

THE NIGERIAN GEOGRAPHICAL JOURNAL

New Series Volume 10 No. 1 (2014)



**PUBLISHED BY THE ASSOCIATION OF NIGERIAN GEOGRAPHERS
FORMERLY NIGERIAN GEOGRAPHICAL ASSOCIATION FOUNDED IN 1957**

**ASSOCIATION OF NIGERIAN GEOGRAPHERS
COUNCIL MEMBERS FOR 2014**

President:	Professor Adeniyi Gbadegesin
1st Vice President:	Professor O. O. Oyesiku
2nd Vice President:	Professor A. I. Tanko
3rd Vice President:	Professor P. A. O. Odjugo
National Secretary:	Professor Sani A. Mashi
Asst. National Secretary:	Professor H. K. Ayuba
Treasurer:	Professor A. Ogidiolu
Financial Secretary:	Dr I. M. Dankani
Editor of the Journal:	Professor P. O. Phil-Eze
Assistant Editor:	Professor Ayo Omotayo
North-West Zonal Rep.:	Professor J. G. Laah
North-East Zonal Rep.:	Dr Yagana Bukar
North Central Zonal Rep.:	Dr S. D. Musa
South-West Zonal Rep.:	Mr L. O. Ogundele
South-East Zonal Rep.:	Dr Mrs E. C. Onyenechere
South-South Zonal Rep.:	Mr T. T. Tamuno
Special Member:	Professor M. M. Daura
Special Member:	Professor Osi Akpogomeh
Special Member:	Dr A. M. Dambazau

Volume 10 (1)

Title	Author(s)	Page
Soil Fertility Status under Rain-Fed Agriculture in Gwagwalada Area Council, Abuja, Nigeria	Y. H. Madaki and A. Jibrin	1 - 16
Evaluating Peak Runoff Hydrographs for Oyun River Catchment in Kwara State Using GIS and Remote Sensing Techniques	Olanrewaju, R.M, Adedayo, I.T, and Iroye, K.A	17 - 29
The Role of Urban Agriculture in Reduction of Poverty in Urban Areas of North West Region, Nigeria	Ibrahim Jaro Musa and Salisu Gwadabe	30 - 38
Influence of Geology and Anthropogenic Activities in the Seasonal Variation of the Water Quality of Orle River, SW Nigeria	C. I. Ikhile	39 - 52
Housing Quality in Yenagoa, Bayelsa State, Nigeria	O. Ohwo	53 - 67
A Multivariate Statistical Analysis of Public Institutions Water Demand in Enugu Urban Area, Nigeria	Ezenwaji E. E., Phil-Eze, P. O. and Enete I. C.	68 - 80
Gender and Geography: A Preliminary Survey of Gender Balance of Academics in Nigerian University Geography Departments	Emmanuella Chinenye Onyenechere	81 - 96
Telecommunications and Travel Demand Relationship: The Nigerian Perspective in Relation to Economic Growth	Oyesiku, Kayode and Onakoya, Adegbeni	97 - 117
Analysis of Landuse Use Change in Abuja Federal Capital City Using Geospatial Techniques	M.A. Ade	118 - 132
Reservoir Sedimentation of a Regional Water Development Scheme in a Tropical Rural Settlement of Kwara State, Nigeria	K.A Iroye and Prof. H.I. Jimoh	133 - 143
Microbacteria in Micro Morphologic Units on Bima Sandstone, Dukul- Sekule Limestone Rocks <i>Insitu</i> in the Upper Benue Trough of Adamawa State, Nigeria	Mubi Aishatu Mohammed and Joseph Ngyabiya	144 - 156
Effects of Urban Heat Island (UHI) on Urban Hydrology and its Associated Health Problems in Enugu Metropolis	Enete, I. C., Ezenwaji, E. E. and Phil-Eze, P. O.	157 - 172

RESERVOIR SEDIMENTATION OF A REGIONAL WATER DEVELOPMENT SCHEME IN A TROPICAL RURAL SETTLEMENT OF KWARA STATE, NIGERIA

K. A. Iroye¹ and H. I. Jimoh²

¹*Department of Geography and Environmental Management, University of Ilorin, Nigeria.
iroyekayode@yahoo.com*

