarded as unpaid work and their value may not be reflected in the accounts. The implication of this is that we may be underestimating the contribution, particularly of women to the gross domestic product in these countries. Improving access to safe water by the vulnerable segments of society is therefore one way to getting the national income accounts right, by freeing women and other vulnerable groups from unpaid work, and the time so saved, applied to other more productive activities that are captured in the national accounts.

As already noted, income earning potential by vulnerable groups may also be significantly reduced due to water-induced poor health, the time spent on collecting water, and lack of opportunity for setting up microbusinesses that require water as input. And then there is the high variability and consumption

risk that may arise due to factors of seasonality and nature (such as flooding and droughts), which necessarily exacerbate their vulnerability to poverty. From the development policy point of view, the consequences of lack of access to water are grave and intensely adverse, as virtually all systems of production in the primary, secondary (and to some extent, tertiary) sectors of the economy require water as input.

It is important to note that the poorest people in society are often the ones whose quality of life is most affected when environmental episodes affect the quality of water adversely. They are also the ones who have least access to water and sanitation services. From the economic and equity points of view, they are also the ones who pay most for water services. For example, in the typical Nigerian urban centre, where municipal water supply services are available, the poor are usually the ones whose zones are not connected to the public water supply grid. Consequently, they are the ones who are usually forced to procure their own water, often from polluted sources, with adverse health diseconomies resulting from contaminated water and improper sanitation. They are also the ones who purchase water from water vendors, oftentimes at prices higher than the tariffs paid by the privileged that are connected to the municipal supply system. It is the poor who are most affected by lack of access to water to support their livelihood through farming. They are also the ones that are most adversely affected by drought-induced famines and conflicts. These observations imply that there is a complex relationship between the availability of water and the quality of life, as water in insufficient quantity and quality leads to several adverse consequences. The design and implementation of an effective and efficient system of water management must be hinged on a proper understanding of the fact that water is not an isolate commodity. Water itself is life, therefore economic policies that should engender sustainable development, must of necessity address the problem of access to water and improved sanitation services.

2.5 The empirical linkage

In a number of pre-MDG and immediate MDG period studies, the strong link between access to safe water and improved sanitation services and human development, and hence quality of life, has been confirmed. The World Bank, in a study published in its 1994 World Development Report, estimated that a

0.3% increase in investment to improve households' access to safe water and improved sanitation services increases the Gross Domestic Product by 1%, thus suggesting that access to improved water and sanitation services are essential, and a necessary condition for generating and sustaining growth and development, particularly in developing countries. Later studies by the World Health Organization lend further credence to this linkage (WHO, 2002; 2004), by establishing that lack of access to safe water, basic sanitation and hygiene, taken together, were the most significant risk factors for poor health in developing countries, and particularly in African countries. Moss, Wolff, Gladden and Guttierez (2003) noted, with particular reference to African countries, that the importance of investment in improved access to water and sanitation services cannot be overemphasized in terms of creating greater impacts. They confirmed that, in many countries in sub-Saharan Africa, a substantial proportion of the population spend relatively a large fraction of their income on treating water-related diseases.

Jalen and Ravillion (2003), in a related study for India, provided further evidence in support of the view that increased access to water and sanitation facilities and services reduces both infant and child mortality. Similarly, Leipziger, Fay and Yepes (2003), in a related study on the MDGs, confirmed the role of access to water and sanitation in reducing infant mortality. They estimated that about 25% of the difference in infant mortality and about 37% of the difference in child mortality between the rich and the poor can be explained by their differential access to water and sanitation. The World Bank (2010), in a study using data sets from 70 countries, estimated the effect of water and sanitation on child mortality and morbidity. It found that there exists a robust association between access to water and sanitation technologies and both child morbidity and child mortality, with the point estimates implying that, depending on the technology level and the sub-region chosen, water and sanitation infrastructure lowers the odds of children suffering from diarrhoea by 7–17% and reduces the mortality risk for children under the age of five by about 5% to 20%. Sawada, Shoji, Sugawara and Shinkai (2014) specifically established a positive relationship from irrigation infrastructure to poverty reduction, by improving permanent income and eliminating the negative effect of transient poverty in Sri Lanka.

Extensive reviews of the empirical literature by Joshi and Amadi (2013) and Mill and Cumming (2016), on the impact of access to water and sanitation

services on quality of life, largely support the observation of a positive correlation with productivity and enhanced quality of life. Usman, Gerber and von Braun (2018), in a study on the Ethiopian experience, found that uncontaminated stored drinking water and safe child stool disposal are associated with decreased child diarrhoea incidences of 18 and 20 percentage points respectively. In contrast, neighbourhood concentration of pit latrine shows an increased incidence of child diarrhoea of 16 percentage points. This finding led them to suggest that in order to protect rural children from the risk of contracting diarrhoea, improving household drinking water quality and changing people's behaviour towards safe sanitation practices are necessary. As for countries in the West African region, where access to water and sanitation services is still relatively poor, the empirical evidence on the link to economic growth remains weak, and suggests the need for quantum investment in order generate the desired impacts (Orubu, 2017).

The primacy of investment in water and improved sanitation services is better summarized by the conclusions reached in a report, which was commissioned jointly by the governments of Norway and Sweden – *Making Water a Part of Economic Development* (SIWI, 2005), as their input to the Commission on Sustainable Development and its 2004-2005 round, which centred on water, sanitation and other related issues. These conclusions continue to remain relevant, even as the demand for water remains a burning concern in development policy, particularly in the least developed and transiting economies. The main conclusions drawn from the various reviews can be summarized as follows:

- Improved water supply and sanitation and water resources management contribute greatly to poverty reduction.
- Economic benefits of improved water supply and sanitation outweigh their investment costs.
- National economies are more resilient to rainfall variability and economic growth is boosted with improvement in water storage capacity.
- Investing in water and sanitation is good business, as it contributes significantly to increased production in all sectors of the economy.

- The overall public and private investment needs for improved water supply are enormous, but at the country level, meeting such challenges is highly feasible and within the reach of most nations.

3. Environment and Water Resources Interaction

The water resources of a country can be broadly grouped into two categories – freshwater and marine water resources. Freshwater resources include rivers and their plains, streams, lakes, wetlands, underground water reservoirs and rainfall, while marine water resources consist of lagoons, seas and the oceans. The sustainable welfare of man, and indeed all living things on earth, depends to a large extent on the wise and safe use of water. Freshwater resources provide the main source of drinking water for the human population, and also support agricultural activities through natural feeding and irrigation practices, and it is far cheaper to use freshwater for industrial purposes. In many cases, freshwater resources, particularly rivers and lakes also perform recreational and transportation functions, while marine water resources are of vital importance, particularly for countries with seaward boundaries, providing the natural habitat for exploitable fishery and international navigation.

The key problem that is usually addressed in water management and related issues is that of safe water. Safe water is one, which when used for consumptive or productive purposes will not cause any harm to its user. When not qualified, the common usage of the term refers to drinking (potable) water; but generally, the term could also refer to water used for other purposes, as in swimming pools, and in the feeding of livestock or irrigation for agricultural purposes. For water to be safe, it must have sufficiently low and acceptable concentrations of contaminants. The safeness of water is therefore a function of its quality, which is visibly influenced by environmental factors.

Environment is a generic concept that can be viewed from different perspectives. However, from a development point of view, it can be seen as the aggregate of the physical, chemical and biological entities that are external to man, as well as plants and animals, that help to support their existence, whether on land, water or air. It provides the essential natural assets without which life on earth would be impossible, and can be rightly conceived as the natural capital of any society. As natural capital, it is the source of the raw materials for all industrial activities. It provides vital services such as the maintenance of climatic

stability and ecological balance, both of which are essential to the survival of renewable resources in any society. It delivers the air we breathe with its life-supporting quality, for all living things, including the forests, land and aquatic resources, as well as the water that we drink and use for other domestic and industrial purposes.

