

Inventory and Preliminary Limnological Investigation of Lakes in Opi-Agu, Enugu State, Nigeria

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Abstract: *The purpose of this work was to take a full inventory of existing lakes in a study area where only one lake was recognized. Field trips yielded a total of nine lakes classified genetically and also the basis of trophic characteristics. Three of the lakes have a tectonic origin while six are oxbow lakes formed by fluvial processes. One lake tends towards eutrophication. Eight of the lakes are mesotrophic. All the lakes have excellent biodiversity that will require further investigation.*

Keywords: Opiagu, inventory; biodiversity; tectonic lakes.

1. Introduction

Lakes provide over 50% of the freshwater on earth. They are beneficial to every community where they exist- in the areas of tourism, nature viewing and recreation. It is also an important ecosystem inhabiting all kinds of biodiversity, promoting soil formation and recharging the groundwater system.

In Nigeria, little attention has been given to the study and development of lakes except for the rather large ones like Lake Chad or Kainji. In southeastern Nigeria, some moderate but low-key attention has been given to study of Agulu Lake (Egboka et al, 2006). In Enugu state, where the study area is located, only the Nike Lake at Enugu is well known but in Opi-Agu (less than 30 minutes drive from Nike Lake), there are nine beautiful lakes. Only one of the nine lakes has received any kind of investigative attention and that is by Odo et al, (2014). The reason for this is that for decades, Opi-Agu community was not easily accessible. Eight of the lakes are not yet well known to academia and government authorities but interests in the study area has lingered since the first study of landforms in the area by Grove (1951). Ofomata (1978) studied the geomorphology and geology of the Nsukka region respectively but no details were given about Opi-Agu specifically. Gobin et al. (1999) gave some insights on the gully erosion processes taking place at the escarpment where Opi-Agu is located. Ifediegwu (2013) studied the geology of Opi-Agu and discussed these nine lakes. Odo et al. (2014) wrote on the spatio-temporal

distribution and limnology of crustaceans of only one lake while Ozoko (2015) discussed the hydrochemistry of the lakes.

The aim of this study is to inventorise the existing lakes in the Opi-Agu and provide a preliminary description of their physical characteristics, lake water chemistry and biodiversity with the aim of attracting further research attention from geologists, limnologists, zoologists, botanists and possible government interest in developing these lakes. This should boost the tourism potential of the state.

2. Study Area

1) Location

Opi-Agu is situated northeast of Nsukka, Enugu State, Nigeria. It is bounded by Eha-Alumona in the north, Ugwogo Nike in the south, Mbu in the east and Ekwegbe in the west. It lies between longitudes 7^o28¹E and 7^o33¹ E and latitudes 6^o42¹N and 6^o47¹ N. The area occupies a landmass of about 85.5km² with an estimated population of about 3000 persons. The primary occupation of the people is sand mining and subsistence farming.

2) Physiography and Geology

Figure 1 shows the 3-D topography of the area. Apart from a few conical hills, the rest of the area is marked by a plateau, escarpment and lowland. The most prominent topographical features in the area are north-south trending cuesta over Ajali Sandstone.

