

TOWARDS ACHIEVING SUSTAINABLE WATER RESOURCES MANAGEMENT IN NIGERIA

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ABSTRACT

Sustainable water resources management in Nigerian is the utilization of available surface and groundwater resources to satisfy Nigeria's present and future water needs in terms of quality and quantity. Sustainable water resources management implies a dynamic balance between development of water resources and conservation of nature such that the ecological, social and economic needs and aspirations of the current generation are met without compromising the ability of the future generation to meet their own needs.

The Federal Ministries of Water Resources and Environment, River Basin Development Authorities, Meteorological Department and State Water Boards are some of the agencies that are responsible for water resources management in Nigeria. These agencies have generally succeeded in the supply of water to rural and urban communities, hydroelectric production and establishment of large irrigation projects; but they are also faced with problems of overlapping functions, underfunding, displacement of communities, supply of poor quality water and lack of regular maintenance schedule for the installed water management facilities. These problems that may be categorized as administrative, technical, financial and environmental are the factors that have militated against achievement of sustainable water resources management in Nigeria. The problems can be avoided or reduced by adequate funding of water resources management agencies, development of appropriate technology for safe disposal of wastewater and integration of environmental considerations into the planning, construction and operation of water resources management facilities in Nigeria.

KEYWORDS: Water resources, management, environmental and wastewater.

INTRODUCTION

Nigeria lies in the tropical zone of West Africa and covers an area of about 924,000 square kilometers: Nigeria's current population is estimated at 130 million. Nigeria is endowed with surface and groundwater resources to satisfy the present and future needs of her population. The mean annual rainfall in Nigeria ranges from about 700 mm in the north to over 2000mm in the south Meteorological Department (Nigeria) (2001). There are two distinct seasons in Nigeria. The rainy season occurs from April to October while the dry season occurs from November to March. Rainfall in Nigeria provides water to the surface and groundwater resources through a complex hydrological cycle. Among the surface waters in Nigeria, River Niger and Benue with many tributaries dominate. Other sources of surface water include Ogun, Osun, Imo and Cross Rivers that flow directly into the Atlantic Ocean. The major lake is lake Chad which is the biggest fresh water lake in West Africa (with area of about 20, 000 square kilometers) extends to Cameroon, Chad, Niger and Nigeria. The groundwater resources consist of the aquifers of sedimentary basins and weathered/ fractured crystalline/metasedimentary basement rocks (Akujeze et al., 2003; Akpobories and Nfor, 2007).

Efficient water resources management in any country must be sustainable (Franklin and Hubao, 2004). Sustainable water resources management in Nigeria is

therefore discussed in the context of sustainable development. The World Commission on Environment and Development (WCED, 1987) defines sustainable development as meeting the needs of current generation without compromising the ability of future generations to meet their own needs. Sustainable development implies a dynamic balance between maintenance/conservation (sustainability) and transformation (development) (Robinson et al., 1990), both directed towards human needs. The concept of sustainable development therefore involves the successful integration of environmental considerations into development management (Maconick, 1990). Sustainability is in turn defined by Lawrence (1997) as meeting the ecological, social and economical needs and aspirations of human and other species such that:

- a. the future is not compromised for the present;
- b. certain geographic area(s) are/is not compromised for other geographic area(s);
- c. human needs and aspirations are met within biological limits and natural capital is maintained and enhanced;
- d. a proactive effort is made to maintain the sustainable and eliminate the unsustainable; and
- e. sustainability is recognized as a dynamic concept that will take many forms and will, in part be derived from and adjust to contextual factors.

Water resources management in Nigeria includes the utilization of available surface and groundwater resources to satisfy the total amount of water in terms of quality and quantity required to attain and maintain a better living condition for Nigerians and accelerate her technological development. In order words, water resources management includes the establishment and operation of water resource policies and agencies to ensure:

- a. supply of good quality water to satisfy the present and future domestic, industrial and agricultural water requirements;
- b. utilization of available surface water for transportation, and recreation (swimming, boating and fishing);
- c. safe disposal of waste water from domestic and industrial activities;
- d. prevention of surface and groundwater pollution;
- e. control of flood and erosion; and
- f. preservation of natural values of water resources (wildlife, fish and vegetation).