The transmission of environmental impacts to water resources essentially comes through anthropogenic economic activities, and to a lesser extent through land-use practices and natural incidents. The economic activities of man manifestly impact on the physical, chemical and biological qualities of water, which when applied in consumptive and productive uses can cause both short-term and long-term welfare damage. In this section of the paper, these interactions are examined briefly under the following headings:

a) Pollution from industrial wastes and other sources
b) Pollution from refuse and domestic waste
c) Threats to water quality by sediments
d) Effect of excessive water withdrawal
e) Effect of climate change on water quality
f) Land use patterns and disregard for planning laws

3.1 Pollution from industrial wastes and other sources

Both consumption and production activities generate a lot of wastes and by-products which can pollute the air, land, and water resources. Technically, the amount of waste that is generated and disposed into recipient bodies depends significantly on residual intensity, and pollution occurs when the assimilative capacity of the recipient body is over-stretched. When industrial and domestic wastes are disposed into water bodies, the pollutive effect is direct; when industrial wastes are disposed into the air, they affect the quality of rain water, both above and below ground surface water, and have the capability to pollute ground water that is consumed by humans.

A distinction is often made between point-source and nonpoint-source pollution of water as a result of industrial and other processes. Point-source pollution is that which has a single and clearly identifiable source. A good example of point source pollution is that which occurs in many of the oil-producing communities in Nigeria (particularly in the Niger Delta area), where

crude oil spills from oil facilities into adjoining water bodies. Other good examples of point-source pollution are direct discharges from sewage-treatment plants, industrial facilities, and produced formation water, say from oil facilities. Such facilities and structures commonly add sufficient loads of a variety of contaminants to adjoining water bodies and streams, which may adversely affect the quality of the stream for long distances downstream. Depending on relative flow magnitudes of the point source and of the stream, discharge from a point source such as a sewage-treatment plant may represent a large percentage of the water in the stream directly downstream from the source.

On the other hand, nonpoint pollution is that whose source is not clearly identifiable with an environmental incident within the immediate vicinity. The distinction between point-source and nonpoint-source pollution is of great significance from a policy point of view, as it is easier to identify the point polluter, and remedial action taken at that point. On the other hand, it is relatively more difficult to identify the non-point polluter, and so, direct remedial action is relatively more difficult. For example, suspended particulate matter in the atmosphere that is actually generated in factories located long distances away may find their way into a local suburb, and it may be difficult to trace its true origin. Fresh water is often polluted by factory effluents, industrial wastes, and even vehicular fumes. When industrial fumes are released into the atmosphere, they can travel over long distances before the accompanying particulates fall to the ground. In the air, chemical reactions take place in the medium of water, and get down polluting the recipient body in the form of acid rains. The acidic condition created has a damaging effect on the ecosystems, including water bodies such as streams, brooks, lakes and other open sources of water, thereby creating amenity diseconomies.

Contaminants in streams can easily affect groundwater quality, especially where streams normally seep into groundwater, where groundwater withdrawals induce seepage from the stream (GreenFacts, 2008), and where floods cause stream water to overflow traditional sources of water such as dug-out wells. Incidentally, only a small fraction of chemicals, including different types of pesticides, are regulated in terms of use and disposal, particularly in the developing world. Nigeria provides a classic case of unregulated use of chemicals. The indiscriminate disposal of a large number of pharmaceutical products, including even pain killers and antibiotics have significant adverse effects on surface and underground water resources and conventional water

treatment does not work for most of them, while their regulation is made even more difficult by legislative constraints. An exception to this observation may be made for the Nigerian petroleum industry, where there exists a clearly articulated framework for addressing pollution from all aspects of oil industry activities, as contained in Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (DPR, 2002; Orubu, Fajingbesi, Odusola & Magbagbeola, 2004). However, it is doubtful if the implementation of the standards and guidelines are being effectively monitored by the appropriate authorities (Orubu, 2014).

3.2 Pollution from refuse and domestic waste

Huge refuse dumps, which are usually residuals generated in markets and by individual households are a very common site in many cities. A typical refuse dump has a multiplicity of products, ranging from contaminated food, fruits, vegetables, plastic cans and buckets and different types of waste matter. Domestic sewage or municipal waste water is waste stream generated through household activities and in general contains faeces, urine and laundry waste. Untreated or under-treated domestic sewage may contain harmful waterborne-disease-causing microorganisms (diarrhoea, dysentery, typhoid, cholera, etc.), oxygen depleting organic substances and toxic and hazardous inorganic substances. The higher the organic waste concentration of the sewage, the more polluted the water bodies. Again domestic sewage contains inorganic substances such as phosphorus and nitrates. These increase the amounts of nutrients in water and cause unwanted algae growth and eutrophication in water bodies. They also diminish the water quality for fish and other aquatic communities and make it unsuitable for any other aesthetic uses.

3.3 Threats to water quality by sediments

Sediments can occur in water bodies naturally, but they are also produced in large amounts as a direct response to land-use changes, agricultural practices as well as other developmental activities. Activities such as farming, clearing forests, building roads, mining and dredging can put too much soil and particulate matter in rivers, although sediment loads can occur naturally in poorly vegetated terrains, and most commonly in arid and semi-arid climates following high intensity rainfall. This sediment can harm plants and animals by

carrying toxic chemicals into the water, smothering fish eggs and small organisms used by fish as food, raising water temperature, and reducing the amount of sunlight penetrating the water. Sediment can also reduce the capacity of reservoirs and make it difficult for ships to navigate waterways. It can also damage equipment used in water supply installations and hydroelectric plants, thus increasing their maintenance costs. When sediments occur excessively, they can dramatically change the profile of water resources.

3.4 Effect of excessive water withdrawal

Around the world, certain lakes, rivers and inland seas are drying up because too much water is being drawn from them or from their tributaries. Groundwater too is used faster than it is replenished, as is clear from a growing number of reports documenting sharp drops in aquifer levels. In many cases, drought periods have compounded this well-documented trend. The Niger, the Nile, the Ganges, the Tigris, the Euphrates, the Yangtze, the Colorado, and the Rio Grande are just some of the major rivers suffering substantial reductions in flow. Numerous lakes and inland seas are shrinking dramatically in many geographic regions. The Aral Sea and Lake Chad have decreased dramatically in size over the last few decades. As noted by Orubu (2006), these problems persist, though their causes have been evident for quite some time. Foremost are the very inefficient ways in which water is supplied to farms and cities, deforestation, and the failure to properly manage and control the withdrawal of water, and to think of more economic ways to use water.