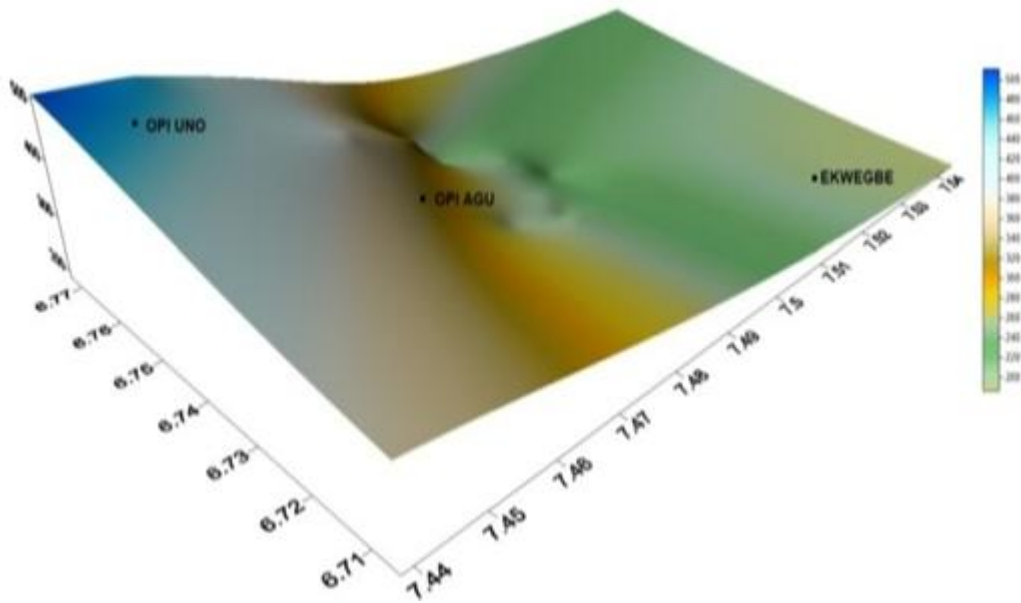


Figure 1: 3-D topography of the area

This cuesta (Udi-Nsukka) was formed during the Lower Tertiary by minor compression and upwarping of the sediments due to tectonic activity and subsequent removal of the eastern limb of the anticline (Pritchard, 1979). The area has an average temperature of about 28°C and 1506mm annual rainfall. (Ofomata, 1978). The study area lies within the tropical rainforest/Guinea Savannah belt of Nigeria (Iloeje, 1978). During the Benue Rift formation, Nsukka region was part of the Anambra Syncline which filled up with Upper Cretaceous and Paleocene (Danian) sediments (Benkhelil, 1988; Popoff, et al; 1988). The study area consists of the Ajali Formation in the upper section, the Mamu Formation in the middle and Nkporo Formation at its base.

The Ajali Sandstone is composed of very friable, medium to coarse-grained, subrounded quartz arenites with massive herringbone cross-bedding structure. The Mamu Formation is overlain by Ajali Sandstone. It consists of clays, shales, carbonaceous shales and coal seams. (Akande et al., 1992). Nkporo Formation underlies the Mamu Formation. It is composed of dark grey shales and interbedded sands and shales (Ladipo et al 1992). The formation strikes N-S and dips westward, with an average dip between 4°-8° (Umeji, 1980)

3. Physical Characteristics of the Lakes

The nine lakes which were discovered in Opi-Agu are typically freshwater lakes. The main physiographic features of the lakes are summarized in table 1. Lakes Varavara (fig. 4) and Iyi-Ikpa (fig. 7) occupy the highest elevation of 263 meters above sea level while Lake Ojii (fig. 1) is at the lowest level (191m). The deepest lake is Lake Adekwegbe (fig. 8) while the shallowest ones are lakes Varavara (fig. 4) and Isiogba (fig. 9) Lakes Ojii, Varavara, Ogeleube, Iyiuga, Iyi-ikpa and Okpo are located in the valley of river Uhere while Adekwegbe, Isiogba and Orufu are located at the foot of the hills in the area. The water level in the lakes gets lowered as the dry season progresses except lakes Adekwegbe and Orufu which maintain their levels throughout the dry season. The lakes have no permanent inlet but during the rainy season when river Uhere is flooded the lakes overflow through their lower ends. The water colors (especially lakes Adekwegbe and Orufu) range from brown to reddish brown. The bright reddish browns indicate seasons of high oxygenation while the dull black colors suggest the onset of reducing conditions.

