Global Challenges on Water Resources: The Nigerian Growing Economy and Her Energy Development

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ABSTRACT
At the global level, over a billion people have inadequate access to safe and secure water, with less than 12% population who actually receive treated supply of water. Increasing demand from industries and agriculture has worsened the situation due to the continual effort in global development. Desertification, salination and pollution are increasing as a result of many complexes and numerous human activities and other interrelated factors which include over-extraction and large scale diversion projects. However, the advancement of technology is highly needed to secure the sustainability of water processing and supply. In this regard more efforts on water purification, treatment and sewage sludge disposal must be instituted.

The challenges of water resources in Nigeria are enormous, because of many factors like; lack of proper maintenance of water processing facilities, upgrading, expansion of existing water plants and construction of new ones. Secondly, apart from the nation's abundance fossil fuel, diversifying the economy through construction of new hydropower generation and expanding the existing facilities can never be over-emphasised. In these efforts, the incessant and serious flooding which has claimed many life and billion naira worth of properties across the country and the global world can be minimised.

This paper is calling on the governments and policy makers to develop sustainable regional water management strategies based on a better understanding of the factors influencing cost and availability. In addition, universal water metering is a desirable goal using appropriate pricing mechanisms and public education to encourage more sustainable use of water. Secondly, improving hydropower facilities through dredging and expansion would not only resolve the flooding crises, but also increase nation power generation and accrued revenues to the nation.

KEYWORDS: *Energy, Facilities, Improvement, Sustainability, Power generation and Revenue.*

1.0 INTRODUCTION

Water remains the driving factor for economic and social development, while it also has a basic function in maintaining the integrity of the natural environment. However water is only one of a number of vital natural resources and it is most important that water issues are not

considered in isolation. Policy makers and managers, whether in the government or private sectors, have to make difficult decisions on water allocation. More and more they have to apportion diminishing supplies between ever-increasing demands. Driving factors such as demographic and climatic changes further increase the stress on water resources. The traditional fragmented approach is no longer viable and a more holistic approach to water management is essential. The 2012 report of the United nations show that globally about 800 million people lack access to water and over 2.6 billion lack access to proper sanitation. The scope and impact of this crisis are staggering. In that report more people die from water- and sanitation-related diseases than from all forms of violence, including war. Recently, the report of the United Nations Development Program show that, in every US$1 spent on water resources and sanitation generates a return of US$9 in saved time, which increases productivity and reduced health costs in Africa continent and some Asian countries.

Beyond loss of life, water poverty and inadequate sanitation cripple all development efforts. A lack of adequate water and sanitation facilities keeps children, especially *girls*, from attending school. Women spend an average of 3-5 hours each day fetching water, missing out on opportunities to perform other tasks or engage in economically productive activity. Parents miss work due to water-related illness or caring for sick family members. Existing medical conditions, such as HIV/AIDS, are exacerbated because of unsafe water and inadequate sanitation. Climate change, population growth, industrialization and urbanization all threaten to make the global water crisis much worse. More interestingly, there is room for hope. Waterborne illness is preventable and lasting water supply and sanitation solutions exist. Through concerted efforts by governments, corporations, foundations and nongovernmental organizations, roughly 200 million people have gained access to clean water during the past decade. However, even with these efforts, many countries are unlikely to meet the Millennium Development Goal (MDG) for water and even fewer will reach the MDG for sanitation.

Unprecedented collaboration between all sectors of society is needed in order to achieve sustainable solutions to this challenge. Global Water Challenge (GWC) brings together leading organizations in the water and sanitation sector to address this fundamental issue through partnerships and innovative approaches to water and sanitation, drawing upon the experience, expertise and assets of its members. GWC is a coalition of leading corporations, NGOs and other organisations committed to achieving universal access to safe drinking water and hygienic environment. GWC is able to create partnerships that achieve far greater results than any one organization could by itself. They know that access to clean water, sanitation and hygiene is the cornerstone for stability, community development and global prosperity. Therefore robust steps toward global resuscitation of water are currently in place. This is been done through the Integrated Water Resources Management (IWRM) approach that has now been accepted internationally as the way forward for efficient, equitable and sustainable development and management of the world's limited water resources and for coping with conflicting demands and shortages is represented in Figure 1.