The threat to groundwater is not as obvious as that to lakes and rivers; there is less visual evidence and it takes longer to recognize the effects of withdrawing too much groundwater. In the last half-century, pumping from aquifers increased globally, but often, the benefits – bigger harvests for example – were short-lived, ultimately resulting in lower water tables, drilling of deeper wells, and sometimes even the depletion of the groundwater source. Cases from all climatic regions illustrate that excessive use of groundwater is relatively common practice. The consequences can be seen in reduced spring yields, diminished

river flow, poorer water quality, damage to natural habitats such as wetlands, and the gradual sinking of land, a process known as *subsidence.*[3]

3.5 Effect of climate change on water quality

Exactly how global warming is affecting water resources is not altogether clear yet. However, new research is suggesting that climate change is increasing existing stress, for example by reducing runoff in areas already suffering from water shortages. Scientists agree that extreme weather events stemming from global warming, such as storms and floods, are likely to be more frequent in the future. However, based on current knowledge, scientists can only make general predictions about the impact of climate change on water resources. More information is needed, for instance, about impacts on water resources in specific regions and under different policy scenarios. One factor that has been implicated in the global increase in temperature is the intensification of the greenhouse effect due to increased load of carbon dioxide due to industrial production processes and carbon vents from hydrocarbon fields as well as other anthropogenic activities, which raise lower atmospheric temperatures.[4]

The major consequences relating to water resources include: temperature increases, unpredictable changes in patterns of rainfall and snow cover, and the likelihood of more frequent flooding and droughts, as well as significant changes in river-flow (European Environmental Agency, 2018). Floods of unusual dimensions, occasioned by global warming can also significantly affect the quality of surface water, particularly in rural areas where dug-out wells are the

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[3] Sinking of the Earth's surface in response to geologic or man-induced causes. When subsidence occurs in great belts, providing troughs for the accumulation of sediments, the resulting features are termed geosynclines; nonlinear subsidence produces basins and irregular depressions. See https://www.britannica.com/science/subsidence

[4] See World Bank (2011). Global greenhouse gas (GHG) emissions are projected to increase by 50%, primarily due to a 70% growth in energy-related CO2 emissions. The atmospheric concentration of GHGs could reach 685 parts per million (ppm) CO2- equivalents by2050, except urgent policy actions are taken.

major source of drinking water. This was a general observation in many parts of Nigeria in 2012, when there were floods in the Niger and Benue river basins.[5]

3.6 Land use and disregard for planning laws

Land use systems essentially define how man has adapted land space for the purpose of development. Land space can be used for several purposes. Over the years, economic growth, urbanization and rising population have led to increased demand for land for several purposes such as residential constructions, farmlands, livestock rearing, factory and industrial sites, physical infrastructure such as roads, airports, railways, recreational purposes such as swimming pools, and so on. The use of land for these various purposes has significant impact on the physical environment. For instance, water bodies and wetlands provide cover for land, and are of critical importance in the sustenance of water supplies and aquatic habitats. Indiscriminate use of land without regard to best practices and planning laws can distort ecological balance. A common observation in many urban and semi-urban centres in Nigeria is the unhealthy clustering of residential structures, sometimes built across natural drains that ought to facilitate easy flow of water during the rainy season. The blockage of such water flow channels amplifies the degradation of water quality, particularly for households that depend on shallow wells and boreholes for the supply of water, particularly during episodes of flood. Apart from a few cities in Nigeria, most urban residents get their supply of water from unregulated private boreholes that are drilled not within a safe distance from toilets and septic soaks. Water from shallow wells is therefore highly prone to pollution from faecal and other sources.

In retrospect, it could be said that the management of Nigeria's water resources and the provision of potable water for its citizens have been a core concern of the economic policies of the various tiers of government over the years. This is evident in the annual budgetary allocations made to the water sector by the federal and state governments. Apart from direct water supply schemes, the Federal Government of Nigeria had also paid great attention to the development of the various river basins, all in attempts to develop the water

[5] See DTSG (2012) on the impact of the 2012 flood disaster in Delta State. Waterborne diseases, malaria and cases of depression were high in the affected communities.

resources of the country to enhance agricultural production and improve access to water for other uses. The role of government in the development of the country's water resources will be discussed in some detail later in this paper after a brief look at the country's endowment of water resources.

4. Brief Overview of Nigeria's Water Resources

Nigeria is blessed with abundant water resources. The freshwater environment consists of a number of rivers and their flood plains, streams, lakes and wetlands, with the rivers and streams relatively evenly distributed all over the country. The Niger river, which traverses the entire country, is one of the 55 international rivers in Africa, and runs through several countries including Chad, Niger, Benin, Burkina Faso, Côte d' Ivoire, Guinea, Mali, Niger, Nigeria, and Sierra Leone. It is of great importance in the management of Nigeria's water resources. The Benue river is another major river in the country. Apart from the Niger and Benue rivers, there are well over 40 other rivers and streams in the country. Chad and Kainji are two great lakes that support the country's freshwater environment. The Nigerian sector of Lake Chad has a surface area of about 550,000 hectares, while that of Kainji Lake is about 127,000 hectares (Majasan and Quinn-Young, 1997).

The freshwater resources of the country support diverse economic activities such as transportation, fishing and recreation. They are also the main source of drinking water for a large proportion of the people, particularly those who live in rural areas, where there are no modern water supply facilities. The rivers in particular play another important hydrological role – that of recharging ground water aquifers and enhancing yields. Rainfall also helps to recharge underground water. However, rainfall is relatively variable across the country, particularly between the North and the South, varying between about 250mm in the extreme north, to about 500mm in the south. Rainfall constitutes a significant source of water, with the annual renewable total estimated at 319 billion cubic meters during the mid-1980s (Aminu, 2000).

The maritime states (Lagos, Ondo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River) are on the Atlantic coastline, which has a total length of about 853 km. The country's marine water resources provide significant support to the economy, particularly in the area of sea transportation and artisanal and commercial fishery. All major ports in the country are located in the maritime

states. Table 1 provides a summary of annual water yields for the 8 hydrological areas (HAs) in the country. Collectively, the Niger-river based HAs account for 36.8% of annual groundwater yield in Nigeria, while HA-1 and HA-8 paint the picture of areas with the highest water stress potentials

Table 1. Annual Groundwater Yields by Hydrological Area

Hydrological Area (HA)	Region	States covered	Annual Groundwater yield (bcm/year)
HA-1	Niger North (Northwest Nigeria)	Katsina, Zamfara, Sokoto, Kebbi, Niger, Kano	5.0
HA-2	Niger Central (West-central Nigeria)	Niger, Kaduna, Plateau, Kogi, FCT,	20.5
HA-3	Upper Benue (East-central Nigeria)	Adamawa, Bauchi, Gombe, Plateau, Taraba,	19.3
HA-4	Lower Benue South East Nigeria)	Nasarawa, Benue, Plateau, Kogi, Rivers,	18.6
HA-5	Niger South (South-central Nigeria)	Anambra, Bayelsa, Delta, Imo, Kogi	31.9
HA-6	Western Littoral (Southwest Nigeria)	Edo, Ekiti, Lagos, Ogun, Ondo, Oyo, Osun	23.4
HA-7	Eastern Littoral (Southeast Nigeria)	Abia, Akwa-Ibom, Cross River, Ebonyi, Enugu, Imo	32.8
HA-8	Chad Basin (North-east Nigeria)	Bauchi, Gombe, Jigawa, Kano, Yobe, Borno	4.3
Total			155.8

Sources: Adapted from FMWR/JICA (2014), FMWR (2016).

Consumptive purposes account for the largest proportion of water use in the country (FMWR, 2016). Water for consumptive purposes includes that which is supplied for domestic uses such as drinking and sanitation and other secondary production activities. Other consumptive aspects of water use include irrigation, freshwater aquaculture, and livestock. The estimated consumption of water in 2010 was put at 5,933 million cubic metres per day (mcm/day), and is expected to rise to 16,585 mcm/day by 2030 (FMWR, 2016, see Table 2). In the same vein, the water use rate (the ratio between the total water demand and the surface water resources potential) in 2010 was just 1.6% and is expected to grow to 4.4% by the year 2030. This implies that total water demand is much less than

the total water resources potential in the country. It should be noted, however that water demand and water resources are unevenly distributed across the regions, and even within the same area. Furthermore, water that is available to consumers may vary spatially in terms of its quality. These observations justify the adoption of an integrated approach to the management of water resources in the country, which makes it possible to address spatial peculiarities, particularly at the local level, for effective water provisioning. Take for instance, the case of water used for irrigation purposes in the country. Looking at the rating in table 2, one may be tempted to think that all is well with the country's active irrigation space. But this is really not the case. Total agricultural land in Nigeria is estimated at 708,000 square kilometres but only about 0.3% of this is under effective irrigation (AfDB, 2016).