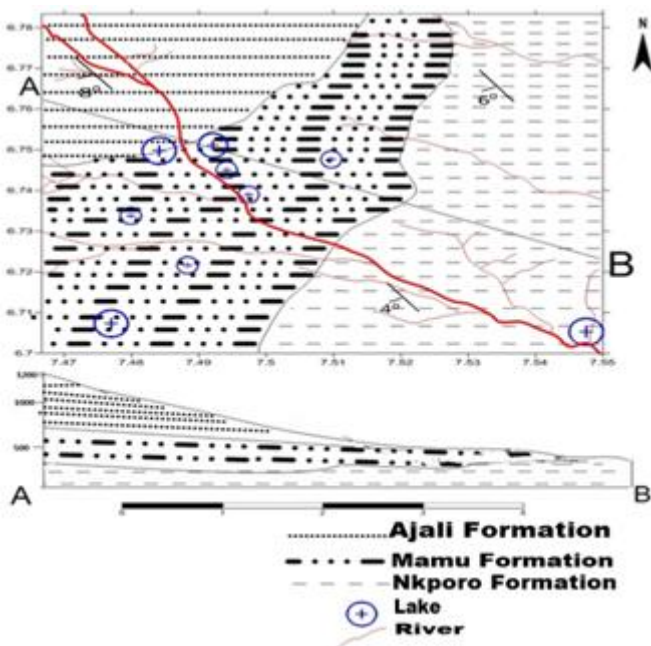


Figure 2: Geologic Map of the Study Area

Lakes	Location	Location	Elevation	Length	Width	Dept
Ojii	N6°42'10.7 ¹¹ E7°32'52.9 ¹¹	Ozioko	191m	1km	250m	7.5m
Varavara	N6°45'33.4 ¹¹ E7°29'05.4 ¹¹	Umueze-aguiyi	263m	500m	90m	3m
Ogeleube	N6°45'16.12 ¹¹ E7°29'26.9 ¹¹	Amaogbodo	246m	300m	30m	4m
Iyiuga	N6°44'54.4 ¹¹ E7°29'36.1 ¹¹	Ogbozara	237m	200m	150m	6m
Okpo	N6°44'35.5 ¹¹ E7°29'49.9 ¹¹	Amuda	221m	250m	100m	6m
Iyi-ipka	N6°45'44.5 ¹¹ E7°29'08.8 ¹¹	Amukpa	263m	100m	30.7m	5.4m
Isiogba	N6°44'13.3 ¹¹ E7°29'25.2 ¹¹	Umuille	249m	400.5m	150m	3m
Adekwebge	N6°43'45.4 ¹¹ E7°29'20.1 ¹¹	Ekwegbe	248m	900m	400m	9m
Orufu	N6°44'05.6 ¹¹ E7°28'54.3 ¹¹	Umuille	249m	700m	150m	7m



Figure 1: Ojii lake N6°42'10.7¹¹ E7°32'52.9¹¹



Figure 4: Varavara lake N6°45'33.4¹¹ E7°29'05.4¹¹
 (note that the water hyacinth on the lake surface).



Figure 2: Orufu lake N6°44'05.6¹¹ E7°28'54.3¹¹



Figure 5: Iyiuga lake N6°44'54.4¹¹ E7°29'36.1¹¹



Figure 3: Okpo lake N6°44'35.5¹¹ E7°29'49.9¹¹
 (note that the lake surface is overgrown with plants).



Figure 6: Ogeleube lake N6°45'16.12¹¹ E7°29'26.9¹¹



Figure 7: Iyiikpa lake N⁶45¹44.5¹¹ E⁷29¹08.8¹¹



Figure 8: Adekwegbe lake N⁶43¹45.4¹¹ E⁷29¹20.1¹¹



Figure 9: Isiogbalake N⁶44¹13.3¹¹ E⁷29¹25.2¹¹

4. Genesis and Classification of Lakes

The origin of lakes Adekwegbe, Orufu and Isiogba is connected with santonian tectonism that gave rise to undulating plains and uplifts. The santonian tectonism was discussed by Popoff (1988), Fairhead and Leach (1996), Obi et al; (2001), and Obi and Okogbue (2004). Lakes Ojii, Varavara, Ogeleube, Iyiuga, Okpo and Iyi-ikpa are oxbow lakes which were formed due to fluvial processes involving meandering of the Uhere River. Table 2 is an attempt to classify the lakes on the basis of their mode of origin.