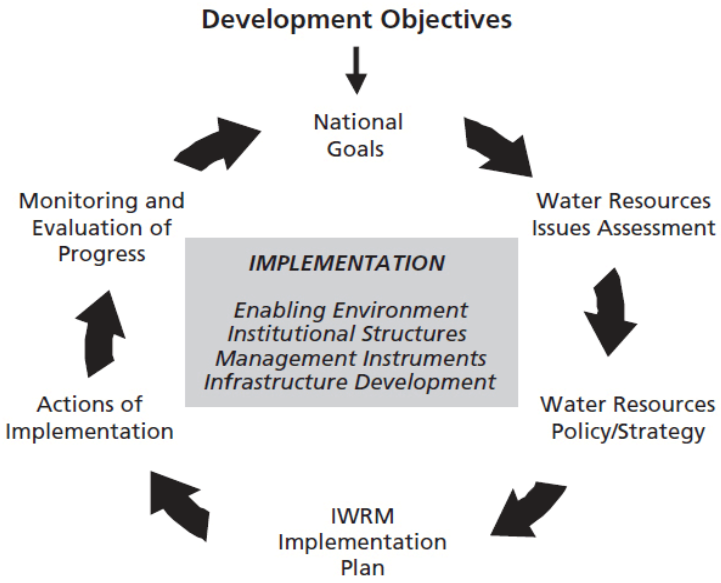

Figure 1: Developmental steps toward global resuscitation

1.1 Global Planning and Implementations in Water Development Stages

There are great differences in water availability from region to region - from the extremes of deserts to tropical forests. In addition there is variability of supply through time as a result both of seasonal variation and inter-annual variation. All too often the magnitude of variability and the timing and duration of periods of high and low supply are not predictable; this equates to unreliability of the resource which poses great challenges to water managers in particular and to societies as a whole. Most developed countries have, in large measure, artificially overcome natural variability by supply-side infrastructure to assure reliable supply and reduce risks, albeit at high cost and often with negative impacts on the environment and sometimes on human health and livelihoods. Many less developed countries, and some developed countries, are now finding that supply-side solutions alone are not adequate to address the ever increasing demands from demographic, economic and climatic pressures; waste-water treatment, water recycling and demand management measures are being introduced to counter the challenges of inadequate supply.

In addition to problems of water quantity there are also problems of water quality. Pollution of water sources is posing major problems for water users as well as for maintaining natural ecosystems. In many regions the availability of water in both quantity and quality is being severely affected by climate variability and climate change, with more or less precipitation in different regions and more extreme weather events. In many regions, too, demand is increasing as a result of population growth and other demographic changes (in particular urbanization) and agricultural and industrial expansion following changes in consumption and production patterns. As a result some regions are now in a perpetual state of demand outstripping supply and in many more regions that is the case at critical times of the year or in years of low water availability.

2.0 NIGERIA AND HER WATER DEVELOPMENT

Water development in Nigeria has improved over the years, although there are various challenges that may have bedeviled what is currently obtainable in terms of production processes, quantity and qualities etc.

2.1 Current Status of Quality Water in Nigeria

In Nigeria today still, good water of reasonable quality are mostly found in the urban region and capital city like Abuja. Whereas the rural populace which takes nearly 70 – 80% are mostly dwelling of stream water (a water source that are in a far distance which sometimes in several kilometers), local-ridge water that only function during wet season, pipe-born water that are present in few locations and may not be functional etc.

2.2 Problems Associated with Water Facilities

As if there is still a doubting hope to the end of water issue in a developing economy like Nigeria. The reason for these is not farfetched, because the few quality water sources available in the country may not have world-class sustainable facilities that can withstand the test of time. There are various factors that resulted to these problems. These ranges from use of unqualified personnel during facility installations, use of sub-standard equipments and chemicals for treatment, no organized records of process operations, lack of proper maintenance of water facilities etc.

2.3.1 Use of Unqualified Personnel

The use of unqualified staff either from the conceptual design, facility installation and/or operation of the plant is a very serious crisis that bedeviled the quality of water that we have in Nigeria. The use of half-trained personnel does not only affect the quality of water that would have health effect to human life, but also to the nations' economy.