Table 2. Water demand estimates for Nigeria (2010 and 2030)

Estimated national consumption	Estimated consumption (2010) mcm/day	Estimated consumption (2030) mcm/day
Water supply	3047	8852
Irrigation	1926	6245
Aquaculture	728	1166
Livestock	233	312
Total	5933	16585

Source: FMWR (2016).

The fact has already been noted that the bottom-line in water management practices is how to ensure that water is available for all potential uses in a form that is safe. With particular reference to drinking water, it should have the desirable properties that make it fit for human consumption, in terms of the required hydrogen ion concentration and being free from harmful contaminants. It has however been observed that the country's water resources are under serious threat from inadequate catchment management and widespread pollution, including the indiscriminate disposal of hazardous substances. There is limited groundwater availability in the areas of the country underlain by crystalline rocks. In the more productive sedimentary areas, groundwater exploitation is heavy and uncontrolled. In addition to the above challenges, poor watershed management, deteriorating water quality, drought and desertification are

significantly increasing water scarcity. Scarcity threatens urban and rural development with rapidly rising water supply costs, reduced reliability of water supplies, prolonged droughts, flood and erosion and increasing costs of irrigated food production (FMWR, 2016). Being a concurrent policy issue, both the federal and state governments, have over the years, assumed greater responsibility for overall management of the nation's water resources. In the next section of this paper, we take a brief look at some of the policy measures taken over the years by government in addressing the problem of meeting the demand for water in Nigeria.

5. Government Policies on Water Resources

Government policies on the country's water sector have been hinged on the need for effective development of the nation's water resources to provide safe drinking water for the people; irrigation for agriculture, and hydro-generation of electricity along the country's main watersheds. The earliest efforts by government, particularly at the central level to develop and manage the country's water resources predate the era of political independence. For example, during the decade between 1946 and 1956, the colonial administration spent about 15.1% of the country's total capital expenditure on water supply, with water supply schemes focused on specified urban areas.[6] The First National Development Plan (1962 – 1968) allocated ₦48.6 million, representing 3.6% of the total planned capital investment expenditure, to the development of water resources. The Second National Development Plan (1970 – 1974) allocated N148.6 million to water resources development – representing 4.5% of the total planned investment. However, allocation to the sector under the Third Plan (1975 – 1980) was ₦930.04 million, representing 2.83% of total planned capital expenditure. It further rose to ₦3.12 billion under the Fourth Plan, representing 4.4% of projected total capital expenditure (Aminu, 2000).

[6] Over the period 1957- 1960, the share of water resources in total capital expenditure of the federal government however declined to 7%. It is interesting to note that during the active MDG years, and immediately after, the total annual budget (both capital and recurrent) of the federal government was far less than 4% of total. For a comprehensive discussion of the development of water resources in Nigeria in the post-independence period, see also Orubu (2006).

During the early 1960s, the regional governments in the country (and later state governments) were responsible for the production and distribution of potable water in urban and semi-urban areas. By 1978, all states in the federation had established their own water boards, whose main function was to provide drinking water for residents in urban and semi-urban areas. The water sector had earlier in 1976 received a boost, through the creation of the River Basin Development Authorities (RBDAs) to provide water for irrigation purposes, control of pollution, as well as for human consumption, particularly in rural communities in the basins of the country's major rivers.[7]

The RBDAs were relatively more active during the mid-1980s. In 1985, the RBDAs had about 32.6 thousand hectares (ha) under irrigation, and sank 108 boreholes and 8 earth dams. The respective achievements for 1989 were 67.9 thousand ha; 462 boreholes and 16 earth dams. During the period 1991 – 1996, the total area of land brought under irrigation by the RBDAs was 46.6 thousand hectares, representing only 16.9% of the cumulative total of 275.4 thousand hectares achieved for the period 1985 – 1996. Under the Agricultural Development Projects (ADPs), the cumulative number of boreholes drilled countrywide over the period 1985 – 1996 was 53,499, with the total area of land brought under irrigation estimated at 85.6 million hectares, mainly through the Fadama Irrigation Programme (Sharma et al., 1996).

The Directorate for Food, Roads and Rural Infrastructure (DFRRI) was also established under the Babangida administration in the mid-1980s, with rural water supply as one of its mandates. DFFRI did not however make any significant impact on water supply throughout the country, and in 1994, all water supply activities under DFFRI were transferred to the Federal Ministry of Water Resources and Rural Development created in 1993 (Orubu, 2006).

The new ministry, in collaboration with the Japanese International Cooperative Agency (JICA) prepared a National Water Resources Master Plan for the country in 1993, which was updated in 1995.[8] In the same year, the

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[7] The River Basin Authorities, which worked closely with the Agricultural Development Projects (ADPs), were relatively more active during the mid-1980s, and up to 1993, when the late General Abacha took over government.

[8] The Master Plan was updated in 1995 and has been updated several times since then. See FMWR (2004, 2014, 2016).

federal government and the European Community also sponsored the Middle Belt Water Supply Project, and Water Resources Decree (No. 101) was promulgated. The objective of the decree was to effectively control and use the country's surface and groundwater and any other watercourses affecting more than one state, together with their beds and banks. Decree 101 of 1993 vested the powers of control and use of Nigeria's water resources in the federal government, and up to the early 2000s, these powers were effectively exercized through the activities of the Federal Ministry of Water Resources and Rural Development, which also co-ordinated the activities of the National Council on Water Resources.[9]

At the state level, the governments continued to run their own water boards/ corporations. Some local government authorities also made efforts to supply water to the populace, particularly in rural areas. In furtherance of its objective to increase the population's access to safe water, the federal government, in the year 2003, adopted a presidential water initiative, tagged 'Water for People, Water for Life', with the ultimate aim of increasing water access in all state capitals to 100%; urban and semi-urban areas to 75% and rural communities to at least 66% by the year 2007. This initiative was part of government's programme of poverty alleviation, integrated rural development, and job creation. This scheme did not achieve much in terms of meeting the targets (USAID, 2007), although it provided a framework for putting the National Water Policy in place in 2004 ((FMWR, 2004), with the specific aim of providing a framework for the achievement, amongst others, of:

- Clear and coherent regulatory framework for the country's water resources
- Clear definitions of the functions and relationship of sector institutions
- Effective co-ordination and funding of water services
- Reliable and adequate data for water resources planning and projections
- Decentralization of water services in order to boost efficiency, performance and sustainability

[9] Under the water initiatives of the RBDAs, several water schemes were developed in their areas of jurisdiction. Many of such water schemes never worked for too long before they packed up.

- Autonomy of water supply agencies
- Regarding water as an economic good
- Creating public awareness about water conservation and management
- Provision of stable and adequate power supply through hydro-generation
- Technical and financial capacity building to efficiently manage water delivery system

Earlier on in the year 2000, the federal government had approved the National Water Supply and Sanitation Policy, which encouraged private-sector participation and envisaged institutional and policy reforms at the state level. Almost two decades later, only a few states in the country have records of private sector participation in providing water directly to the people, apart from the multiplicity of producers of bottled and sachet water. It is also important to note that under Vision 2020, the long-term plan for the development of the country's water resources, which covered the period 2016 – 2020 (FGN, 2009), centred on the following targets, to be achieved by 2020:

- Increase national improved water supply coverage from 75% to 100%
- Increase national improved sanitation coverage from 65% to 100%
- Increase minimum water supply service from 25 litres per capita per day to 30 litres per capita per day for rural communities
- Increase minimum water supply service from 40 litres per capita per day to 60 litres per capita per day for small town (semi-urban) communities
- Increase minimum water supply service from 100 litres per capita per day to 120 litres per capita per day for urban communities.

