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Need for Sustainable Management of Ground Water Resource in the Niger Delta

Saviour Akuaibit P*

Department of Physical Oceanography, Nigeria

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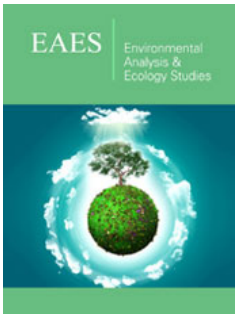

***Corresponding author:** Saviour Akuaibit P, Department of Physical Oceanography, Nigeria

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Abstract

Groundwater is a renewable geologic resource that constitutes 95% by volume of global supply of liquid fresh water. It is considered as the major source of potable water supply in the Niger Delta. Yet inadequate attention is given to the management of this essential resource to human existence in the region. This paper reviews and examines the health need, mostly drinking and domestic uses, and societal production functions of groundwater in the Niger Delta as a basis for sustainable management of the resource. Discussed also are threats to the sustainable use of the resource which include industrial pollution, poor waste management by the people, salt water intrusion due to climate change, saline water entrapment associated with the Benin formation, unregulated drilling of water bore-hole, subterranean oil pipeline leakage due to oil exploration and production activities and high rate of abstraction attributed to high demand for clean and potable water due to high human population density in the area. Strategies suggested for sustainable use and management of groundwater are development of sustainable management policy and objectives, groundwater quantity and quality mapping and assessment in the area, adaptation to climate change and sea-level rise, good waste management practice, environmental education, and attitudinal change. It is believed that adequate priority to the management of groundwater by the appropriate agency, private sectors, and individuals will enhance sustainable and optimum use of the resource in the Niger Delta.

Keywords: Groundwater; Resource; Sustainable use; Management

Introduction

Figure 1: Geographic map of the Niger delta region showing the oil producing states in Nigeria (http://www.nairaland.com).

Groundwater is an important natural resource which varies in quantity and quality from one location to the other both in a local and regional scale. Similarly, the degree of utilization and management also varies significantly based on the quality of groundwater resource and the level of development of the area. Unsustainable management of groundwater resource is most common in the underdeveloped and developing countries where the usage is not

regularised and regulated such as Nigeria and the Niger Delta in particular. It is obvious that drilling and development of water borehole in the Niger Delta require less effort and cost due to low water table of less than 10m which characterised the area. The Niger Delta Sedimentary Basin is bounded to the West by Akitipupa Ridge in Ondo State and the East by the Oban Massif Complex in Cross River State (Figure 1).

The modern Niger Delta is the arcuate delta of the River Niger which spanned an area of about 75,000km^2. The sub-surface geology of the basin is litho-stratigraphically sub-divided into three Formations which are Akata, Agbada and Benin Formations. The Akata Formation is the source rock for oil and gas consisting of uniform shale while the Agbada Formation consists of sand which is the reservoir of oil and gas deposit in the Niger Delta. The Binin formation is the continental and delta top sedimentary deposit (2000m thick) overlays by superficial deposits (Figure 2). It consists of massive and highly porous continental/fluvial sand and gravel with clay/shale intercalations which form a multi-aquifer system that supplies quality water to boreholes in the area [1-4].

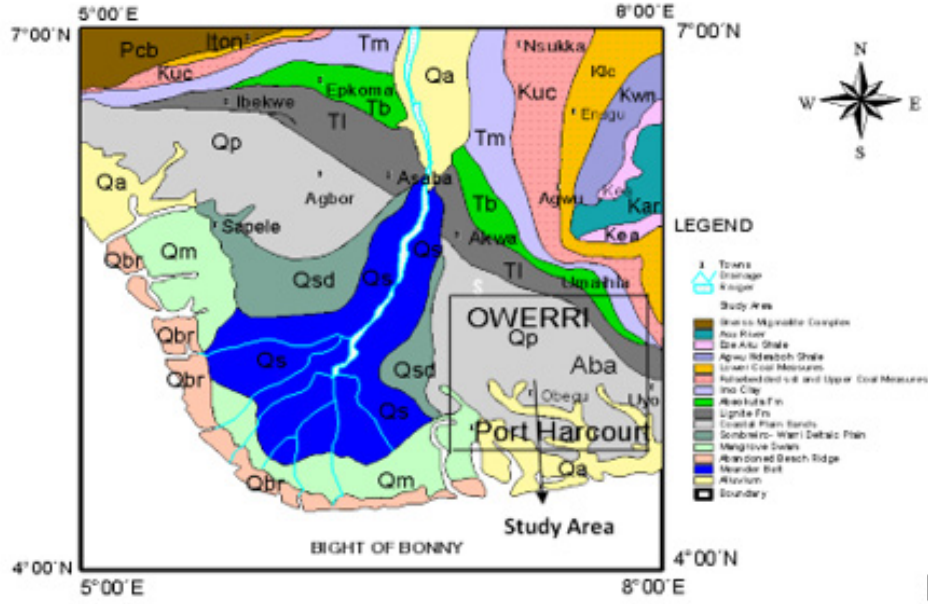

Figure 2: Geologic map of the Niger delta [5].