Van der Most (1988) states that the process of water resources management looks for a balance between water demand of activities a – f above and water supply from available water resources. Imevbore (1990) and Sadler (1995) insist that water resources management must also be environmentally sound. This means that it must operate within the limits of its ecological resources.

In this paper, the problems, achievements and challenges of water resources management agencies in Nigeria are reviewed in the context of sustainable development. Recommendations are also made on how to improve the practice of sustainable water resources management in Nigeria.

Water Resources Management Agencies in Nigeria.

Prior to 1975, water resources management programmes were uncoordinated. Thus several Federal and State ministries and other organizations set up their own water management agencies.

The Meteorological Department of the Federal Ministry of Aviation was responsible for the collection of rainfall, wind and temperature data. The Inland Waterways Department of Federal Ministry of Transport was responsible for the collection of hydraulic data of the river Niger and other major rivers in the country. The National Electric Power Authority (NEPA) and Geological Survey of Nigeria (GSN) Agency of Federal Ministries of Mines and Power were responsible for construction of hydroelectric plants on the nations rivers and itemization of the nations groundwater resources, respectively. There were also the Lake Chad Commission and River Niger Commission for the management of international surface waters in Nigeria. However, there was no central body to supervise or coordinate the activities of these agencies.

Water resources management in Nigeria took a definite turn in 1975 with the establishment of Federal Department of Water Resources in the Federal Ministry of Agriculture, Water Resources and Rural Development. Rearrangement in the Ministry in 1990 led to creation of Ministry of Water Resources and Ministry

of Rural Development as separate ministries. In 1976, the eleven River Basin Development Authorities were established by decree No. 25 by Federal Military Government (FMG, 1976) with the general objective of water resources development and conservation. Other government water resources management agencies include National Water resources Institute (of the Federal Ministry of Water Resources), Federal Ministry of Environment and Water Boards/ Agricultural Development Projects (ADP) at the state level. Table 1 shows the government owned water resources management agencies in Nigeria which illustrates the relationships between the water management agencies and their supervising ministries. The Federal, State and Local governments are therefore involved in the water resources management in Nigeria.

PROBLEMS OF SUSTAINABLE WATER RESOURCES MANAGEMENT IN NIGERIA

In spite of the establishment of numerous water management agencies in Nigeria and expenditure of huge sum of money in the management sub sector of the Nigerian economy, many rural and urban communities still lack good quality water supply, flood and erosion still devastate many parts of the country and the river transportation potential of the country has not been fully exploited. Only 49% of Nigeria's total water needs has been satisfied. The major factors that are responsible for this ugly situation include: overlapping functions/under funding of water management agencies; lack of basic data for design of water supply structures and inadequate maintenance of installed structures (Oteze, 1989; Okeke, 1997; Offodile, 2000).

Efficient water resources management in any country must adopt an integrated approach, taking into account a wide range of ecological, economic and social factors (UNESCO, 1997). In order words, it must be sustainable and this means that the management system should meet the present and future water needs of the community, without destruction of other environmental resources. UNESCO (1997) also listed the means of measuring the effectiveness of water resources management as:

- a. Human health, which has a direct correlation with water supply and sanitation;
- b. Environmental health which correlates with water use and pollution discharges; and
- c. Food production with its correlation with nutrition and the availability of affordable water.

Sustainable water resources management practice in Nigeria is discussed in terms of successes achieved in various aspects of present and future water needs by water resources management agencies as listed below.

