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WATER RESOURCES: MANAGEMENT AND STRATEGIES IN NIGERIA

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Abstract

Nigeria has a population of about 160 million people and an area of land covering 200,000 square kilometres. Amongst the numerous natural resources in Nigeria; water resources is most plenteous and is developing at a fast pace. Because of the lack of sound early development policy and meaningful investments, the rational use of

water resources poses a great problem and challenge to the nation. These have been seriously tackled by the River Basin Development Authorities which were set up to manage the resources. Total expenditure on various water projects by the federal ministry of water resources has run into billions of Naira since the establishment of the 11 river basic development. The state government ministries of water resources have also impacted on the management of water resources nationwide and in many cases with a financial and technical support from the federal ministry of water resources and donor agencies like the UNESCC, UNICEF, and others. Most recently, the private sector has come into water resources development especially the development and management of potable water through the private, public sector partnership PPP. This paper therefore examines the sources of surface and ground water resources in Nigeria; the goal and present organisation of water management in Nigeria Groundwater protection and vulnerability, water management under drought and flood conditions. Suggestions were made on ways of planning sustainable water supply systems for Nigeria

Key words: Water Resources, Management, Strategies, Climate Change

Introduction

Nigeria is endowed with abundant natural water resources evident in her substantial yearly rainfall, large surface bodies of water-rivers, streams and lakes, as well as in abundant reservoirs of underground water whose extent and distribution have not been fully assessed. Figures of stream discharges of the flowing surface waters are now available and rainfall, which is perhaps the most important of the country's natural water resources, has long records which in some places date from as far back as 1906, (Orjiakor, 1985). The annual mean rainfall distribution ranges from about 4000 mm at the coast to practically zero at the northern border and an average annual mean of

1200 mm for the retire country. Over eighty percent of the rains in the country fall within the six wet months, April to September, of each year. A sizeable amount of the rainwater is lost by percolation to underground flows. The bulk of the rain, however, flows as runoff into rivers, streams and lakes. From these surface water bodies and through vegetation some of the rainwater is lost to the atmosphere by evapotranspiration.

Surface and ground water resources of Nigeria

Surface sources include the River Niger, the third largest river in Africa. The country spans the greater section of the river, with the River Benue dividing the country into three geographical regions (Figure 1). In addition to these two rivers, Cross River, Imo, Sokoto, Ogun, Anambra, Kaduna rivers, together with several streams, channels, lakes and ponds, that provide a national web of drainage basins.

Major ground water reserves exist in numerous localities all over the country. These have been estimated as 30 times the quantity of surface flows (Orjiakor, 1985). The quantity stored varies according to geology and climate, from one locality to another. Geologically, Nigeria lies on two main rock formations — the basement complex (which is mainly precambrian and postcambrian rocks and lignite of the Jos area) and Sedimentary strata which are postcambrian deposits (Offodile, 2000). Both of these rock formations are widely distributed all over the country. The sedimentary strata have both surface water and ground water of immense economic interest.

There are many quantitative records to enable studies of the extent of underground water reserves and availability, including the performance of aquifers under pumping conditions in all the states. In the Chad basin, in the Northern part of the country, the regular seasonal rainfall replenishment ensures that on an area scale average there is no depletion of the aquifer resources. But in the more arid

northern parts of the country where the seasonal rainfall and therefore the annual replenishment to ground water is more variable, the availability of ground water follows the irregular pattern like droughts.

Fig 1: Map showing distribution of rivers in Nigeria



Ground water in Nigeria has the advantages of being generally free from biological contamination, free of sediments, of constant quality and temperature. It is thus normally satisfactory for domestic, agricultural and most industrial uses

Present organization of water management authority

There are Federal and State Governments' agencies independently undertaking various activities in water resources development and utilization (Orjiakor, 2000). Recently the private sector initiative has increased in financing and technical involvement. The Federal agencies principally involved are: Federal Ministry of Water Resources (FMWR), River Basin Development Authorities (RBDAs)

Federal Ministry of Transport, Federal Ministry of Aviation (FMA), National Electric Power Authority (NEPA), Mining Organizations including Oil Companies. Each state government of the 36 states in the Federal has created its own agencies that compete in water resources development. These agencies include State Ministries of Works and Housing and of Agriculture, State water Boards, and Rural Electrification Boards.