2.3.2 Use of Sub-standard Equipments and Chemicals

The use of substandard equipment is another serious crisis that needs a holistic remedy. Where good practice of highly-trained engineering and technical personnel were used, the ethic of the profession demands that standard recommended equipment must be used. In addition, the treatment units deserve the use of quality chemicals with right dosage to achieve the desired qualitative water for human consumption and other domestic uses. For water used in industrial operations like dam, the required treatment must be meeting too.

2.3.3 Proper Record of Plant Operations

In any process operations were not good record is maintained, in the event of troubleshooting, tracing the history of the operations will be a difficult task. This is not a good practice in engineering and technical training.

2.3.4 Lack of Adequate Maintenance of the Existing Water Facilities

The most serious factor that affects various facet of our life today in Nigeria is like of maintenance as we all known. If we believe that a problem identified is a problem half-way solved. Then, we may focast that there could be a light after the tunnel.

2.3.5 Possible Solution to Water Problems

The challenges of water resources in Nigeria are enormous, because of many factors like; apart from lack of proper maintenance of water processing facilities, upgrading, expansion of existing water plants and construction of new ones are better ways to resolve these. Secondly, apart from the nation's abundance fossil fuel, diversifying the economy through construction of new hydropower generation and expanding the existing facilities can never be over-emphasised. In these efforts, the incessant and serious flooding which has claimed many life and billion naira worth of properties across the country and the global world can be minimised.

3.0 WATER SUSTAINABILITY AND GLOBAL SOLUTION

3.1 Water Constraints and Future Sustainability to Water Development

The research studies have shown that the majority of population growth will occur in emerging and developing economies already experiencing water and energy challenges. The unprecedented rates of urbanisation in the emerging and developing economies of Africa, Asia, and Latin America are occurring in regions where water security (including water supply and sewerage) and energy security challenges are already evident at the national level. The prospects of human-induced climate change as a driver for change in the availability, allocation, production, and consumption of water and energy also carry significant implications for managing water and energy security challenges. For instance, the replenishment of freshwater sources - rivers, aquifers, and glaciers - is influenced by global climate and regulated by the hydrological cycle. Climate change will likely exacerbate water stress in many countries, cities, and communities, creating greater competition between different uses, as well as individual users of water. Climate-change mitigation policies have unleashed the search for more and cleaner and low-carbon energy supplies, e.g., first-generation biofuel energy technologies, which in turn creates tension and competition between water used in agriculture for food and fuel production (2 billion hungry versus 600 million motorists). Climate change adaptation and/or mitigation policies require 'water for energy' and 'energy for water' challenges to be considered in parallel.
The generalised energy (or electricity) profile for the developed nations and the developing nations is depicted in Figure 2. In this figure the k/Wh per capita per year for the developed nation show drastic decrease and then a progress decrease along the line, while that of the developing nation give a slow but steady increase with respect to time.

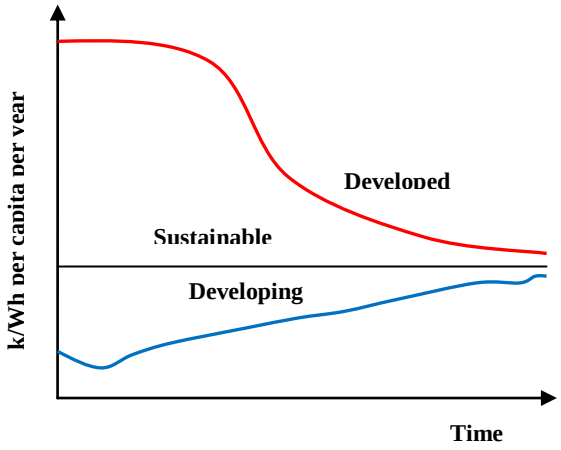

Figure 2: Generalized annual electricity (k/Wh) per capita per year

3.2 Human Health and National Economic Drive through Water

Water remains the most essential aspect of human life. In fact, the quality of human living rested on the quality and availability of water. Where cases of poor or non-hygienic water usually have serious health effect, this factor alone can be used to measure the health standard of a nation.