- a. Rural / Urban Water supply
- b. Irrigation Projects
- c. Hydroelectric Projects
- d. River Transportation
- e. Management of International Waters
- f. Water Resources Research and Training
- g. Environmental Protection and Waste Management
- h. Coordination of Water Management Activities

These are discussed below

Rural/ Urban Water Supply

Over the years, Nigeria has made substantial investments in urban and rural water supply through the state water agencies and other federal establishments (FMWR and DFRRRI). However, the water demand of

some urban areas is far from being satisfied. Recently the Nation Water Rehabilitation Project through financial assistance from World Bank started a programme of improving water supply services to selected urban areas of Nigeria. All states of the Federation and Abuja are benefiting from the project.

Table 1: Water Resources Management Agencies in Nigeria

Supervising Government Establishment	Water Management Agencies
Fed. Ministry of Water Resources (FMWR);	1. FMWR 2. RBDA 3. NWRI
Fed. Ministry of Agriculture and Rural Development (FMARD)	4. FMARD
Fed. Ministry of Aviation (FMA)	5. Meteorological Dept.
Fed. Ministry of Mines and Power (FMMP)	6. NEPA 7. GSN
Fed. Ministry of Environment	8. FEPA
Presidency	9. DFRRRI
State Ministry of Utility	10. WATER BOARDS
State Ministry of Health	11. UNICEF
State Ministry of Agriculture	12. ADP

To date, the projects in the following states have been completed:

- i. Enugu (Enugu)
- ii. Ebonyi (Abakaliki)
- iii. Anambra (Onitsha)
- iv. Imo (Owerri)
- v. Oyo (Ibadan)
- vi. Kano (Joda- Tezawa)
- vii. Lagos (Ikoyi, Victoria Island and 1004 - Estate)

Water Rehabilitation Project in the underlisted states are still under construction:

- i. Katsina (Katsina)
- ii. Plateau (Jos)
- iii. Akwa Ibom (Uyo)
- iv. Cross River (Calabar)

The FMWR in conjunction with DFRRRI and Defence Industries Corporation (DSC) of Kaduna have also embarked on local production of hand pumps for rural water supply. Some state governments. Like Yobe, Jigawa and Kano are subsidizing the local production of these hand pumps.

The possibility of local production of water treatment chemicals from brine and kaolin is currently being studied. Nigeria should consider the local production of drilling rigs like Brazil, Argentina and Colombia (Ricaidi,

1991).

Irrigation projects

In Nigeria, many agencies like ADPs and RBDAs are responsible for supply of irrigation water and management of irrigation projects for increased food production. Over 300,000 hectares of irrigation projects in Nigeria are supported by RBDA water projects (Okeke and Ofulume, 1997) All the major water projects for irrigation projects or schemes in Nigeria are executed by construction of dams and intake works on rivers. Table 2 shows the major irrigation projects in Nigeria supported by RBDA dams and intake works (Okeke and Ofulume, 1997.) It should be noted that only irrigation projects supported by large dams (length greater than 500m) are contained in the table. Over 25 small dams constructed by RBDA support about 70, 000 hectares of irrigation projects. There are also some dams in Nigeria that are not owned by RBDA but equally contributed to supply of water for irrigation purpose. Typical examples are the Bagauda dam in Kano state that serves for irrigation, water supply, fishery and recreation, and owned by Kano State Water Board; and Kainji dam in Niger State that serves for hydroelectric production, irrigation, water supply, fishery and flood control; and owned by NEPA.

Plans are underway for the rehabilitation of some irrigation projects including South Chad, Lower Anambra Kano River and Bakolori irrigation projects.

Table 2: Irrigation projects supported by Dams/Intake works constructed by River Basin Development Authorities in Nigeria (From Okeke and Ofulume, 1997)