Most water resources development activities undertaken by the Federal Government besides power productions are carried out through the eleven (11) RBDAs under the direct surveillance of the Federal Ministry of Water Resources which coordinates their activities. But the Ministry often directly undertakes the resource development such as erosion control, development of underground water and other hydrological activities. For effective control, the Ministry is organized in five main sections or sub-departments-planning: Water Resources and Irrigation, Hydrology and Hydrogeology, dams, water supply and sanitation.

The present Water Management Systems are:

(a) Irrigation

Irrigated agriculture needs rapid expansion as it ensures double cropping for a year for several of the staple food crops whose importation contributes most in depleting the country's foreign reserves. The concentrations of these are in the North where billions of Naira has been sunk on dams. Presently, small earth dams have been discovered as being more adaptable to the farmers and presently the governments are constructing many of these dams. Expected investments in this area would boost Agriculture.

(b) Water supply

The demand for potable water is growing sharply as a result of population increase, industrialization and high standard of living. Also, by placing water supply among top priorities in water resources development, the country hopes to demonstrate its great efforts to meet the aims of the millennium development goals MDGs - the supply of safe and adequate water and sanitation for all, projected for the year 2015 which, may be tenable in few southern states.

(c) hydro-electric power generation

Nigeria has many rivers that carry large volumes of water throughout the year which are basically favourable for the generation of power. If self reliance in energy is to be achieved by the country in the future, hydroelectric power generation is to be explored and exploited further in water resources development planning. Presently the Kanji Dam power station is a major hydroelectric power generating station in Nigeria. It is expected that these big dams would aid the generation of electricity to the success of the transformation agenda of the Government.

(d) Flood control

Owing to heavy rains, all the rivers in Nigeria swell above their normal flow levels. After spilling over their banks during the rainy

season, they flood the surrounding fields; damages are caused to cultivated lands, buildings and life. Floods has become uncontrollable and taking its toll. This is attributed to the climatic changes that are taking its tolls all over the world now. Hundreds of people die and properties destroyed in thousands by heavy flood.

(e) Drainage

The lowland and swamp coastal areas of the country need drainage and protection from salt water intrusion. Inlands, especially in southern parts of the country where the pressure of population on land is most acute, many patches of arable fields become water-logged and remain so for a long period during rainy season. The problem of urban and rural drainage is getting serious because of anthropogenic factors and drawing more attention.

(f) Navigation

With the growth of industrialization in the country, the cost of provision of inland navigable waterway as a cheaper means of transportation of goods, have become economically justifiable. In the present state of the nation, navigation development, have started with river regulation and river dredging. River dredging is going on variously but has not gone on as expected. Mismanagement though seems to be affecting the well thought out venture of dredging of navigable rivers in Nigeria. The River Niger of Onitsha has recently been delivered of a new port that would enhance transportation between the North and South of Nigeria.

(g) Erosion control

Some drainage basins in the country such as Anambra and Imo, lower Benue are facing serious erosion of surface. The erosion has double adverse effects of causing wastage of large residential and potential agriculture areas as well as providing sediment that are transport by surface runoff and eventually deposited in local streams and lakes that

are fast losing their morphology and depths due to sedimentation. They are also a serious aspect of pollution to these streams, lakes and rivers. Gullies are also responsible for loss of lives and properties worth million of Naira. Billions of Naira has been budgeted for engineering and biological control are going on.

Management of river basins

The goal of the water resources management is to increase the reliability of water-related services, and ameliorate the hydrologic extremes (such as, floods and drought). It should be a self-adapting endeavor whereby the management system responds and adjusts to various challenges, such as climate variability, water availability, shifts in water uses and demands, demographic changes along with technological innovations and institutional requirements (Stakhiv, 1998). Additionally, water resources management is being increasingly called upon to address water-related environmental issues, such as, aquatic ecosystems, wet lands, endangered species and waterborne diseases.

Water resources Management is as much concerned with the efficient operation of the physical structures (such as reservoirs), Irrigation canals and (distribution systems) as with Institutional structures (such as, regulatory measures, behavioral changes, water conservation). By the application of such management techniques, it is possible to bring down the total freshwater withdrawals in Nigeria.

Unfortunately, the developing countries like Nigeria are ill equipped to undertake adaptive management systems, for the simple reason that they generally do not have either the physical structures or institutional frameworks needed for the purpose.