The 1995 National Water Master Plan was comprehensively reviewed by the Federal Ministry of Water Resources (FMWR) in collaboration with the Japan International Cooperation Agency (JICA) in 2013 (FMWR/JICA, 2014). The report of the review, which was submitted early in 2014, formed the basis for the formulation of a new National Water Policy for the country in 2016 (FMWR, 2016). While the interventions briefly discussed above relate mainly to the development of fresh water resources in the country, it would appear that not much has been done in terms of the management of marine resources. The greatest challenges here are the twin problems of sea inundation and pollution of the country's maritime environment, particularly along the shorelines and

continental shelf. To this effect, the federal government signed the Basle Convention on the control of trans-boundary movement of hazardous wastes and their disposal in 1990, and is also involved in international co-operation in the monitoring of trans-boundary movement of toxic wastes.[10]

From the foregoing, it is evident that the development and management of the country's water resources has been a core component of government's development policy, even though policy efforts have been more concentrated on freshwater resources, and that policy concern even predates the post-independence period, with a relatively well-defined institutional framework. Constitutionally, the development and management of water resources and the provision of drinking water in Nigeria is on the *concurrent list*. This means that all tiers of government have the constitutional right to provide safe and drinking water for the people. This perhaps explains why there is a multiplicity of water agencies and parastatals in the country.

The institutional framework that has evolved over the years has defined scopes and responsibilities for the agencies of government that are responsible for the development, management and monitoring of water resources, amongst others. The key institutions include, *inter alia*:

- Ministry responsible for water resources at the federal level
- Ministries responsible for water resources at the state level, and their own rural water supply and sanitation agencies
- Nigeria Hydrological Services Agency (NHSA) whose mandate is water resources (groundwater and surface water) assessment of the country; its quantity, quality, availability and distribution in time and space
- Nigeria Integrated Water Resources Management Commission (NIWRMC), that is responsible for regulation of water use and allocation
- National Water Resources Institute, a parastatal of the Federal Ministry of Water Resources, with responsibility for training, research and data management relating to water in general

[10] It is important to note that it was largely the illegal dumping of toxic waste by an ocean liner near the Koko Port in Delta State in 1988 that led to the establishment of the defunct Federal Environmental Protection Agency in 1992.

- All the River Basin Development Authorities, which are also parastatals of the Federal Ministry of Water Resources, involved in the provision of water supply to rural environments within their catchments
- Water Resources Regulatory Commission
- National Council of Water Resources
- National Environmental Standards and Regulations Enforcement Agency (NESREA)
- Nigerian Meteorological Agency (NIMET)
- The Federal Ministry of Environment and state counterparts
- National Food and Drugs Administration and Control (NAFDAC)

One other fact about the management of water resources in the country is that the central approach has been that of public provisioning, even though the various versions of water policy and master plans have also suggested the need for private sector participation in water provisioning.[11] In reviewing the progress made through the various government policies on the water resources sector in the past decades, the Federal Ministry of Water Resources (FMWR, 2016) observed that efforts to improve access to water resources in the country have not been significantly successful due to a number of challenges. In the next section, we examine how the country has fared on the comparative water scale. Against this background, the major constraints facing the water resources centre are examined as a basis for suggestions as to how to improve access to water for domestic and other uses in Nigeria.

6. Assessment of Policy Effectiveness and Challenges

In this section, the effectiveness of the policies adopted in order to increase access to water and improved sanitation services in the country are assessed. The key challenges constraining the effectiveness of the water resources policy in the country are also identified.

[11] The current trend in the provision of basic infrastructure, including water and sanitation is that of private sector participation (see Orubu, 2017, 2019; World Bank/FMBEP, 2017).

6.1 Assessment of policy effectiveness

The assessment of policy effectiveness is undertaken by examining the profiles of four key indicators, namely:

- Percentage of the population with access to water
- Percentage of the population with access to sanitation
- Percentage of the population that practice open defaecation
- Africa's infrastructure development index for water and sanitation

The analysis is done within a comparative frame, by comparing how well the country has performed relative to other ECOWAS countries. But first, we look at the federal budget performance for the water resources sector, mainly over the period 2005 -2017, the summary of which is presented in table 3. Table 3 summarizes expenditure allocated by the federal government to water supply for selected years over the period 1995 – 2017 (only capital expenditure is listed for the years 1995, 1998, 2000, 2002, while the figures for 2005 – 2017 capture both capital and recurrent expenditure). As can be seen from the table, total allocation to the water resources sector, particularly during the period 2005-2017 has not been impressive. The average annual share of water resources in the federal government's total budget over the period 2005-2017 was just 1.98%. It is interesting to note that the share of water resources in the total federal budget indicated a relatively higher trend in 2017, which is a year after the most recent review of the National Water Policy.

Table 4 provides a summary of the proportion of the population of ECOWAS countries with access to water for selected years (2000, 2005, 2010, and 2015). The year 2015 is significant in the sense that it represented the terminal date of the MDG programme, by which time it was expected that developing countries would have achieved full access to improved water sources.

Amongst ECOWAS countries, only Cape Verde, Gambia and Ghana were able to record full access, while Nigeria recorded 81.52%, which is marginally lower than the ECOWAS and Africa averages of 86.41% and 85.22% recorded

for the same year.[12] It is also interesting to note that Nigeria ranked 12th position among ECOWAS countries on this indicator.

Table 3. Share of Water Resources in Federal Government Budget, for Selected Years

Year	Water Resources Budget	Total Federal Budget	Share of Water Resources in Federal Budget (%)
1995	2.58*	122.9*	2.1*
1998	3.84*	256.0*	1.5*
2000	14.32*	954.7*	1.5*
2002	30.2*	915.2*	3.3*
2005	46.5	1822.1	2.62
2006	52.9	1938	2.73
2007	48.7	2450.9	1.99
2008	63.9	3240.82	1.97
2009	99.8	3452.99	2.89
2010	84.3	4194.58	2.1
2011	57	4712.06	1.21
2012	99.8	4605.39	2.17
2013	68	5185.32	1.31
2014	57.7	4587.39	1.26
2015	48.9	4988.86	0.98
2016	55.7	5858.56	0.95
2017	247.2	6456.7	3.83

Source: Central Bank of Nigeria: *Annual Report and Statement of Accounts*; *Statistical Bulletin* (several issues).

* The asterisked figures represent only capital expenditure, while 2005-2017 figures capture the total budget of the federal government.

Table 4. Percentage of Population with Access to Water in ECOWAS (selected years)

Case Number	Country	Year			
		2000	2005	2010	2015*
1	Benin	78.54	83.67	88.66	97.94 (4)
2	Burkina Faso	69.02	82.23	93.05	97.93 (5)
3	Cape Verde	98.06	100.00	100.00	100.00(1)
4	Côte d'Ivoire	92.7	94.25	96.03	97.46 (6)

[12] See AfDB (2018). Comparatively, South Africa had achieved full access by 2015.

Case Number	Country	Year			
		2000	2005	2010	2015*
5	Gambia	98.41	100.00	100.00	100.00(1)
6	Ghana	83.9	91.63	98.89	100.00(1)
7	Guinea	74.61	80.68	86.63	91.39 (10)
8	Guinea Bissau	62	72.23	83.06	94.37 (7)
9	Liberia	74.26	79.49	84.61	89.96 (11)
10	Mali	55.45	67.47	79.61	91.63 (9)
11	Niger	52	57.95	64.26	69.26 (15)
12	Nigeria	61.64	68.78	75.45	81.52 (12)
13	Senegal	80.21	84.61	89.01	93.42 (8)
14	Sierra-Leone	56.17	62.24	68.31	74.49 (13)
15	Togo	63.78	67.47	71.16	75.09 (14)

Source: Adapted from AfDB, *Africa Infrastructure Development Index* (several issues).