Name of Irrigation Projects	Size of Irrigation Projects (ha)	Name of dams/Intake Works Support Irr.	Type of dam	Length of dam (m)	Location of dam (State)	Reservoir Capacity (MCM)	Purpose	Owner
Bakoiri I. P	23000	Bakoiri	C	5491	Sokoto	450	Irr.	SRBDA
Rima River I. P	33000	Goronyo	E	7210	Sokoto	974	Irr.	SRBDA
Kano River I. P	14000	Tiga	E	6000	Kano	1968	Irr.	HJRBDA
Dadinikowa I. P	44000	Dadinikowa	R	9000	Gombe	2765	Irr+WS	UBRBDA
Lower Ogun I. P	12500	Ogun	E	1044	Ogun	270	Irr WS, F	OORBDA
Middle Ogun I. P	12500	Ikere-Gorge	R	600	Oyo	565	Irr WS, F	OORBDA
Swashi I. P	5300	Swashi	E	600	Kwara	5	Irr.	NREBDA
Kiri. P	6000	Kinota	E	1025	Adamawa	325	Irr.	UBRBDA
Hadejia Valley I. P	12500	Galala	E	726	Kano	24	Irr.	HJRBDA
Jibiya I. P	3400	Jibiya	E	3170	Kaduna	121	Irr.	NRBDA
Zobe I. P	6000	Zobe	Na	2750	Kaduna	177	Irr.	NRBDA
Kampe I. P	6000	Ogin	E	750	Kwara	750	Irr.	NRBDA
Erini I. P	4036	Oni	E	1976	Kwara	1600	Irr.	NRBDA
Lower Anamb. I. P	4200	Iife Intake Wks		-	Anambra	103/5	Irr.	AIRBDA
South Chad I. P	60000	South Chad Intake Wks		-	Borno	na	Irr.	CBDA
	248,436							

Legend:

C = Concrete dam, E = Earthfill dam, R = Rockfill dam, ha - hectares, MCM = Million Cubic Metre.
 CBDA = Chad Basin D. A, AIRBDA = Anambra/Imo RBDA, SRBDA = Sokoto BDA, HJRBDA = Hadejia/Jamare RBDA
 UBRBDA = Upper Benue RBDA, OORBDA = Ogun/Ohun RBDA, NRBDA = Niger River BDA, Irr., = Irrigation.
 WS = Water Supply, F = Fishery.

Hydroelectric Projects.

Three hydroelectric plants were completed on rivers Niger and Kaduna between 1968 and 1987 by NEPA; and they have the capacity to function as an integrated system to sustain a 1,760MW. The Kainji dam had reservoir capacity of 15000mcm (million cubic meter), height of 66m and total crest length of 775m. The Jebba dam was completed in 1984 on the river Niger with an installed capacity of 54MW, reservoir capacity of 1000mcm, height of 40m and length of 1940m. The Shiroro dam was completed on river Kaduna in 1987 with an installed capacity of 600MW reservoir capacity of 700mcm, height of 125m and length of 700m. NEPA (now PHCN) has completed feasibility studies on the following rivers: Katsina Ala, Mada, Donga and Cross River for construction of hydroelectric plants. Approvals and release of funds for the projects are being expected.

River Transportation

River Niger and Benue in Nigeria form major transportation system in West Africa. With construction of navigation locks at Kainji and Jebba dams on the river Niger and canal (3.25km long) to by pass the Awuru rapids on the river by NEPA, boats and barges can sail from Port Harcourt in Nigeria to Gaya in Niger Republic. However, low water levels and sandbars in the rivers have prevented the full utilization of these rivers as transportation routes. The River Niger is navigable for only five months of the year (July to November) (Okeke, 1992). The Inland Waterways Department of the Federal Ministry of Transport collects and documents hydrological and hydraulic information on the river and other major rivers in Nigeria. River ports have also been constructed at Onitsha and Ajaokuta along river Niger to facilitate river transportation in Nigeria. An annual dredging programme has been proposed for the river Niger to improve its navigability.