3.3 Possible Solutions to Global Water Problems

A good policy and proper implementation remains the best approach to address the water problems globally. Although, the effort of IWRM and other world organisations can never be overemphasized. The progress of the IWRM so far may be used through the United Nation, UN water policies and implementations in order to find the lasting solution to water problem across the globe.

4.0 WATER FOR ENERGY AND GLOBAL CHALLENGES

Water for energy challenge: Global population growth and economic development are enabled through human ingenuity in harnessing water for power and energy. The process may take place from the water mill to grind wheat, to hydroelectric power that utilises run-of-river, dams, or glacial melt-water in harnessing water for energy. The process involves could be: extraction & refining hydropower, fuel production (ethanol, hydrogen), thermo electric, cooling, wastewater treatment extraction & transmission, energy associated with uses of water.

Energy for water challenge: The ability of early civilizations, and more recently the technology advancement have allowed nations, to move water to people has rested on the availability of energy for water. In early agrarian societies, manual labour and oxen provided the means to construct irrigation channels to pump water and divert rivers. In recent decades, modern energy supplies have been harnessed to pump water from increasing deeper groundwater reserves and to divert whole rivers across larger distances. With continuous global population growth and increasing global economic development set and a significant proportion of the current human population lacking access to clean water supply and

sewerage services, the energy for water challenge has become a significant factor and of global-scale concern.

The effort to underpinning both challenges is previously described as *'water scarcity'* issue, and the recent challenge of *'water stress'*. There is every need to find appropriate solutions to deal with these challenges will be one of the biggest issues in the forthcoming years.

4.1 Energy Derivatives through Water

Water is needed throughout the energy sector. The water requirements for producing the different primary energy carriers vary. Equally, there are significant differences between the different types of electricity generation. However, freshwater is required for each step - energy extraction and production, refining and processing, transportation and storage, and electric-power generation itself. The changed outlook for water availability affects all forms of energy production and electricity generation and can lead to price volatility in wholesale electricity markets. On-going drought conditions and lower water inflows in some parts of the world have the potential to reduce water reliability and availability to electricity generators. In the longer term, continued growth in electricity demand will require additional investment in power stations that need water for electricity generation.

There is also the need of water for other energy processes, such as the refining of energy products and the production of alternative fuels. A large portion of present-day water use is obtained specifically from water recycling, and in general from increasing the effectiveness of traditional water uses, such as in agriculture. In some parts of the world, some of this water is obtained from seawater desalination. This water demand will continue to grow as both developed nations as well as emerging economies demand more energy products.

4.2 Fuel production – Water Applications

Water consumption for making primary energy carriers vary from fuel to fuel, whether fossil energy or renewable energy. The water footprint - the amount of water consumed to produce a unit of energy (m^3/GJ) - of diverse energy carriers has been assessed many times in the past. With improvements in technology, the footprint is being reassessed continuously. However, a very large fraction of the energy supply in developing countries comes from biomass and solar in ways difficult to measure and assess. The methods employed to record and compare energy and water uses is most often referred to developed regions, where certain measurements and statistics are a common and accepted practice. That is not so in developing countries, rural areas, heavily dependent on solar for drying and even cooking, and on lumber or firewood collection for making fire.

4.2.1 The Crude oil

Crude oil is at present the fossil fuel with the highest energy production rate, and it will stay that way for the next 20 years, after which the production of coal may exceed the production of oil as reported by (WEC Scenarios, 2007, model updated in 2009).

4.2.2 Natural gas

While oil production over the next 40 years will rise rather slowly, every record has shown that natural-gas production worldwide will almost double, with the biggest increases in Asia, mainly in the Middle East, where it will almost triple, and North America, where it will double (WEC Scenarios, 2007, model updated in 2009).

4.2.3 Coal

Energy from coal production is currently below crude oil but may likely become higher over the next 30-40 years (WEC Scenarios, 2007, model updated in 2009). Mining and refining coal (refining includes washing and beneficiation) which requires water at various stages of processing. (see Table 1). Estimates show that approximately 0.164 m^3 of water is needed per GJ (Annex 1). Overall, the production of coal accounts for less than 1% of total water consumption in energy production (Annex 2).