²*Department of Geography and Planning, Kogi State University, Anyigba*

ABSTRACT

This paper investigates the level of silts and sediments deposited in Oyun dam; a regional water supply project designed to serve seven communities in Kwara State of Nigeria. The dam was commissioned in 1967 with initial height of 7 meters was later raised to 9.8 meters in 1988 so as to meet the increasing water need of the region. Data used was generated from simple land survey technique which entails the imposition of 45 grids of 40m x 40m on the lake. In each grid, depth of the lake was measured and this data helped in estimating the current capacity of the lake. The result of sediments obtained showed that Oyun reservoir currently has a mean depth of 4.33 meters which indicates a loss of about 5.47 meters depth to sedimentation in filling. This figure represents about 55.8 percent loss in storage capacity of the lake. Likely reasons for high sediment level in the reservoir were examined while recommendations that can be used in abating the high sedimentation rate of the reservoir were also suggested.

Keywords: *Dam, Reservoir, Sedimentation, Siltation and Landuse*

INTRODUCTION

The main source of water supply, both for domestic and industrial uses in Oyun, Offa and some parts of the Irepodun Local Government areas of Kwara State, Nigeria is Oyun dam. The dam which is a regional water supply project was commissioned in 1967 with an initial height of 7 meters. This height was later raised by 2.75m in 1988 to meet the increasing water need of the explosive population and growing number of industries within the region (FMWRRD, 1994). Today, twenty six years after the

dam initial capacity was raised, water supply situation has become highly erratic, especially during the dry season in all the settlements being served by the dam.

Lack of portable water supply constitutes a major constraint on development. The human population concentrating in areas of water supply problems especially in the opinion of Ijaiya (2000) are not only affected by common effects of water related diseases, but also by long period of time wasted in searching for water. Similarly, WHO (2004), observed that more than one billion people in low

income countries such as Nigeria lack access to safe water. Inaccessibility to adequate water supply has resulted in low enrolment in schools, particularly of girls who must spend time collecting water, higher crime against women due to lack of toilet privacy, as well as the more obvious impacts of disease, higher infant mortality, high absenteeism in schools and at work and low productivity (FGN, 2000). The declaration of the period, 1981-1990 by United Nations as International Drinking Water and Sanitation Decade is a reflection of the collective concern of the international community to improve water and sanitation services in the developing countries of the world.

The problem of shortage of water supply from Oyun dam may not be unconnected with sedimentation problem in the lake; this is because, water supply problems are usually more acute during the dry seasons in the communities being served by the dam, and this strongly suggests loss in storage capacity. Since the dam was constructed almost five decades ago; sedimentation study has never been carried out in the reservoir despite the rapid rate of urbanization and poor land use practices within the catchment of the dam. Sediment generations induced by high rate of deforestation and construction activities are no doubt posing great challenges on water storage capacity of the lake. This is because, the reservoir which is an earth dam acts as filter by allowing the inflow of water and sediments into the lake throughout the year while allowing water and just the suspended sediments to flow out during the rainy season.

The bed loads which flow into the lake during both the rainy and dry seasons are thus retained in the reservoir, hence the gradual reduction in storage capacity of the dam. Studies such as Anderson (1957), Imervore, *et al.* (1988) Nabegu (2005) and Beilicci and Beilicci (2013) have reported that earth dams, such as Oyun dam, whose catchment areas are undergoing rapid urbanization process are prone to siltation. While Mahmod (1987) observed that by 2017, more than fifty percent of the initial storage of the world's reservoir would have been lost to sedimentation, Basson (2009) estimated the overall cost of world reservoirs sedimentation to between 15 and 20 billion US dollars per year. Though Busari *et al* (2013) observed that sedimentation problem is inevitable in any reservoir created by a dam constructed on a natural water course; the concern according to Egbulem (2002) is the rate of siltation before the useful storage capacity is seriously impacted. In view of the fact that the cost of sediments removal in a large reservoir such as Oyun dam can exceed the original cost of construction (Akar, *et al* 2010), efforts should be directed at monitoring its sedimentation rate as currently being done in this study. This will not only aid in boosting water supply from the dam, but will also help in restoring the reservoir to its full functions.