Management of International Waters

Many rivers in Nigeria like rivers Niger, Benue, Katsina Ala and Donga are shared by Nigeria and other countries. The river Niger flows through four West African countries, namely Guinea, Mali, Niger, and Nigeria. It is 4,184km long and only about 1,174.6km of its total length (about one third) is in Nigeria (Okeke, 1992). Rivers Benue, Donga, Katsina Ala and Cross River have their sources in Cameroon Republic. Lake Chad, the largest fresh water lake in West Africa with an area of about 20,000km² extends from Nigeria through Chad, Niger and to Cameroon Republic. The construction of Kandadji dam on the river Niger in Niger Republic and Construction of Lagdo dam on the river Benue in Cameroon are adversely affecting the water flow condition in these two rivers in Nigeria. The establishment of Niger Basin Authority and Lake Chad Commission by Nigeria and other West Africa Countries that possess riparian rights of the two international waters (River Niger and Lake Chad) was to create forum for development of acceptable management system of the international surface waters. Discussion with officials of Cameroon Republic have started on the establishment of such multinational water management agency concerning rivers Benue, Donga, Katsina Ala and Cross River. In the spirit of sustainable development, activities to exploit the potentials of the

river upstream by any country should not adversely affect the ability of other countries and future generation living downstream of the river from meeting their own needs from the river (Okeke, 1992).

Groundwater Problems and Management

Groundwater occurrence in Nigeria is restricted to the aquiferous sedimentary basins and fractured/weathered basement rocks. However, some geological, geophysical and geotechnical/drilling problems influence its economic development (Martins *et al.*, 2000, Obioha and Nwachukwu, 2007).

The Groundwater resources from both sedimentary basins and basement rocks are also highly polluted by anthropogenic activities including nitrate and bacteriological pollution (Edet, 2000; Adelana and Olasehinde, 2003; Yekina *et al.*, 2004; Akujieze and Oteze, 2007). Other environmental problems of overexploitation of groundwater such as subsidence and sea water intrusion have been reported (Okeke, 2000; Edet and Okereke, 2001, Akujieze *et al.*, 2003).

Franklin and Hubao (2004) and Akpoborie and Nfor (2007) suggested provision of comprehensive data gathering and monitoring framework and conjunctive use of surface and groundwater for any planned water project as long-term solution to some of these problems.

Environmental Protection and Waste Management

Sustainable water resources management in Nigeria implies that the management process must take care of the present and the future water needs of Nigerians without destruction of other ecological resources of the environment. According to Marconick (1990), it involves integration of environmental considerations into the management process. In Nigeria, FEPA (now Ministry of Environment) is the environmental regulatory body. It is therefore responsible for environmental protection in Nigeria. To date, it has published two important documents, namely, the National Policy on Environment, (FEPA, 1989), and (National Interior Guidelines and Standards for Industrial Effluent, Gaseous Emissions and Hazardous Waste Management in Nigeria (FEPA, 1991)). The goal of the National Policy on the Environment is to achieve sustainable development in Nigeria. The implementation of the policy through many strategies in different sectors of the economy will lead to:

- a. The establishment of adequate environmental standards as well as monitoring and evaluation of changes in the environment; and
- b. The prior environmental assessment of proposed activities, which may affect the environment or the use of a natural resources.

In the water resources management sub-sector, the strategies for achieving sustainable development include:

- a. The provision of water in adequate quantity and acceptable quantity to meet domestic, industrial, agricultural recreational needs;
- b. The consideration of environmental impacts of water resources development at the planning stage;