A consensus is emerging in favour of the view that adverse environmental changes that are evident all around us are driven more by human activities (such as, damming of the rivers, water diversions aid water withdrawals, land-use changes through engineering

constructions, deforestation and agriculture) in Nigeria rather than by climate change. Global climate may, however, be the primary cause for system function and service changes in areas such as coastal zones where sea level rise could salinize the coastal freshwater resources through salt water intrusion in Lagos, Delta areas, Port Harcourt and Calabar amongst others.

Groundwater protection in Nigeria

The importance of groundwater in the water resources management arises from the following considerations. It is imagined that the quantity of fresh groundwater within drillable depth is about 70 times greater than all the surface waters (rivers, lakes, reservoirs) in the world put together. The quality of groundwater is generally superior of surface water, unlike surface water, groundwater hardly suffers any evaporation losses, and groundwater is the main source of potable water for domestic purposes in many parts of the world.

Vulnerability of ground water

The French hydrogeologist, Margat, pioneered the concept of groundwater vulnerability, and ways and means of addressing it through vulnerability maps (Albinet et al, 1970).

Groundwater originates principally through the infiltration of the precipitation falling on the land surface. Thus, many activities, domestic, agricultural, industrial taking place on land have the potential to adversely affect the quality and availability of groundwater. Once pollution has occurred, the water has to be treated at the point of abstraction. Trade off between economic development and aquifer protection is a fact to be accepted. Groundwater protection strategies have to be designed by meshing hydro geological understanding with the requirement of land-use policies, so as to lead to land-surface zoning (Foster & Skinner, 1995).

The vulnerability to pollution of an aquifer is a measure of its sensitivity to being adversely affected by surface-applied contaminate.

It depends upon the extent to which the strata separating the saturated aquifer from the land surface allow the penetration of the pollutants, and attenuate the pollutants, as consequence of the adsorption on solid aquifer material or other chemical reactions.

Source protection is an essential part of groundwater protection. The objective of demarcating source protection areas or zones is to protect the groundwater from two kinds of pollutants:

Contaminants which decay with time - the longer they reside in the subsurface, the greater will be their attenuation and the less will be their ability to contaminate the groundwater;

Non-contaminants, whose adverse impact on the groundwater can be mitigated through flow path dilution (Aswarthaya, 2001)

Water management under drought conditions

Statistical analysis of climate data in Nigeria suggests that the frequencies of extreme weather events which are already rampant in Nigeria are likely to increase as a consequence of global warming and climate changes. Water managers are expected to come up with strategies to cope with both drought and floods that has been features of both the North and South of Nigeria.

There is a well-established link between precipitation and ecosystems, to wit: (Aswathanarayana, 2001)

Ecosystem	Precipitation (rpm yr ¹)
Desert	< 100
Arid lands	< 250
Semiarid lands (range lands)	> 250

Semi-arid tropical lands are characterized by long dry seasons, low and unpredictable rainfall and poor soils.

Drought has adverse impacts on the environment, water quality and water availability, water supply system, hydropower generation, navigation, vegetation cover, dilution capacity of the rivers, groundwater balances, deposition of sediments in lakes and reservoirs in Nigeria and all over the world.

Falénmakr et al. (1990) emphasize that droughts and famines should not be regarded as disaster but processes; Drought occurs when the available moisture in the root zone falls below 30% of the water-holding capacity of the soil. There are four different kinds of water scarcity (Falkenmark et al. 1990).

Natural: Aridity, reflected in the short length of the growing season, and intermittent droughts, reflected in recurrent drought years with risk of crop failure;

Man-made: Landscape desiccation caused by soil degradation, resulting in water not reaching the plant roots, and water stress, whereby the demand for water by the growing population exceeds the regenerative capacity of the system.

Water management under flood conditions

Extreme conditions of flood in Nigeria have been noted recently and flood has caused serious havoc to life and property worth millions: especially in the Northern region and coastal plains of rivers and oceans.

The flood hazard itself cannot be prevented, but through an understanding of the land conditions which are prone to hazard and the processes which could culminate in the damage to life and property, it is possible to minimize the damage through preparedness for a particular eventuality.

Flooding takes place when the river channels are unable to contain the discharge. In Nigeria, floods are caused by various factors:

- Climatologically; rains
- Coastal storm surges, estuarine interactions
- Failure of dam and other control works; excessive release from drains and control works recently in Adamawa State.
- Blockage of Drainage and River Channels; Ogunpa in Ibadan and Onitsha are examples.

Floods could get intensified because of basin, network, and channel characteristics, each of which has both stable and variable components.