Table 1: Projected water consumption related to worldwide coal production 2005–2050

Primary production (EJ)	**2005**	**2020**	**2035**	**2050**
Total World	460.4	561.5	667.6	769.6
Coal	121.1	144.0	170.3	217.2
Water Consumption (Billion. M^3)	**2005**	**2020**	**2035**	**2050**
Total World	1,774.5	1,930.0	2,011.9	1,919.9
Coal	19.9	23.6	27.9	35.6

Source: Based on WEC Scenarios, 2007 (model updated in 2009); UNESCO-IHE, 2008.

4.2.4 Uranium

Uranium production presently accounts for approximately 6% of worldwide primary energy production and will rise to 9% over the next 40 years, with the main producers being in Asia, Europe and North America. Africa and South America account for only 1% of the global uranium production.

4.2.5 Biomass

Biomass plays a very significant role in meeting energy demand in many regions in the world. It is considered as the fuel for the poor, it plays a crucial role especially in the energy mix of developing countries. Although easy available and affordable, especially for cooking and space heating, biomass used in small-scale appliances is rather inefficient and highly polluting. A correlation between poverty level and traditional biomass use can easily be found, but actual statistics on the use of biomass and its composition (wood fuel, agro fuel and municipal by-products, waste, etc.) are poor and hardly complete (see Table 2). A general rule of thumb has been that an additional 10% can be added to global energy consumption for traditional biomass.

Table 2: Correlations between poverty level and traditional biomass use

	Countries	**Biomass production (GJ. 2005)**	**GDP/capita (PPP, USD, 2005)**
1.	Brazil	0.8	8,500
2.	Canada	0.1	35,000
3.	China	9.4	4,000
4.	India	8.1	2,000
5.	Mexico	0.1	12,000
6.	North Africa	0.1	6,000
7.	Sub Sahara Africa	8.9	4,000
8.	Russia	0.4	13,000
9.	United States, USA	0.5	43,000

Source: WEC Scenarios, 2007, model updated in 2009; IMF 2007

4.3 Water for Energy in Africa

Presently, nearly 15% of world's population lives in Africa, consuming not even 6% of the total freshwater annually (refer to Table 3). In comparison with other regions of the world, African countries on average consume less water per capita. As the development in these countries progresses, e.g., such as in the case of Egypt, Libya, South Africa, and Tunisia, the per capita amount of water withdrawn annually increases. The lower income countries of Sub-Saharan Africa have a total amount of annual water withdrawal of less than 50 m^3 per capita; with sometimes even less than 2 m^3 of water per capita for domestic uses. The more developed countries of North Africa withdraw between 200 - 1,000 m^3 of water per capita annually, with almost 60 m^3 of water per capita for domestic uses, just slightly below the world average. Looking into the future and assuming Africa's population will continue to increase on an average of 2% per year, 22% of the world's population will live in Africa by 2050, withdrawing more water, using more energy, and requiring more water to produce the

Table 3: Water withdrawal of various African regions

Country (year)	Population (Million)	Total water withdrawal (billion m3/year)	Water withdrawal (m3/person)	Domestic (in %)	Industrial (in %)	Agriculture (in %)
North Africa* (2000)	149.0	93.9	630.5	10.4	3.0	86.6
Sub-Sahara Africa * (2000)	711.0	120.9	170.1	9.4	5.8	84.5
Africa	860.1	214.8	249.8	10.0	4.2	85.8
World	6290.0	3836.3	609.9	10.2	20.0	69.9

Source: Aquastat, 2010

*Northern Africa: Egypt, Libya, Algeria, Tunisia, and Morocco

necessary amount of energy. Besides, programmes to give more people access to electricity (e.g., the South African National Electrification Programme or Egypt's establishment of a rural electrification authority to implement sub-transmission and distribution networks for rural areas and remote communities) will further accelerate changes in the amount of electricity generated and consumed in Africa. Whereas African primary production is likely to increase by approximately 50%, electricity generation will be 7 times as high as nowadays. To identify the water needs of the energy sector in Africa over the next few decades, the earlier identified water requirements for fuel production and electricity generation are adapted to the projections made in WEC Scenarios Report, 2007 and updated in 2009 (see Table 4).