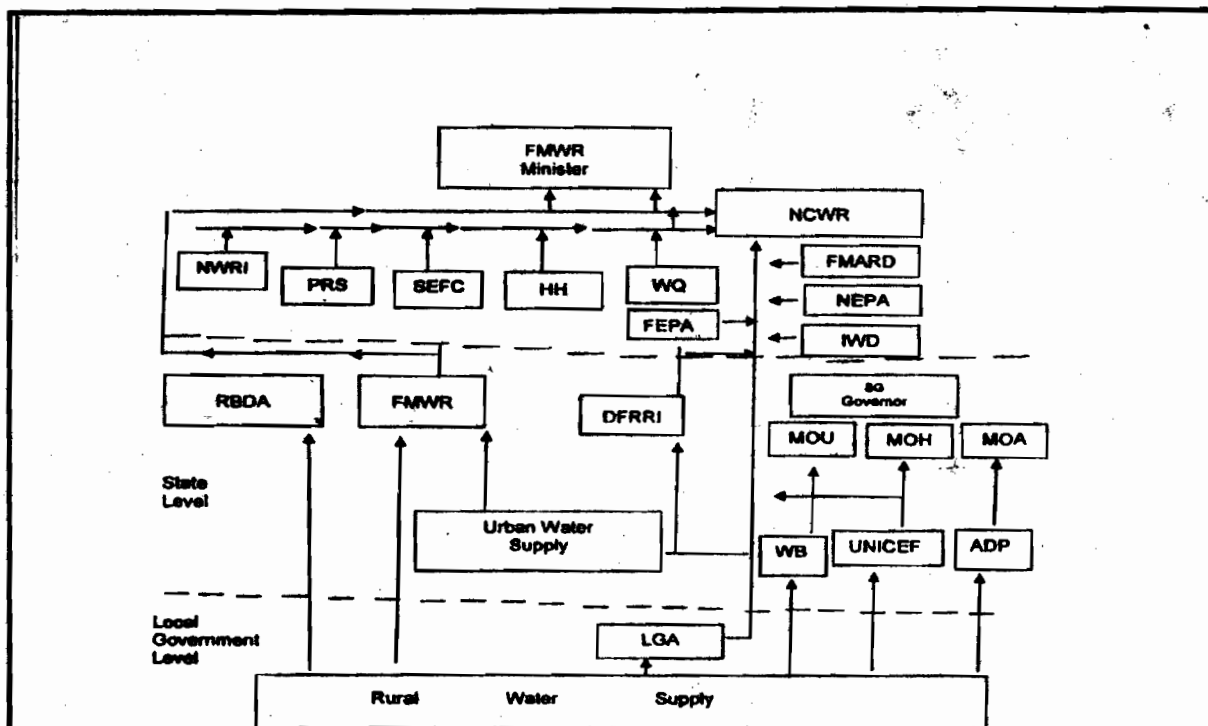
- c. efficient water use; and
- d. Specification of water quantity criteria for different water uses.

FEPA has organized several seminars on the protection of Nigerian environment including the National Symposium on Water Quality Monitoring and Status in Nigeria in 1991, FEPA now has reference laboratories in Lagos and Kaduna and zonal offices in some states. There are also state Environment Protection Agencies that have similar function as FEPA but at state levels. FEPA also monitors the disposal of industrial wastes in the environment and recommended that such wastes should be appropriately treated before disposal. It is now mandatory for any proposed water and other projects in

Nigeria to undergo Environmental Impacts Assessment (EIA) before it should either be financed (by UNPD and World Bank) or executed.

Coordination of Water Management Activities

The National Council on Water Resources (NCWR) comprises all representatives of all water agencies in the country and meets regularly for water resources policy formation (Fig. 1). The activities of water management agencies are coordinated through the NCWR. The Federal Minister of Water Resources is the chairman of the council. One of its major achievements is the publication of Nigeria's Water Resources Decree in 1993. It is currently considering the modus operandi of charging private borehole owners.



LEGEND

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|-------------------------------------|-------------------------------|
| FMWR = Fed. Min. of Water Resources | SG = State Government |
| NWRI = Nat. Water Res. Inst. | MOU = Min. of Utilities |
| PRS = Plan. Res. and Statistics | MOU = Min. of Health |
| SEFC = Soil Erosion/Food Control | MOA = Min. of Agric. |
| HH = Hydraulics & Hydrology | WB = Water Board |
| WQ = Water Quality | LGA = Local Govt. Area |
| NCWR = Nat. Council On W. Resources | FEPA = Fed. Env. Prot. Agency |
| RBDA = Riv. Basin Dev. Authority | ADP = Agric. Dev. Project. |
| IWD = Inland Waterways Dept. | |

Fig. 1 Organogram of Water Resources Management in Nigeria.