THE STUDY AREA

Ijagbo is the study area and it is located on the intercept of longitude 8° 34' and latitude 4° 34' (Fig. 1). The settlement has an annual rainfall of 1,280mm spread over 8 months of the year. Relative humidity in

the area is usually around 76% in the morning while mean maximum and minimum temperatures are 35°C and 27°C respectively (Oyegun, 1983). The study area according to Oyegun (1983) falls within the broad region of Nigeria known as grass plains where land is heavily farmed with just a very limited area of forest. The area which is located in an undulating landscape is underlain by basement complex comprising of granite, schist and gneiss which are intact in places such as Ijagbo and Offa and fractured in

other neighboring settlements such as Ojokun, Ikotun, Irra, Ipee and Igosun. Urbanization process is fast replacing the limited forest area in the region with artificial surfaces with consequent effects on sediment transportation.

Oyun dam, the case study, is an earth dam located on River Oyun, a subsequent stream of River Niger in Ijagbo. The dam has storage depth of 9.8m, spillway length of 80meters, gross storage capacity of 3,500,000m³ and catchment area of 106km².

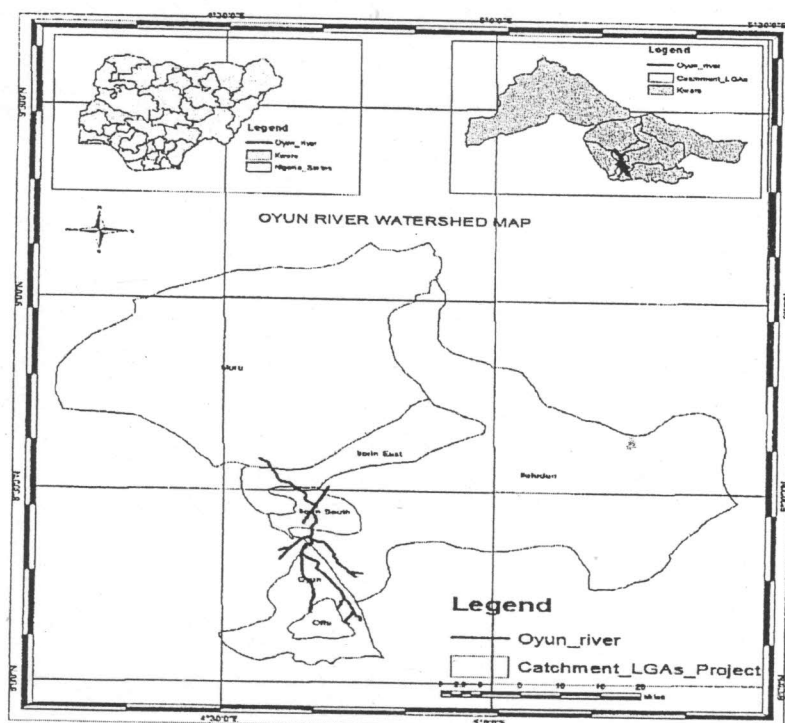


Fig. 1: Map of Oyun showing the Oyu River watershed and Dam

This regional water supply project was designed to serve seven towns with a total population of 184,000 people. The dam with two treatment plants has a production capacity of 20,160m³ per day. The first plant which was built in 1967

produces 4,320m³ per day while the second plant which was built in 1988 produces 15,840m³ per day. Treated water from Oyun dam is usually pumped to storage reservoir in seven communities served by the dam (Table 1).