Improper land-use practices accentuate flood devastation. There are, hardly any forests left in the catchments areas of the rivers. It is well known that the forest areas are characterized by high infiltration capacity and transmissibility. The infiltration capacity of the forest areas is 2-3 times greater than in the open fields; the surface runoff in the forested areas may be as little as one-tenth of that of the open fields. There is hardly any protective vegetation on the banks of the River Niger and Benue. Crops are grown right to the edges of the rivers, even on river slopes. Thus, the combination of absence of forest cover, inappropriate farming practices and allocation of land for residential building (Akpaka forest Reserve at Onitsha) on flood plains intensifies the floods. Urban forestry is being projected in the built environment to serve as an antidote to the numerous flood disasters.

Floods can be mitigated by structural, water control and non-structural measures. The structural methods include dams, reservoirs, and retarding basins, channel management and embankments and other shore line protection works.

Flood management

From times immemorial, flood plains have been the preferred locations for human settlements and agricultural development in Nigeria. Unfortunately the very same rivers periodically overflow their banks, and cause considerable loss of life and property. Most of the flood management methodologies address the economic issues, whereas both economic and social criteria should be included in the decision-making process.

There are three stages in the flood management process adopted:

Planning: techno-socio-economic evaluation of various alternative issues to minimize flood damages.

Flood emergency management: appraisal of the current flood situation and daily analysis of how the flood control units are working, potential events that could affect the current flood situation and urgent capital works that may be needed to abate flooding, etc.

Post flood recovery: evaluation of flood damage, rehabilitation of damaged properties, and assistance to flood victims to return to normal life.

Recent climate change impact, water resources and agriculture

Among the potential impacts of climate change is its effect on the hydrological cycle and water management systems. For instance, an increase in floods and droughts will increase the frequency and severity of disasters. Relatively small changes can cause severe water resource problems, especially in semi-arid regions and humid areas where demand or pollution has led to water scarcity. The statement adopted by the Second World Climate Conference, held in Geneva in 1990, concluded that the design of many costly structures to store and convey water, from large dams to small drainage facilities, is based on analyses of past records of climatic and hydrological parameters.

Some of these structures are designed to last from 50 to 100 years or even longer. Records of past climate and hydrological conditions may no longer be a reliable guide for the future.

The possible effects of climate change should be considered in the design and management of water resource systems for the future in Nigeria. Agricultural impacts could be significant but researchers are uncertain whether global agricultural potential will increase or decrease. Increases in drought risk are potentially the most serious effect of climate change on agriculture. Disease and pest patterns, raised sea levels and storm surges are additional problems. It also appears that many areas will have increased precipitation, soil moisture and water storage, thus altering patterns of agricultural ecosystems and other water uses. The effect of climate change in Nigeria is causing serious anxiety since.

Water generally provides four types of important economic benefits: commodity benefits; waste assimilation benefits; aesthetic and recreational benefits; and fish and wildlife habitats. Individuals derive commodity benefits from water by using it for drinking, cooking and sanitation. Farms, businesses and industries obtain commodity benefits by using water in productive activities. Government policies and regulations that concentrate on improving market access and competition are important means for improving the productive and allocative efficiency of the commodity uses of water. The current Fadama World bank sponsored projects are typical examples.

The second and increasingly important economic benefit of water is waste disposal. Water bodies have a significant, but ultimately limited, assimilative capacity, meaning that they can process, dilute and carry away wastes.

Recreation and aesthetic benefits and fish and wildlife habitats were once regarded as luxury goods outside the concern of governments. Today, these two types of benefit are gaining increased attention. In

developed countries, more and more people are focusing their recreational activities around lakes, rivers and seas. In developing nations, as incomes and leisure time grows, water-based recreation is becoming increasingly popular and an adequate supply of good-quality water helps provide a basis for attracting the tourist trade. Information and knowledge about how humans have an impact on ecosystems have raised concern about the fish and wildlife benefits provided by water.

Waste assimilation and recreational and aesthetic values are closer to being public goods than private goods.

Planning of sustainable water supply systems for Nigeria

Sustainable development has been defined as that kind of development that meets the needs of the present without compromising the ability of the future generations to meet their own needs. Sustainable development of water resources encompasses those patterns of water resources utilization that will enhance social and economic benefits for the present and the future generation, without impairing the hydrological processes.

It is now widely realized that mitigation methodologies developed on the basis of biophysical studies alone have very little chance of success, unless they have been drawn up in consultation with the stakeholders' right from the beginning.