Generally, the regional fresh deeper groundwater flow pattern within the Benin formation is south-westerly towards the Atlantic Ocean which is recharged in-land by rain fall in the areas of Binin City, Owerri and Onitsha [5]. It is shielded at the coast from the upper saline water in the superficial deposits by clay layers and vertical flow gradients that prevent movement of water downward [3,6-9]. Moreover, the common hydro-geochemical features in the region are the presence of saline, brackish and freshwater system, and the occurrences of stable metal sulfides with limited mobility and carbonate. For instance, many groundwater production wells in the eastern part of the Niger Delta such as Twon-Brass, Kolo, Gbaran-Ubie, Nembe-Bassambiri,Bille, Degema, Harry's Town, Dema-Abbey (Bonny), Opobo, Gbarantoru, Kpansia, Etegwe and Swali, revealed salt water and iron contaminations at 1710.00mg/l and 1.600mg/l respectively above World Health Organization standards in the areas [10,11].

Exploiting from the above hydrogeological characteristics and advantages of the Niger Delta, uncoordinated and indiscriminate abstractions of groundwater resource from both confined and unconfined aquifers are rampant creating a platform for groundwater contaminations through direct and indirect borehole development activities. The increasing awareness over the past decades on the need for clean and potable water, the increase in population towards the coast, urbanization and industrialization have imposed significant pressure on the groundwater resource hence the need for sustainable management and optimum utilization. One of the envisaged challenges to groundwater resources management in the Niger Delta is lack of government full commitments to integrated water resources management policies where potable water supply is considered as one of the basic amenities in which the government owes its citizenry. Therefore, this paper highlights the need for, threats to and strategies for sustainable and optimum management of groundwater resource in the Niger Delta.

Need for Sustainable Management of Groundwater Resources

Health need and societal productions functions of groundwater resources are the main focus of this work.

Health need and societal production

Water is life if it is potable and can also become a source of nightmare which, perhaps, may result in death if it is contaminated or drowned in it. Therefore, the need for potable water cannot be under-emphasized. Since most of the surface water in the Niger Delta is readily prone to pollution by anthropogenic activities in the area therefore, groundwater remains an indispensable source of clean water in the Niger Delta. This is evident by the presence of, at least, a private water bore-hole in most of the communities in the area which serve as a good source of water for drinking, cooking, laundry and other domestic uses thus reducing the risk of exposure of the people to water borne infections and diseases such as typhoid fever, cholera, etc. Moreover, the abundance of groundwater resource and the low production cost per bore hole provide enabling environment for domestic and industrial water productions which attracts investors and other settlers to the area. Groundwater resource provides an immediate source of water for industrial use such as manufacturing, building construction, agriculture, cooling of engines, production of sachet/bottle water, recreation like in swimming pools, etc.

Threats to Sustainable Groundwater Management

The sustainability of groundwater resources in the Niger Delta is threatened by a number of factors which include saltwater intrusion, cognate water entrapment, industrial pollutions, poor waste management, climate change and indiscriminate sinking of water bore-hole and over abstraction.

Saltwater intrusion and iron contamination

Saltwater intrusion is a serious environmental problem in the Niger Delta especially in the coastal areas where the aquifer system has a semi-diurnal interaction with sea water. Several boreholes especially in Burutu, Obuguru, Akugbene, Okwagbe, Ezebiri, Okwama, Ofrukama, Deghele, etc, in Delta State, and Iwuokpom, Ibeno in Akwa Ibom State drilled so far have produced salt water. This caused most of the inhabitants to depend on rainwater for drinking and other domestic purposes while sachets/bottles water purchased from hinterland are for those who can afford [4,12]. However, the occurrence of salt water in wells at Borokiri-Port Harcourt, Buguma, Bille, Kulama, Bonny, Okirika and Akasa in Rivers State [5,13] which is attributed based on presumption to an entrapment of connate water in aquiclude can also be linked to the lifting process of sea water intrusion and landward salt water wedge migration in the aquifer system in the areas [14].