Table1: Facilities and Coverage of Oyun Regional Water Supply Scheme

Town	Capacity of Services Reservoir (M ³)	Length of Distribution Network (M)	Number of Connections
Ijabo	105	2623	287
Offa	9973	22420	1850
Igosun	130	4000	59
Erin-Ile	220	4615	267
Omupo	220	3200	124
Ipe	105	2394	101
Ajase-Ipo	220	3751	195

Source: Kwara State Water Corporation (2009)

MATERIALS AND METHODS OF STUDY

Data used in this investigation was collected from direct fieldwork exercise in the month of September, 2013 when the dam was at its bankful capacity. The dam reservoir area was delineated using simple land surveying technique after which 45 grid squares of 40m x 40m were

superimposed. Within each grid, depth of lake was measured using a line graduated in meters with beads and a medium weight plumb tied to its zero end. The rope was lowered down into the water in each grid by the researcher from a canoe paddled by a fisherman (Fig 2). The sagging of the rope indicates that the plumb has reached the lake bed. The rope is then pulled up until it gets taut and point of

intersection between the rope and water surface marked. The plum is then pulled out, and the number of beads up to the point marked counted and recorded by a research assistant as the depth of the lake in meters at that point. In cases where the point of intersection between the line and

water surface do not fall precisely on a bead position, a tape rule was used in reading off the remaining length. The difference between the measured depth and the previous depth of 9.8m is then taken as the depth of accumulated silts and sediments in the reservoir.

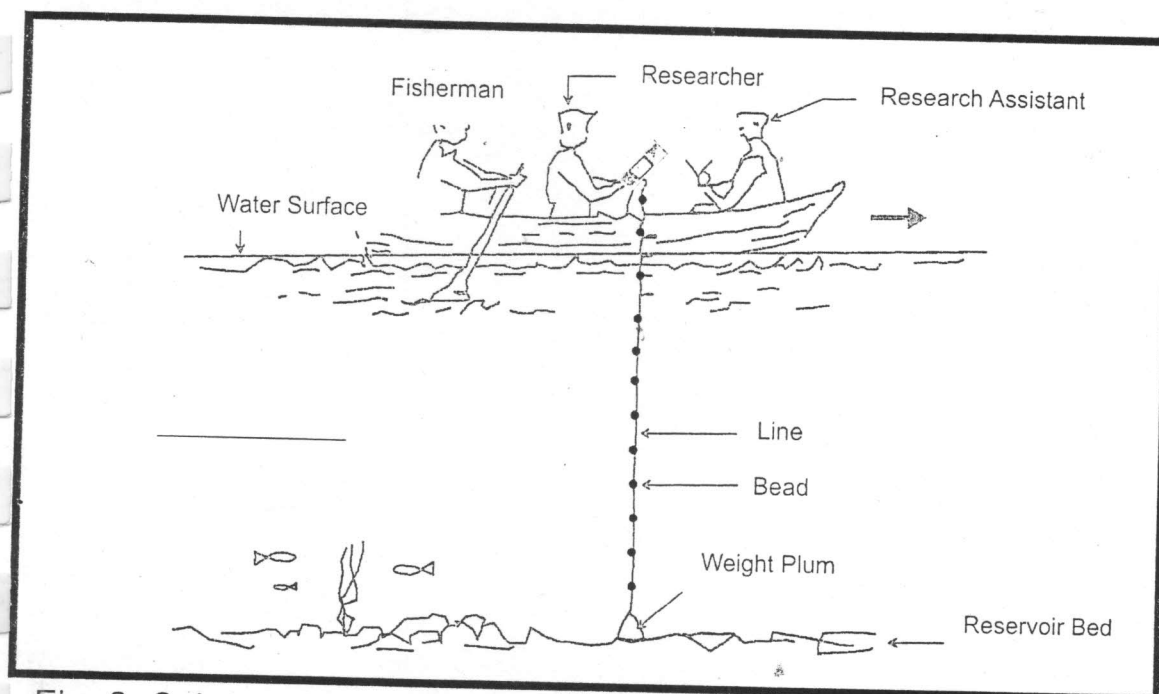


Fig. 2: Schematic Representation of Data Collection Process
 Source: Adapted from Busari, Ejieji and Abegunrin (2013)

DATA ANALYSIS AND DISCUSSION OF RESULTS

Depths of lake at Sampling Points

Table 2 shows the lake depth in each of the 45 sampling points.