* The figures in parentheses are the corresponding ranks for 2015.

The situation with respect to improved sanitation is summarized in table 5. As shown in table 5, Cape Verde had the highest rank of 1, with access recorded at 85.92% in the year 2015; followed by Gambia, ranked 2, with an access score of 70.09%; followed by Senegal, ranked 3 with an access score of 56.64%. Although Nigeria's access score of 34.5% is by all standards, relatively low, it ranked 4th amongst all ECOWAS countries, in terms of the proportion of the population that had access to improved sanitation services in 2015. Even though the country's access score for 2015 was higher than the ECOWAS access figure of 30.07% for that year, it is interesting to compare the country's relative position to that of South Africa, which recorded 79.02% for the year 2015 (AfDB, 2017).

The proportion of the population that practices open defaecation is another critical indicator of improved access to sanitation services. Open defecation can pollute the environment with faecal residues and can cause serious health problems, particularly among vulnerable segments in society, such as children, and the poor. High levels of open defaecation have been linked to high child mortality, poor nutrition, poverty, and large disparities between the rich and the poor in many developing countries.

Table 5. Percentage of population with access to sanitation in ECOWAS countries (selected years)

Case Number	Country	Year			
		2000	2005	2010	2015*
1	Benin	14.16	16.66	20.59	23.44 (9)
2	Burkina Faso	13.80	17.14	20.71	23.44(9)
3	Cape Verde	51.88	64.26	76.40	85.92(1)
4	Côte d'Ivoire	20.59	22.85	24.87	26.78(6)
5	Gambia	71.04	70.45	69.97	70.09 (2)
6	Ghana	12.23	14.28	16.30	17.73 (12)
7	Guinea	15.35	18.21	21.30	23.92 (8)
8	Guinea Bissau	14.75	18.56	24.49	24.75 (7)
9	Liberia	15.59	17.02	18.56	20.11 (11)
10	Mali	21.42	24.04	26.66	29.39 (5)
11	Niger	7.85	9.40	11.31	12.97 (15)
12	Nigeria	40.46	38.32	36.30	34.51 (4)
13	Senegal	47.96	50.69	53.67	56.64 (3)
14	Sierra-Leone	13.45	14.16	14.99	15.83 (13)
15	Togo	13.57	13.57	13.69	13.80 (14)

Source: Adapted from AfDB, Africa Infrastructure Development Index (several issues).

* The figures in parentheses are the corresponding ranks for 2015.

Table 6 provides a summary of the proportion of the population practising open defaecation in ECOWAS countries for the years 2000, 2005, 2010, and 2015. As shown in table 6, Niger has the highest rank of 1, with a total score of 71.31% in 2015, that is, 71.31% of the total population in that country, practised open defaecation in 2013, while The Gambia ranked 15, with a recorded score of 0.85% . Nigeria ranked 7th, with a recorded score of 25.54 %, implying that in that year (2015), 25.54 % of the population of Nigeria practised open defaecation. This figure is marginally higher than 23.04%, which is the average for sub-Saharan African countries (WDI, 2016).

Table 6. Percentage of Population Practising Open Defecation in ECOWAS Countries (selected years)

Case Number	Country	Year			
		2000	2005	2010	2015*
1	Benin	67.74	63.67	59.48	55.16 (2)
2	Burkina Faso	71.42	64.11	55.80	47.98 (4)
3	Cape Verde	23.26	25.90	28.10	28.10 (6)
4	Côte d'Ivoire	36.28	31.96	27.66	23.66 (8)
5	Gambia	5.96	3.91	2.09	0.85 (15)
6	Ghana	21.83	20.78	19.74	18.75 (11)
7	Guinea	27.49	23.33	19.27	15.36 (12)
8	Guinea Bissau	35.95	28.69	22.01	19.06 (9)
9	Liberia	54.56	50.34	46.25	42.26 (5)
10	Mali	21.53	16.75	12.24	8.05 (14)
11	Niger	81.54	78.36	74.96	71.31 (1)
12	Nigeria	22.65	23.67	24.62	25.54 (7)
13	Senegal	24.16	21.17	18.15	15.11 (13)
14	Sierra-Leone	26.27	22.74	21.26	18.81 (10)
15	Togo	57.54	55.45	53.16	50.68 (3)

Source: Adapted from AfDB, *Africa Infrastructure Development Index* (several issues)

* The figures in parentheses are the corresponding ranks for 2015.

An alternative way of assessing the performance of African countries in the area of core development infrastructure is by reference to the Africa Infrastructure Development Index, which has been developed by the African Development Bank. The key indexes developed are the composite infrastructure development index and the sub-components for transportation, electricity, information and communication technology (ICT), and water and sanitation. The composite index for water and sanitation for ECOWAS countries for selected years up to 2018 is shown in table 7.

Table 7. Africa Infrastructure Development Index for Water and Sanitation in ECOWAS Countries

Case Number	Country	Year						
		2000	2005	2010	2015	2016	2017	2018
1	Benin	32.78	36.66	41.25	43.19	44.22	46.53	46.69 (9)
2	Burkina Faso	29.43	38.13	46.12	47.28	47.71	49.60	49.96 (6)
3	Cape Verde	62.32	68.20	74.31	78.11	79.60	81.30	81.60 (1)
4	Côte d'Ivoire	47.0	49.07	50.29	48.56	48.90	50.79	50.98 (5)
5	Gambia	71.68	77.05	78.48	73.26	73.36	74.19	74.24 (2)
6	Ghana	36.89	43.65	49.70	47.77	48.82	51.58	52.48 (4)
7	Guinea	33.08	38.4	43.0	42.48	43.51	45.92	46.06 (10)
8	Guinea Bissau	23.68	32.16	36.76	42.34	43.86	46.71	48.25 (8)
9	Liberia	30.65	36.46	42.27	37.77	40.61	42.83	44.66 (11)
10	Mali	22.76	30.25	37.74	42.0	43.73	46.62	48.37 (7)
11	Niger	14.45	18.33	20.50	24.93	25.94	27.76	27.89 (15)
12	Nigeria	35.71	37.61	37.84	41.45	42.06	43.51	44.06 (12)
13	Senegal	50.52	53.94	58.31	57.17	57.97	59.46	60.23 (3)
14	Sierra-Leone	19.31	23.42	26.80	28.67	29.54	31.44	32.30 (13)
15	Togo	26.80	28.97	31.14	29.14	29.68	31.33	31.87 (14)

Source: African Development Bank, *Africa Infrastructure Development Index* (several issues).

As can be seen from table 7, in the year 2018, Cape Verde had the highest score of 81.6 on this indicator, with a rank of 1 among ECOWAS countries, followed by The Gambia, which ranked 2nd, with an index value of 74.24, and Senegal, 3rd, with an index value of 60.23. Comparatively, Nigeria had an index score of 44.06, and ranked 12th among the 15 ECOWAS countries, and 34th among all African countries. In the same year (2018), South Africa had an index score of 80, ranking 8th among all African countries (AfDB, 2018). It is however important to note that most of the countries, including Nigeria, recorded marginal improvement in the water and sanitation infrastructure development index between 2015 and 2018 (see figure 1).