Moreover, the occurrences of high concentrations of salt and iron at 1710mg/l and 1.600mg/l respectively above the World Health Organization standards in groundwater from boreholes are likely to cause health hazard to consumers of groundwater from areas like Twon-Brass, Kolo, Gbaran-Ubie, Nembe-Bassambiri,Bille, Degema, Harry's Town, Dema-Abbey (Bonny), Opobo, Gbarantoru, Kpansia, Etegwe and Swali. Also, the exposure of such iron contaminated water to air could result in the oxidation of ferrous (Fe^{2+}) ion to ferric(Fe^{3+})ion in which a rust-coloured ferric hydroxide would precipitate out from water and stains water tanks, cooking utensils, laundry materials, metal pipes, etc. High iron content in groundwater may also cause scaling in pipes and poses hazards to industrial processes which required iron free water such as: brewery, process water, municipal water supply, ice making, distillery, food processing, etc. Also, health associated hazards with iron contaminated groundwater may include odour, frothing taste, colour, high turbidity, bacterial growth, etc., which contribute to the deterioration of water quality [15-21].

Industrial pollution

Pollution from point sources such as industrial effluent from oil and gas industries, oil spills, pipeline and underground tank leakage of petroleum products, waste dump sites and nonpoint sources from agro-allied industries such as the use of fertilizer in the farms, flooding and erosion pose serious threats to groundwater management in the Niger Delta. For instance, more than 2000 incidents of oil spill have been recorded in the Niger Delta since the beginning of oil activities in 1969, in which some underwent natural attenuation over the years making the groundwater system in the area to be vulnerable to pollution. Cases of underground oil pipeline leakages which led to the contaminations of groundwater resource have been reported at places such as Ejama Ebubu in Ogoni, Onne Port vicinity, etc., in Rivers State. The Nigeria flood of 2012 which affected a greater part of the Niger Delta flushed septic tanks and areas, which were polluted by oil spills and other hazardous waste over the past decades, drained into and which may reduce the quality of groundwater resource in the area.

Waste management

Poor management of sewage, liquid and solid waste also constitute a setback to sustainable management of groundwater resource in the Niger Delta. Poor waste management is evident by indiscriminate dumping of refuse, discharge and spill of lube oil on the ground from factories and workshops, and lack of sanitary landfills and adequate waste treatment facilities in the area.

Climate change and sea level rise

The effect of climate change and sea-level rise is also a threat to groundwater resource in the Niger Delta. Sea level rise in this century is estimated in the range of 20 to 88cm which will result in the migration of the salt water interface further inland from the coast making the extraction wells which were in the freshwater area to become brackish and saline [22]. This phenomenon is evident in the coastal communities at Ibeno, Iko in Eastern Obolo and Ikot Abasi all in Akwa Ibom State, etc. The rise in sea-level and the attendant coastal retreats will accelerate saltwater intrusion into the coastal aquifers and landward salt wedge migration in the

multi-aquifer system, causing salinization of groundwater in the coastal communities in the Niger Delta.

Uncontrolled access to groundwater resource

It is quite common in the Niger Delta that due to low water table and lack of regulation, access to groundwater resource is free. This made many groundwater wells to be produced without the services of experts which result in indiscriminate sinking and poor development of production wells which eventually become sources of contaminations to groundwater system.

Over abstraction

With the increase in population due to oil and gas activities in the area, there is also a corresponding need for large quantity of potable water in which the major source is the groundwater resource. When the rate of withdrawal for both domestic and industrial needs, through numerous boreholes, exceeds the rate of recharge in the hydrologic cycle, ground water stress becomes evident. Eventually, there would be a change in groundwater gradient which may cause saltwater intrusion through advection and /or infiltration of saline water if the freshwater aquifer underlays saltwater aquifer like at Bonny Island [5]. Also, wasteful habits in the utilization of groundwater are also a threat to the sustainable yield of the resource which could lead to over abstraction.

Strategies for Sustainable Management of Groundwater Resource

Development of groundwater resource management policy

There is need to develop a sustainable groundwater resource management policy in the country. This will serve as a guide in which objectives and goals of sustainable use of groundwater resources will be articulated for optimum use.

Mapping of the quantity and quality of groundwater resources in the Niger Delta

In order to ascertain the quantity and quality of groundwater system in the area there is need for detail mapping to establish and produce groundwater resource distribution map in the Niger Delta. The map will be very essential in demarcating areas of high or low sensitivity and/or vulnerability and resilience to numerous threats to sustainable management of groundwater resource in the area. Such studies will enable delineation of areas of alternate sequence of and depth to fresh and saltwater occurrences, fresh water-salt water interface and hydrogeological evaluation of groundwater in the Niger delta. This knowledge will aid groundwater resources managers in decision making. For instance, the cost of development of a well for potable water in an area where fresh water aquifer is overlain by salt water aquifer requires expertise and adequate knowledge of hydrogeology of the area to prevent the fresh water aquifer from being contaminated by salt water during drilling. Moreover, this will enable groundwater resource managers to demarcate areas of industrial pollution to groundwater such as crude oil at Ejama Ebubu in Ogoni, Rivers State, and areas of uncontaminated groundwater such as Jones Creek in Delta State which is devoid of the presence of oil and grease but has appreciable iron content which needs treatment to improve it quality for safety in domestic use [22].