CONCLUSION AND RECOMMENDATION

Nigeria is endowed with sufficient surface and groundwater resources that if efficiently managed in the context of sustainable development would satisfy the present and future water requirements of her people for domestic, industrial, agricultural, hydroelectric and recreational purposes. Sustainable water resources management practice would also prevent the adverse impacts of soil/coastal erosion, floods and water pollution. Many government agencies and international organizations are actively involved in water resources management in Nigeria. Even with their relative progress in terms of urban water supply, soil erosion control, and documentation of hydrological data, the coordination of their activities is still poor, they are poorly funded, installed facilities are not properly maintained, and serious attention is not paid to quality of water supplied to rural communities. In order to achieve sustainable water resources management in Nigeria, it is recommended that:

- a. The functions of Water resources management agencies in Nigeria should be streamlined to remove areas of overlap. For example, FEPA should be responsible for specification of water quality standards while state and local government agencies should be responsible for rural water supply;
- b. The Federal Ministry of Water Resources should be active in her role as a coordinating agent, though the National Council on water resources. It will also supervise the hydrological data collection and the production of hydrological year books;
- c. Water resources agencies should be adequately funded;
- d. Water resources facilities should be properly maintained after installation;
- e. More attention should be paid to groundwater level/quality monitoring and recharge studies;
- f. More attention should be paid to the quality of water supplied to rural/urban dwellers;
- g. An environmental impact assessment (EIA) of any proposed water project should be performed and problems identified should be remedied both during and after construction; and
- h. Active research programme should be initiated on wastewater treatment and reuse; and local production of drilling rigs for groundwater abstraction.

REFERENCES

- Adelana, S. M. A. and Olasihinde, P. I., 2003. High Nitrate in Water Supply in Nigeria, Implications of Human Health. *Water Resources, Journal of Nigeria Association of Hydrogeologist (NAH)*, 14: 1-11.
- Akpoborie, I. A. and Nfor, N. B 2007. The Development of Groundwater and the Practice of Hydrogeology in Nigeria: A new Paradigm. *Water Resources-Journal of the Nigerian Association of Hydrogeologists (NAH)*, 17: 70 - 76.
- Akujeze, C. W; Coker, S. J. L. and Oteze, G. E., 2003. Groundwater in Nigeria. A millennium Experience-Distribution, Practice, Problems and Solutions. *Hydrogeological Journal*, 11: 259 - 274.
- Akujeze, C. W. and Oteze, G. E. 2007. Deteriorating Quality of Groundwater in Benin City, Edo State, Nigeria. *Water Resources, Journal of Nigerian Association of Hydrogeologists (NAH)*, 17: 17 - 23.
- Edet, A. E. 2000. Water Pollution by Nitrate near some Waste Disposal Sites in Calabar (Nigeria). *Groundwater 2000, Prag. Int. Conf. Groundwater Research, Copenhagen*.
- Edet, A. E. and Okereke, C. S., 2001. A Regional Study of Saltwater Intrusion in Southeastern Nigeria based on Analysis of Geoelectrical and Hydrochemical Data. *Environ. Geol.* 40: 1278-1289.
- Federal Military Government (FMG), 1976. River Basin Development Authorities Decree, Supplement to Official Gazette no. 25, vol. 66 Part A.
- Federal Military Government (FMG), 1989. National Water Resources Institute Decree. Supplement to Official Gazette no. 27, vol. 77 Part A.
- Federal Environment Protection Agency (FEPA), 1989. National Policy on the Environment. Federal Environment protection Agency, Abuja, Nigeria.
- Federal Environment Protection Agency (FEPA), 1991. National Interior Guidelines and Standards for Industrial Effluents, Gaseous Emission and Hazardous Waste Management in Nigeria. Federal Environment Protection Agency, Abuja, Nigeria.
- Franklin, W. S. and Hubao, Z., 2004. Fundamentals of Groundwater. John Wiley and Sons (Asia) Ltd. Replika Press Ltd. Kundli, India.
- Gleick, P.H., 1993. Water in Crisis. In: P.H. Gleick (Ed). *A guide to the Worlds Freshwater Resources*. Pacific Institute for Studies in Development, Environment and Stockholm Environmental Institute. Oxford University Press, London.