Table 2: Depths of Lake at Sampling Points

Lake Embankment					
West Bank	2.3	2.1	2.3	2.3	1.8
	2.7	5.7	8.7	7.4	2.2
	2.6	5.1	8.5	6.8	2.7
	2.4	3.9	8.4	7.6	3.8
	2.3	3.6	8.1	7.8	3.8
	2.4	3.8	7.5	7.2	3.1
	1.9	3.7	7.4	4.6	2.9
	1.7	3.5	6.9	3.5	2.9
	1.5	3.1	6.2	3.2	2.8
(Upstream)					
East Bank					

Source: Author's Fieldwork, 2014

From Table 2, it is obvious that the depth of Oyun dam exhibits high variability. Maximum depth of 8.7m was observed in the midsection at a distance of about 80 meters away from the embankment while the shallowest point (1.5 meters) was observed in the south-western bank of the lake at a distance of about 360 meters upstream of the embankment. The lake was generally shallow at the banks, especially at the west bank and deep in the central region. The current mean depth of the lake based on the data collected is 4.33 meters.

When Oyun dam was commissioned in 1967, it had initial depth of 7m; this depth was later raised to 9.75m in 1988. Since field observation in this study estimate the mean depth to be 4.33m; this thus indicates that Oyun dam has recorded as a loss in depth of about 5.42m to silts and sediments. This value represents about 55% loss in storage capacity since the dam was commissioned 47 years ago. The 55% loss in storage capacity of Oyun Dam over a period of almost five decades reflects what is obtainable in similar earth dams, especially in tropical environment. This is because, such dams usually acts as filter by allowing inflow of water and sediments

into the reservoir throughout the year while allowing only the suspended sediments to flow out in the short period the reservoir is full during the rainy season. The bed loads which are carried into the lake all year round are usually

retained, hence the gradual increase in height of the lake bed.

Figures 3 and 4 show the underwater contour pattern and a 3-dimensional image of underwater topography.

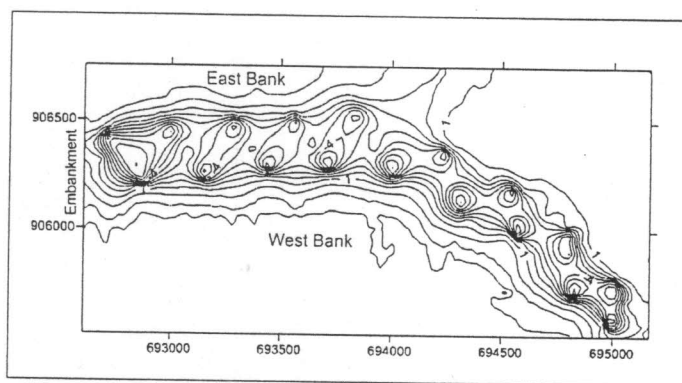


Fig. 3: Underwater Contour Pattern of Oyun Dam

Source: Author's Finding (2014)

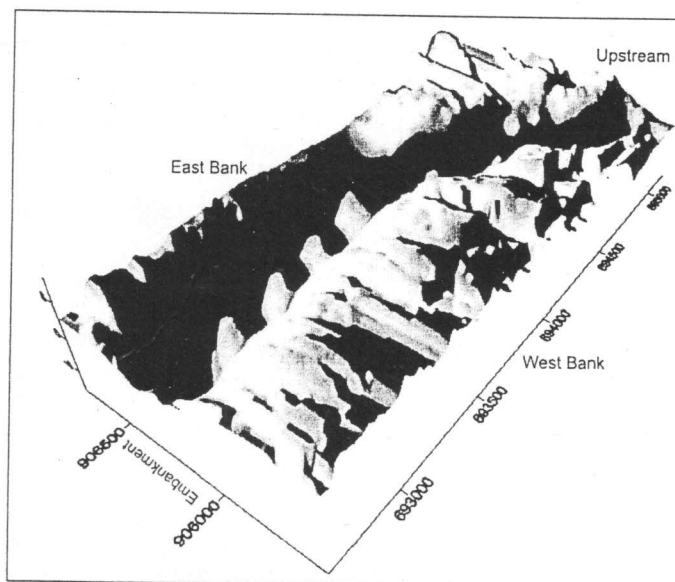


Fig. 4: Dimensional Image of Underwater Topography

Source: Author's Finding (2014)

These two figures revealed higher sediment deposition in the western and eastern banks of the lake than in the mid-lake region. Depth of sediment deposited in the mid-lake region ranges between 1.1

and 7.5m while sediment depth for western and eastern banks ranges between 7.1 and 8.3m and between 6.0 and 7.6m respectively (Table 3).