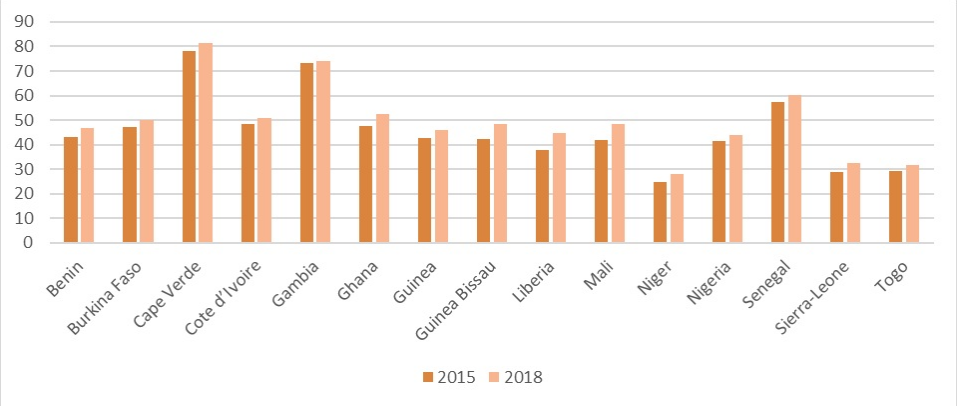

Figure 1. Plot of AIDI for water and sanitation for ECOWAS countries (2018).

What inference can we draw from these statistical tables, regarding access to water and sanitation? Evidently, the country has not done too well in comparison to other countries, even within the ECOWAS sub-region; ranking 12th among ECOWAS countries in terms of the proportion of the population with access to water in 2015; and also 12th position amongst ECOWAS countries on the composite water and sanitation infrastructure index for the year 2018. This is definitely not a good showing for a country whose GDP is more than half of the GDP of ECOWAS countries.[13]

In terms of simple correlational relationships, the data for Nigeria over the period 2000-2015 (2015 was the terminal date for the UN's MDGs programme) establish results that are generally in consonance with *a priori* expectations, with specific reference to the Human Development Index (HDI) and child mortality. The Pearson moment correlation coefficient between the composite infrastructure development index and the HDI, estimated at 0.7542, was found to be statistically significant at the 5% level of significance. The correlation coefficient between the composite infrastructure development index for water and sanitation and infant mortality was estimated at -0.7960, and statistically significant. A similar result was obtained for the associative link between access to improved sanitation and infant mortality, the correlation coefficient of which

[13] The Nigerian economy is dominant among ECOWAS countries, accounting for $537.97 billion or 77.15% of the sub-regional economy and 23.77% of the African economy (see Orubu, 2018b).

was estimated at -0.9. Open defaecation was also found to have a negative correlation with economic growth (measured at -0.35), but the relationship was not statistically significant. In all cases, non-significant correlations were observed between all the indicators of water and sanitation and growth, thus indicating that greater policy efforts are required if the water resources sector must impact significantly on the growth of the Nigerian economy.[14] There is no doubt that the water resources sector in Nigeria faces substantial constraints, and it is necessary to properly identify these constraints, and take them into account in the design of policies to improve access to improved water and sanitation services. We briefly examine these constraints in the next section.

6.2 Policy challenges in the water resources sector

The policy challenges facing the water resources sector in Nigeria include the following (among others), which are briefly discussed:

- Scarcity of the necessary information and data required for meaningful planning
- Constitutional constraints on role definition and multiple agencies
- Increasing public fiscal burden and issues with private sector participation
- Bottlenecks and lags in the public budget cycle
- Societal mind-sets about water and willingness to pay
- Problem of shared trans-boundary water resources
- Institutional incapacity and effect on co-ordination, monitoring and evaluation
- Possible effects of climate change and extreme weather conditions
- Multiplicity of unregulated small and individual water producers
- Inability to control and manage the adverse effects of the absence/failure of public provisioning

[14] These correlational outcomes generally agree with the results of an earlier panel data analysis of the relationship between access to water and sanitation and economic growth in ECOWAS countries (see Orubu, 2017).

- Lack of stakeholder involvement in the planning and management of water resources

Scarcity of the necessary information and data required for meaningful planning is a key issue in the Nigerian water resources sector. Adequate and reliable information about water, its availability, access to sanitation, pricing mechanism are important for water management and planning, and these are generally not reliably available (AfDB, 2016). There is, for instance, a dearth of information regarding the production and use of water in Nigeria. Information relating to consumption as well as the cost of procurement are necessary inputs in modelling to forecast future demand for water. All these lead to poor planning and faulty project design in the water sector.

Water provisioning appears in the *concurrent list* in the Constitution of the Federal Republic of Nigeria (FGN, 1999). Consequently all the tiers of government are constitutionally empowered to provide water for the people. Decentralization of public water provisioning is not bad on, but in Nigeria, this has often led to undesirable outcomes. Oftentimes, the roles of the different Ministries, Departments and Agencies (MDAs) are not well-defined, and without inter-MDA consultation, project duplication is a common problem encountered, and this is usually associated with fraudulent interfaces, which may not be identified by independent monitors.

The cost of building supportive infrastructure has increased significantly over time, particularly in the face of inefficient infrastructure management. This rising cost results from several factors, including inflation and exchange rate downgrades. In the face of competing fiscal demands, the increasing cost of producing and distributing water for industrial and domestic uses, irrigation, animal husbandry, and other uses, has increased the fiscal burden at all levels of government, against the background of down-sliding public finances. Meanwhile, the general populace has been used to the common reasoning that it is the government that provides water, particularly for domestic use. This observation calls for a new approach to financing water supply that argues in favour of public-private partnerships, and private provisioning of water and sanitation services.[15] At present, a mind-set bordering on unwillingness to pay

[15] Under the State Employment for Results (SEEFOR) programme, with pilots in Bayelsa, Delta and Edo states, a recent first round impact assessment study found that private sector

for water services has constrained significant private sector participation in the water sector.

Bottlenecks and lags in the public budget cycle can delay the implementation of important water development projects, particularly in flood-prone areas. Revenue shortfalls are critical bottlenecks in the financing of water projects, while legislative and executive lags in budget cycle can cause cost overruns that may lead to project abandonment.[16] Societal mind-sets about water provisioning have over the years, constrained the effectiveness of efforts made by government to provide water facilities, particularly because the usual thinking is that water is a free commodity, particularly in rural and semi-urban areas. Consequently, individuals are not very willing to pay for water services provided by government. Paradoxically, these same individuals are willing to pay for sachet water that is produced by unregulated small outfits, where product quality is not assured, even though some of them may have been registered by NAFDAC.

There is the riparian problem of shared trans-boundary water resources. The management of common water resources that are shared by different countries usually poses a problem to governments, and requires substantial inter-regional or international cooperation. For example, the Chad Basin Aquifer is shared by Nigeria, Cameroon, Central African Republic, Chad, Niger and Nigeria; the Keta Basin Aquifers are shared by Nigeria, Ghana, Togo, and Benin, while the Benue Trough is shared by Nigeria and Cameroon. Critical infrastructure owned by one country at upper basin points can easily affect down-point developments, hence cooperation is important.[17]

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participation in basic sanitation services works (see World Bank/FMBEP, 2017) Draft Report of Impact Assessment Study, 2017.

[16] It is a more serious case when funding is mainly through international development agencies, and the Memorandum of Agreement requires the provision of counterpart funding by government. A classic case is the World Bank-funded water project in Warri metropolis, which was abandoned in the 1990s because government could not provide the necessary counterpart funding at the right time.

[17] For some time, Egypt and Ethiopia faced disagreements over developments in the Nile basin. Issues also exist between Nigeria and Cameroon over up-reach dam water control and associated floods in Nigeria.