- Imevbore, A. M. A., 1990. Environmentally Sound Management of Natural Resources in Nigeria. Proceedings, Workshop on the Environment and Sustainable Development in Nigeria 25-26 April 1989, Abuja Nigeria, pp.53-61.
- Lawrence, D.P., 1997. Integrating Sustainability and Environmental Impact Assessment. *Environment Management*, 21(1): 23-42.
- Marconick, R., 1990. Environment and Concept of Sustainable Development. Proceedings, Workshop on the Environment and Sustainable Development in Nigeria 25-26 April 1989, Abuja Nigeria, pp. 44-52.
- Mayor, F., 1997. Towards a New Water Ethic. *IMP Waterway*, No 9. UNESCO, Division of Water Sciences p.1.
- Martins, O., Ajayi, O. and Idowu, O. A., 2000. Factors Influencing Yields of Boreholes in Basement Complex Aquifers of Southwestern Nigeria. *Journal of Science*, 34: 295 - 300.
- Meteorological Department (Nigeria), 2001. Rainfall Data in Nigeria, Federal Ministry of Aviation, Abuja.
- Obioha, Y. E. and Nwachukwu, M. A., 2007. Geologic Problems of Groundwater Development: A Case Study of Nkwele and Nwangele Areas in Imo State, S.E. Nigeria. *Water resources, Journal of the Nigerian Association of Hydrogeologists (NAH)*, 17: 61-69.
- Offodile, M. E., 2000. The Development and Management of Groundwater for Water Supply in Nigeria. Paper Presented at the 2nd Fellows Workshop of the Nigerian Mining and Geosciences Society, 6th May.
- Okeke, O. C., 1992. Aspects of Transboundary Development and Conservation of the River Niger. Proceedings, International Symposium on Transboundary River Basin Management and Sustainable Development. 18th - 22nd May 1992 Delft University of Technology, the Netherlands, pp. 205-253.
- Okeke, O.C., 2000. Environmental Issues of Industrial Development in Nigeria. *Geoscience and Development*, No. 6: 21 - 24.
- Okeke, O.C. and Ofulume, A. B., 1997. Role of River Basin Development Authorities in Satisfying Agricultural Water Needs in Nigeria. Paper presented at the 19th Annual Conference of Nigeria Society of Agricultural Engineers, 2nd - 6th Sept. 1997, Owerri, Nigeria.
- Oteze, G. E., 1989. Problems with Water Supply, *Water Resources Vol. 1, No 2* Editorial.
- Oyebande, I., 1989. Problems, Needs and Objectives of Water Resources Planning in Nigeria. *Water Resources, Journal of the Nigerian Association of Hydrogeologists (NAH)*, 1(2): 221-227.
- Robinson, J. G., Francis, G., Legge, R. and Lerner, S., 1990. Defining a Sustainable Society. *Alternatives*, 2: 36 - 46.
- Sadler, B., 1995. Sustainable Development and Water Resources Management *Alternatives*, 17(3): 14 - 19.
- UNESCO, 1997. Comprehensive Assessment of the Freshwater resources of the World. *IMP Waterway*, No 11. UNESCO Division of Water Sciences, pp. 3 - 6
- Van der Most, H., 1988. Introduction to Water Resources Management. Delft Hydraulics Publication, the Netherlands, 27p.
- World, Commission on the Environment and Development (WCED), 1989. *Our Common Future*. Oxford University Press Oxford, 400p.
- Yenika, M. E., Uma, K. O. and Obiefula, G., 2003. The Impact of Human Activities on Groundwater Quality: A Case Study of Shallow Aquifer in Jimeta-Yola Metropolis, Northeastern Nigeria. *Water Resources, Journal of the Nigeria Association of Hydrogeologists, (NAH)*, 14: 54 - 91.