Table 3: Depths of Sediment at Sampling Points

Embankment					
West Bank	7.5	7.7	7.5	7.5	7.0
	7.1	4.1	1.1	2.4	7.6
	7.2	4.7	1.3	3.0	7.1
	7.4	5.9	1.4	2.2	6.0
	7.5	6.2	1.7	2.0	6.0
	7.4	6.0	2.3	2.6	6.7
	7.9	6.1	2.4	5.2	6.9
	8.1	6.3	2.9	6.3	6.9
	8.3	6.7	3.6	6.6	7.0
South (Upstream)					
East Bank					

Source: Author's finding, 2014

While the high siltation at the eastern and western sides of the lake may not be unconnected with erosional activities on the land bothering these two regions of the lake, the higher siltation at the western side may be the direct result of land use activities in the immediate western vicinity of the lake. This side, unlike the eastern region, is highly built-up. Extensive

property development is also taking place in this region with the attendant problem of high soil wash. The growth pattern of Ijagbo, the settlement in which the dam is located is also titled in this direction. Studies such as Simon and Senturk (1992), Frenette and Julien (1996), Abu (2011) and Busari *et al* (2013) have linked reservoir sedimentation to complex interrelation-

ships between climate, drainage basin characteristics and human activities. Sediment deposition in reservoirs does not only result in loss of storage, but also influences placement of sluices and affects floods lines upstream of reservoirs (Annandale, 1984).

CONCLUSION

This analysis has showed that Oyun dam has lost 55.8 percent of its installed capacity within a period of 47 years to siltation problems. Though, the estimated annual loss in depth to sedimentation for the 47 year period is 0.12 meters deep; it is therefore believed that the current rate of sedimentation will be higher than this figure because of increased rate of anthropogenic activities within the catchment area especially in the recent years. Thus, it is right to predict that within the next three decades, Oyun dam would have been completely silted up if drastic measures are not taken to reduce the rate of solid leakage into the reservoir. Though reservoir siltation is not a process that can be completely stopped, the rate of the process can be substantially reduced through monitoring and control of catchment land-use pattern. This is germane as studies by Adejuwon and Jeje (1977), Annandale (1987), Komolafe and Wakili (2004), Nabegu (2005), and Kamaleldin *et al* (2010) have linked dam sedimentation problems with the deforestation activities and poor landuse management. According to Simons and Senturk (1992), reservoir sedimentation problems result from complex interrelationship between climate,

drainage basin, fluvial system and human activities.

Sediment deposition in reservoirs does not only result in loss of storage capacity, it also impairs water quality and influence placement of sluices. Dam sedimentation stimulates growth of aquatic weed and algae and affects flood lines upstream of reservoirs (Annandale, 1984; Michael and Ojha, 1999; Busari *et. al.* 2013).

In order to abate the aforementioned problems induced by reservoir sedimentation, efforts should be directed at:

- i. Studying and monitoring landuse and discharge pattern in any basin intended to be used for reservoir construction,
- ii. Enforcement of proper landuse regulation,
- iii. Promotion of good soil conservation practices, and
- iv. Controlling of indiscriminate refuse disposal.

REFERENCES

- Abu, R. D. (2011): Water Resources Management in the Context of Global Climate Change: Application of Conventional Hydrographic Survey in Monitoring Sedimentation in the Lower Usuma Dam, Abuja. *NIMET Proceedings*, 113-119.