Institutional incapacity and deficiency can also have large effects, particularly on the ability of technical personnel to design projects, co-ordinate, monitor and evaluate water resources development projects. This calls for strengthening and building technical capacity in MDAs to cope with the activities of economic agents that pollute water resources through illegal activities such as sand mining and dredging, for which environmental impact assessments may not have been carried out. Strengthening institutional capacity of technical personnel would also create the spirit of alertness to engage situations that demand emergency responses, such as those arising from the effects of climate change and extreme weather conditions resulting in prolonged droughts, increased flooding, widespread erosion and communal conflicts. Finally, lack of stakeholder involvement in water resources planning and management engenders unsustainable water development projects. Particularly at the local level, it is of prime importance to get the people involved right from the planning stage, particularly with regard to deciding on project type and design and the role that beneficiaries can play in maintaining the projects. Stakeholder involvement creates a feeling of ownership, which is critical to sustainable project practice.

The points discussed above are not exhaustive. However, taking them into account would be critical in the design and implementation of any policy package that would improve access to water and improved sanitation services in the country by all categories of economic agents. In the next section, we make some suggestions on the way forward to achieving access to water for all.

7. The Way Forward and Conclusions

Nigeria's National Water Resources Policy is based on the fundamental premise that the nation's water resources are part of its environmental and natural capital, and that it is only judicious and well-planned exploitation of these resources that can secure the maximum complementarity between environmental sustainability and the processes of economic development that enhance the quality of life. The primary guiding principles of the National Water Resources Policy include, *inter alia*:

- The objective of managing the quantity, quality and reliability of the nation's water resources so as to achieve optimum, long-term,

environmentally sustainable social and economic benefit for society from their use.

- The planning and management of Nigeria's water resources shall take place within a framework which facilitates awareness and participation among all users at all levels.
- Water resources shall be assessed, developed, apportioned and managed in such a manner as to enable all users to have equitable access taking into account the sustainability of the resource.
- Water quality and quantity are interdependent and shall be managed in an integrated manner, which is consistent with broader environmental management approaches.
- Water quality management options shall include the use of economic incentives and penalties to reduce pollution; and the possibility of irreparable environmental degradation as a result of pollution shall be prevented.
- The management of water resources shall seek to harmonize human and environmental requirements so that the human use of water does not individually or cumulatively compromise the long-term sustainability of aquatic and associated ecosystems.
- International water resources, specifically shared river systems, shall be managed in a manner that optimizes the benefits for all parties in a spirit of mutual co-operation. Allocations agreed for downstream countries shall be respected.
- Water quality management options shall include the use of economic incentives and penalties to reduce pollution.
- Beneficiaries of water services shall contribute to the cost of its establishment and maintenance on an equitable basis.
- The resource base shall be protected against any kind of pollution. The protection measures shall be based on both regulatory and market approaches to waste management, applying the "polluter pays" principle.

7.1 Suggestions for an effective water resources policy

Based on the challenges identified and the guiding principles of the National Water Policy (FMWR, 2004; 2016), the following suggestions are made for a more effective water policy in Nigeria.

Improve information/data base for water policy. This requires a comprehensive survey and analysis of the country's freshwater and marine water resources, based on the designated hydrological areas. Accurate and reliable data should be collected on the quantum and patterns of resource use that cover all aspects of the consumptive uses of water (domestic, industrial, livestock and animal husbandry, inland fishery and aquaculture, etc.).

The decentralization of water provisioning to lower tiers of government is apprpriate, but there is the need to properly define the role of each MDA at all levels of government in order to avoid administrative conflicts and project duplication. Beyond this, there should be a more pragmatic channel of consultation between all bodies concerned with the provision of water and the management of water resources, within the context of the National Council on Water Resources (NCWR). Representation at this level should be sufficiently encompassing to include relevant interventionist agencies and non-governmental organizations (NGOs).

Government has been traditionally charged with the provision of potable water for domestic consumption and for irrigation purposes. With dwindling financial resources, the fiscal burden on government is enormous. The National Water Policy also seeks to address this problem by encouraging private participation in water provisioning, either directly, or through some model of public-private partnership (PPP) arrangement.

For water projects that are to be funded by government, concerted efforts must be made to reduce executive and legislative lags in the budget cycle, while government should at all times honour counterpart funding arrangements, particularly for projects that are funded by international development partners. This is necessary in order to deliver such projects on time, avoid cost overruns and possibly project abandonment.

Substantial education and sensitization of the people are critical strategies for changing existing mind-sets that hinder defining water as an essential economic good, and entrenching willingness to pay for water and sanitation services. The changing of mind-sets that fix water as a service that must be provided, if

possible as a free commodity by government is a necessary condition to seeking private sector participation in the provision of water and sanitation services, as investors must of necessity recover cost and adequate returns on their investments.

Mechanisms for the management of trans-boundary water resources must be properly spelt out, and in such a way that no individual riparian entity has an advantage over others, in the use and application of shared water resources. This is important, and will help to reduce areas of disagreements and possible conflict.

There is a need for institutional strengthening and capacity building for personnel that are responsible for designing, monitoring and evaluating water projects. For example, large water projects may require the conduct of environmental impact assessment studies, or building in climate-proofing mechanisms. Capacity building will also create emergency response capabilities in times of environmental episodes of unusual dimension, such as floods, droughts and other conditions caused by climate change and extreme weather conditions.

The use of economic instruments could be beneficial, particularly when they are directed at activities that degrade the quality of water due to industrial and related processes. For instance, economic incentives could be used to encourage producers to install technology that reduces the residual intensity of production, while penalties are imposed on producers that pollute water resources, in line with the *polluter pays* principle.

The water market in Nigeria is characterized by a multiplicity of individuals and small water producers, whose products are not fully monitored by the relevant authorities, particularly the [National Agency for Food and Drug Administration and Control (NAFDAC). The quality of water, particularly sachet water, produced in some of these water factories is not assured. There is therefore the need to come up with stricter regulations to address the problem of adulterated sachet water, which is sold everywhere in the country.

The involvement of all stakeholders at all phases of the project cycle is necessary to create sustainable water projects. This is particularly necessary in water schemes that are designed to serve designated communities. Models that require beneficiary communities to bear part of the project cost, for example, meeting the cost of maintaining the water facility are highly recommended, and

such arrangements could be discussed at stakeholder meetings that may be part of a needs assessment interaction. Even for larger water schemes and projects, stakeholder involvement is a necessary condition for project sustainability.

Economic instruments may be used to achieve a reduction in impacts on the structure and functional activity of water ecosystems produced by specific types of economic activity. For example, incentives may be given to farmers in order to promote agricultural practices which increase soil conservation or minimize human occupation of flood plains. Economic incentives can also be used to promote water stress resistant crops in drought-prone areas.

Above all, the provision of water must not be done in an uncoordinated manner. In this regard, we recommend the Integrated Water Resources Planning (IWRP) model as the core planning framework for a sensible exploitation of the country's water resources for sustainable development and enhanced quality of life for all citizens.[18]

7.2 Conclusion

In this paper, we examined the role of water resources in the development of an economy, and particularly the nexus between access to water and improved sanitation services and the enhancement of human productivity and the quality of life. The interface between water resources and the environment was also discussed, as a prelude to a more detailed analysis of the role of government in the development of Nigeria's water resources. An assessment of the different policy measures taken by government in order to improve access to water and sanitation services shows that even though some measure of success has been achieved, the country still ranks relatively low on the scale for access to water and sanitation, even in comparison with other ECOWAS countries.

Against this background, the key challenges facing the water resources sector in the country were identified, as a basis for making suggestions on the way forward. The identified challenges and the guiding principles of the National Water Policy formed the core frame of the suggestions advanced.

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[18] Integrated Water Resources Planning (IWRP) defines a holistic approach to the management of water systems combining water supply, water demand, water quality, environmental protection and enhancement, rate structures, financial planning, and public participation. See American Water Works Association (AWWA, 2001).

Ultimately, the adoption of the Integrated Water Resources Planning model in the exploitation and management of the country's water resources is the most optimal policy frame that would guarantee sustainable synergy between the sector and enhanced quality of life for the people.

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