Table 4: Water requirements for several energy processes in Africa

Primary production (EJ)	2005	2020	2035	2050
Total World	460.4	561.5	667.6	769.6
Total Africa	41.1	57.6	63.3	62.4

Percentage of Total	9%	10%	9%	8%
Electricity generation (TWh)	**2005**	**2020**	**2035**	**2050**
Total World	18,069	27,126	39,071	53,436
Total Africa	546	1,194	2,362	4,146
Percentage of Total	3%	4%	6%	8%
Water for Energy (Billion m^3)	**2005**	**2020**	**2035**	**2050**
Total World	1,615.6	1,986.4	2,087.6	2,020.1
Total Africa	663.2	771.9	826	746.9
Percentage of Total	37%	43%	46%	43%
Primary Production	662.1	769.8	886.1	759.2
Electricity Generation	1.1	2.1	3.5	5.6

Source: Based on WEC Scenarios, 2007 (model updated in 2009); DOE-NETL, 2008; UNESCO-IHE, 2008; Gleick, 1994.

Although Africa's low share in the world's total primary energy production (9% in 2005, estimated at 8% in 2050), the water used to produce and generate energy accounts for more than one-third of water consumed in the energy sector worldwide. This is mainly due to a relatively high share, about 25%, of traditional biomass in Africa's energy mix. Whereas existing legislation and policies to ensure adequate water for energy seem to be in place in South Africa and other more developed African countries, the biggest challenge lies in the implementation, execution, and enforcement of the various pieces of legislation and policies. In South Africa for example, current concerns on water.

4.4 Water Resources as a Revenue Generation to the Economy

This paper is to clearly show the distinct importance of water, and economically as uncompromised revenue to any nation. Studies have shown that some advanced nations generate enormous resources through domestic, industrial and agricultural uses. Table 5 depicts the summary of these incomes generated through water uses.

Table 5: Water uses for main group of countries

Applications and Uses	**Domestic %**	**Industrial %**	**Agriculture %**
World	8	22	70
High Income Countries	11	59	30
Low and Middle Income Countries	8	10	82

Source: Water for people, water for life, UNESCO 2003.

5.0 CONCLUSIONS

Corporate policies and qualitative implementation coupling with technology advancement is highly needed to secure the sustainability of water processing and supply. Globally, water availability, sustainability and health quality has more effect to developing nation and less

effect to less developed nations. In addition to problems of water quantity there are also problems of water quality. Pollution of water sources is posing major problems for water users as well as for maintaining natural ecosystems. In many regions the availability of water in both quantity and quality is being severely affected by climate variability and climate change, with more or less precipitation in different regions and more extreme weather events.

In years ahead, Africa's population will continue to increase on an average of 2% above per year, 22% of the world's population will live in Africa by 2050, withdrawing more water, using more energy, and requiring more water to produce the necessary amount of energy. Unfortunately, the challenges of water resources in Nigeria are enormous, because of many factors like; lack of proper maintenance of water processing facilities, non-upgrading and/or expansion of existing water plants and construction of new ones. Secondly, apart from the nation's abundance fossil fuel, diversifying the economy through construction of new hydropower generation and expanding the existing facilities can never be over-emphasised. In these efforts, the incessant and serious flooding which has claimed many life and billion naira worth of properties across the country and the global world can be minimised.

In conclusion, the governments and policy makers should develop a sustainable regional water management strategies based on a better understanding of the factors influencing cost and availability. In addition, universal water metering is a desirable goal using appropriate pricing mechanisms and public education to encourage more sustainable use of water. Secondly, improving hydropower facilities through upgrading facilities, dredging and expansion would not only resolve the flooding crises, but also increase nation power generation and accrued revenues to the nation.

Symbol and Abbreviation

AGM:	Annual General Meeting
DOE:	Department of Energy
GDP:	Gross Domestic Products
GWC:	Global Water Challenges
GWP:	Global Water Programme
IWRM:	Integrated Water Resources Management
MDG:	Millennium Development Goal
NETL:	National Energy Technology Laboratory
WBCSD:	World Business Council for Sustainable Development
UN:	United Nation
UNESCO:	United Nation Education Scientific and Cultural Organisation

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