Monitoring

The effort of the National Centre for Marine Geosciences, Yeneogoa, Bayelsa State, in establishing hydrogeological monitoring wells in coastal aquifers at strategic locations along the Nigeria coastline is a good development. But there is also need for establishments of such monitoring wells as control in the hinterland at strategic locations within the Niger Delta Basin. The envisaged control wells will be useful in monitoring the landward or seaward migration of freshwater-salt water interface.

Legislation

There should be a functional legislation to regulate access to and use of groundwater resource in the Niger Delta. This will act as a measure to restrain abuses of the groundwater resource.

Good waste management

It is necessary to develop and imbibe good waste management practice through the three R's waste management principles-reduce, reuse and recycle, and even recovery by individuals, private and public sectors. Segregation of waste from source, use of sanitary land fill for disposal of domestic and municipal waste, incinerators and thermal desorption units for disposal of toxic and hazardous waste will prevent contamination of groundwater resources in the area.

Adaptation to climate change

Saltwater intrusion into coastal aquifers is one of the effects of climate change and sea level rise in the coastal areas of the Niger Delta. It would be economically feasible and expedient to boost the local economy of the coastal dwellers through small scale and medium enterprises. This will enable the people to be able to purchase, from merchandise, sachets and bottles water produced hinterland for domestic consumption in the coastal communities in the Niger Delta. It is considered as a preferable option to pump and treat and desalinization in this context.

Sustainable Management of Groundwater Resource in the Niger Delta

In other to manage groundwater resource sustainably in the Niger Delta, the following groups are essential for consideration to constitute the management framework. These include managers, stakeholders, technical assistants, financiers, and consultants Figure 3. The role of management of groundwater resource should be vested on the Federal Ministry of Water Resources as

the coordinating ministry with the Nigeria Geological Survey Agency and the universities providing the technical assistance. The coordinating ministry is expected to organise, control and regulate the activities of other components of the framework. The Ministry of Niger Delta, Niger Delta Development Commission, international donor organisations, private and public companies, etc., constitute the major financier, while universities and research institutes are to provide consultancy services to the coordinating ministry on the sustainable use and management of the resource in the area.

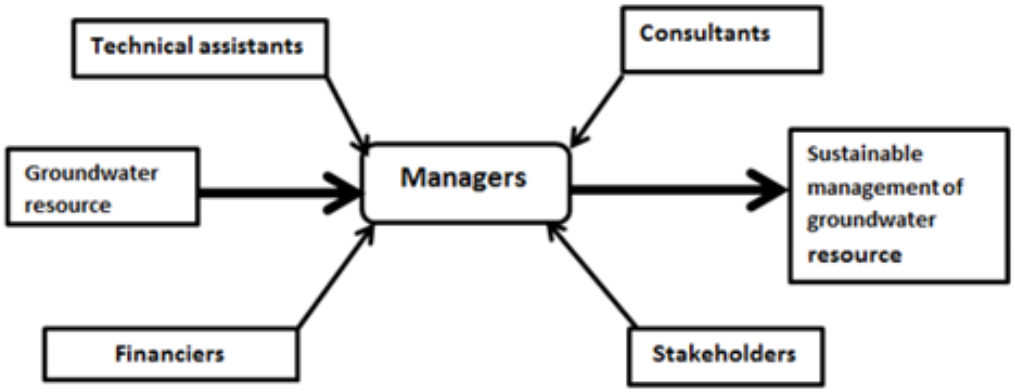

Figure 3: A conceptual model for sustainable management of groundwater resource in the Niger delta.

Moreover, central to the success of this framework is the involvement of stakeholders-community participation, as direct beneficiaries of groundwater resource, in the management process through periodic town hall meetings, awareness campaign, and environmental education on the need to protect the resource and avoid wasteful habits to ensure sustainability. Therefore, sustainability of groundwater resource, and/or any other resource, is a function of the resource and a good management framework and practice.

Conclusion

Sustainable management of groundwater resource in the Niger Delta is a necessity in which the present generation is obliged to uphold for the interest of the future. It requires a collective effort and the right attitude by the government, public and private sectors, and individuals alike towards optimum use, development and protection of the resource. It entails a holistic and systematic approach by the stakeholders in tackling the threats to sustainable yield of quality groundwater resource which is driven by the need to provide sustainable potable water to the teaming populace in the area.

Recommendations

A. Wasteful habit in the use of groundwater resource especially from private borehole operators should be discontinued.

B. Regular monitoring of the integrity of water pipelines installations by both private and public water suppliers to forestall leakages due to pipeline breakage is imperative.

C. Government should consider the provision of potable water to all its citizens as one of the top priorities in the agenda of good governance.

D. The Ministry of Water Resources should be re-enforced with more workforce to regulate sustainable management of groundwater resource.

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