- Adejuwon, J. O. and Jeje, L. K. (1977): University of Ife Water Supply Scheme: Potential Environmental Hazards. In Adejugibe, O. and Hellenir, F. M. (eds.) *Environmental and Spatial Factors in Rural Development in Nigeria. Proceeding of Nigerian Geographical Association.*
- Akar, A; Gokalp, E; Bayata, H. and Akar, O. (2010): Determining the Effects of Degirmendere Rive on Trabzon Habor After Construction of Black Sea Highway on Black Sea Coast. *Scientific Research and Essays*, 5, 2965-2974.
- Anderson, H. W. (1969): Relating Sediment Yield to Watershed Variables. *Trans. Amer. Geophysical Union*. 38(6): 921-924.
- Annandale, G.W. (1984): Predicting the Distribution of Deposited Sediments in Southern African Reservoirs, *Proceedings of Harare Symposium on Challenges in African Hydrology and Water Resources*, IAHS Publication No. 144: 549-558.
- Annandale, G.W. (1987): *Reservoir Sedimentation*, Elsevier Science Publishers, Amsterdam.
- Basson, G. R. (2009): Management of Siltation in Existing and New Reservoirs. *General Report*, Q89.
- Beilicci, E. and Beilicci, R. (2013): Study and Forecast of Reservoirs Silting of Barzava River Watersheds. *Proceedings of 13th SGEM Geo Conference on Water Resources, Forest Marine and Ocean Ecosystems*, 325-332.
- Busari, T.I; Ejieji, C.J. and Abegunrin T.P. (2013): A Study of Storage Capacity Degradation of Agba Reservoir in Ilorin, Kwara State, Nigeria. *Proceedings of the 1st Regional Workshop by National Water Capacity Building Network, North Central Regional Centre, University of Ilorin*, 189-196.
- Egbulem, A.N. (2002): Note on River Siltation. *National Water Resources Institute Bulletin*, Kaduna, Nigeria.
- Federal Government of Nigeria (2000): Water Supply and Sanitation, *Interim Strategy Note*
- FMWRRD (1994): National Water Rehabilitation Project: *Final Planning Report, Kwara State*. Federal Ministry of Water Resources and Rural Development. Vol. 6 Tahal Consultants, Ibadan, Nigeria.
- Frenette, M and Julien, P.Y. (1992): Physical Processes Governing Reservoir Sedimentation. *Proceedings of International Conference on Reservoir Sedimentation*
- Ijaiya G.I. (2000): Impact of Water Shortage and Depletion of the Productive Time of Women in Ilorin Metropolis: A Pilot Survey. *GeoStudies Forum*, 1 (1 and 2): 38-45.
- Imevore, A.M; Ogunkoya, O.O. and Sagna, V.O. (1988): Effects of Soil Erosion on Aquatic Ecosystem in Nigeria, In: Sauga, V.O et al (eds.) *Ecological Disasters in Nigeria: Soil Erosion*. Federal Ministry of Science and Technology, Lagos.
- Kamaleldin, E; Tahir, O. E; Sami, A.F, Alnazir, S.A; Muna M and Ishraqa, O.S. (2010): Nile Basin Reservoir Siltation Prediction and Mitigation. *Hydraulics Research Institute Publication*, 13621, Cairo, Egypt.
- Komolafe, B. and Wakili, G.K (2004): Reservoir Mapping and Volume Computation: A Case Study of College of Agriculture and Animal Science, ABU Dam, *National Water Resources Institute Publication*, Kaduna.
- Kwara State Water Corporation (2009): *Water Supply Situation in Kwara State, Nigeria*.
- Mahmood, K. (1987): Reservoir Sedimentation: Impact, Extent and Mitigation. *World Bank Technical Paper*, No. 71. World Bank, Washington, D.C.
- Michael, A.M. and Ohja, T.P. (1991): *Principle of Agricultural Development*, Vol. II. Jain Brothers, New Delhi-110005.

- Nabegu, A.B. (2005): Determinant of Sediment Yield in River Basins: Implications for Reservoir Management. *International Journal of Environmental Issues*, 3 (2): 40-49.
- Okeola, O.G. (2000): Evaluation of Effectiveness of Oyun Regional Water Supply Scheme, Kwara State. *Unpublished M.Eng. Dissertation*, University of Ilorin
- Oyegun, R. O. (1983): *Water Resources in Kwara State Nigeria*. Matanmi & Sons Publishers 113pp.
- Simons, D. B. and Senturk, F. (1992): Sediment Transport Technology: Water and Sediment Dynamics. *Water Resources Publications*, 897.
- WHO (2004): *Water, Sanitation and Health*, World Health Organization, www.who.int/water.