The high rate of population growth with associated changes in land use, extreme variability of precipitation, both in time and space, and high potential evapotranspiration in dry lands — these issues can only be addressed by an imaginative integration of biophysical approaches with socioeconomic approaches as Vogel (1999) puts it elegantly.

The poor people in Nigeria have to cope not only with socio economic realities (such as HIV/AIDS, armed conflict and armed robbery, population dislocation and problems of economic reform), but also

environmental degradation and extreme weather events (such as floods in North and South, and drought in the North).

Research is needed to find out how these socio-economic factors are contributing to the global change, and how the global change is feeding back to the system and affecting the communities. There is little doubt that these improper land-use practices exacerbated the devastating floods. Thus, with each disaster, the people become less able to cope with extreme weather events. This vicious cycle would only stop when mitigation measures are taken and preparedness systems are put in place for Nigeria.

Private sector participation

Recently the private sector participation in water resources development is gaining ground and there are numerous proposals for this new initiative in many state of Nigeria. In Lagos state, the PPP programme which, forms part of the Lagos Water Supply Master Plan, is designed to eliminate the demand gap in the state by 2020. With unaccounted-for water levels up to 60%, and the population of Lagos expected to increase from around 20 million today to around 29 million by 2020, the need to tackle the water resourcing challenge from both a supply and demand management standpoint has never been more urgent.

The presidential water summit that was held in February 2013 indicated that, the policy thrust in Nigeria is now towards private sector involvement in the water sector,” For example, Lagos Water Corporation (LWC) has appointed transaction advisors to spearhead the implementation of its ambitious water supply PPP programme, which envisions \$1.9 billion of Greenfield BOT projects, as well as a series of Operation and Maintenance Contracts.

The International Finance Corporation (IFC) will establish a roadmap for the execution of operation and maintenance contracts for the state’s 955,000m³/d of existing water treatment capacity.

There have been attempts at water sector PPPs in Nigeria in the past, particularly in Cross River State, but Lagos State is currently the most advanced in terms of rolling out large-scale infrastructure projects. The establishment of the Lagos state water regulatory commission at the end of last year was a major step forward.

The BOT concessions are envisaged as having operating periods in the 20- to 25-year range, and the project company in each case is likely to have a mixed equity structure involving private sector partners and the Lagos Water Corporation.

The proposal is that the operator is responsible for the operation and maintenance costs, and at the end of each month or quarter, the operator will be reimbursed for costs and paid for services rendered.”

On top of the operating contracts, Lagos Water Corporation also intends to form a series of joint ventures with private sector partners to oversee downstream operations in each of the state’s 11 service areas, such as metering, billing and customer service. It remains unclear whether the downstream operations will be incorporated into the scope of the plant operation and maintenance contracts; although this is expected to become clear once the IFC has completed its preliminary studies.

Lagos has the largest group of middleclass income earners in Nigeria, and while informal water sellers currently charge around 500 times what LWC charges for water, there is evidence that citizens are willing to pay for reliable service delivery.

Conclusion

Water resources management and the environment

The recommendation made by Shiklomanov (1998) to address the situation and, the way the issues raised by him is very important to the Nigerian situation and the economy.

1. Protection of water resources: deal with all aspects of protection of water quality. Ground water is sought to be protected through an understanding of its vulnerability.
2. Drastic decrease in specific water consumption, particularly in irrigation and industry: In the future, the efficiency of irrigation has to be improved greatly (through measures such as drip irrigation and cutting down of conveyance losses) as exemplified by Israel, so that with lesser total withdrawal (about 60%), more food could be grown.
3. Complete cessation of the practice of discharging waste water into the hydrological systems (such as, rivers and lakes): As pointed out by Shiklomanov (1998), every cubic metre of contaminated water discharged into rivers and lakes spoils up to 8-10 m of good water. This is a monstrous situation, and every effort should be made to stop this practice. The River Niger at Onitsha is a typical example in Nigeria; most Nigerian rivers and lakes serve as discharges for waste water and flood presently.
4. Harvesting of precipitation and making a more efficient use of runoff:
5. Use of water stored in lakes and underground aquifers. The conjunctive use of water resources, and the design and management of ground water reservoirs

Anthropogenic activities tend to degrade the freshwater resources, thus complicating the problem even further. Under the circumstances, the transfer of water between one state to another and between different parts of Nigeria is unavoidable, and every effort should be made to minimize the problem.

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