Table 2: A classification of Opiagu lakes on the basis of mode of formation

S/N	Lake	Geological Formation	Origin	Types
1	Varavara	Ajali	fluvial	Oxbow
2	Iyikpa			
3	Ogeleube			
4	Iyiuga	Mamu	Tectonic	Tectonic
5	Okpo			
6	Orufu			
7	Isiogba			
8	Adekwegbe	Nkporo	Fluvial	Oxbow
9	Ojii			

The lakes may also be classified on the basis of their trophic characteristics. Table 3 shows the trophic classes of the lakes on the basis of their observed biodiversity

Table 3: Trophic classification of the lakes

S/N	Lakes	Trophic State	Nutrient Characteristics
1	Iyi-ikpa	MESOTROPHIC	Increased production, Accumulated organic matter, Occasional algal bloom and Good fishery.
2	Varavara		
3	Ogeleube		
4	Iyiuga		
5	Isiogba		
6	Ojii		
7	Orufu		
8	Adekwegbe		
9	Okpo	EUTROPHIC	Very productive, may

Table 3 indicates that except for Okpo Lake, which is trending towards eutrophication, all the other lakes are mesotrophic.

5. Lake Water Chemistry

Table 4. shows selected physico- chemical and nutrient characteristics of the lake waters. The pH varies from 5.1 to 6.6 which represent a slightly acidic geochemical environment. The temperature range (at noon) goes from 26⁰C to 31⁰C while electrical conductivity goes from 12μS/cm to 33μS/cm. The value of total dissolved solids shows very low solute concentrations.

Values of NO₃ and PO₄ reflect the nutrient characteristics of the lakes. The nitrate levels range from 3.88mg/l to 80.17mg/l while the phosphate levels go from 0.015mg/l to 90.00mg/l. High levels of NO₃ and PO₄ suggest a system with moderately high nutrient loading. Some of the lakes have black bottoms thereby indicating dead organic matter. These lakes display stratification of their water layers which may be due to temperature or density differences. The black bottom suggests possible anoxic geochemical conditions.

Table 4: Selected physico- chemical parameters for the lakes

LAKES	pH	TEMP °C	EC μs/cm	TDS Mg/l	PO ₄ ²⁻ Mg/l	HCO ₃ ⁻ Mg/l	NO ₃ ⁻ Mg/l
Ojii	5.6	26 ⁰ c	19	1.9	0.020	15.25	25.43
Orufu	6.4	29 ⁰ c	33	3.3	0.282	15.25	36.64
Ade-ekwegbe	6.6	29 ⁰ c	29	2.9	90.00	41.41	12.07
Isiogba	5.8	25 ⁰ c	29	2.9	0.015	91.50	23.71
Okpo	6.0	29 ⁰ c	30	3.0	0.042	30.50	4.74
Iyiuga	6.0	29 ⁰ c	12	1.2	0.020	15.25	23.47
Iyi-Ipka	6.2	28 ⁰ c	12	1.2	0.028	30.50	80.17
Ogeleube	6.5	31 ⁰ c	13	1.3	0.037	15.25	3.88
Varavara	5.1	30 ⁰ c	16	1.6	0.026	30.50	23.71

All the lakes listed in this inventory are full of biodiversity in terms of plants and animals. All of them have animals like fishes, crocodiles, pythons and amphibians. Fourteen species of plants (Table 5) were easily identifiable in the lakes but the diversity is far greater.

Table 5: Plants diversity in the lakes of the area

Family	Species
Commelinaceae	Commelinadiffusa
Cabombaceae	Braseniaschreberi
Azollaceae	Azollafiliculoides
Apiaceae	Centellaasiatica
Nymphaeales	Nymphaea alba

Typhaceae	Typhalatifolia
Araceae	Lemna minor
Verbenaceae	Lantana camara
Poaceae	Paspalumdimidiatum
Dioscoreales	Dioscoreabulbifera
Polypodiaceae	Fern
Cyperaceae	Rhynchospora alba
Chlorophyceae	Green algae
Poaceae	Chrysopogonzanioides

At least 50 types of invertebrates were sampled. About 16 of them were identified to species level. See Table 6.

Table 6: Animal diversity in the lakes

<i>Insects</i>	<i>Animals</i>
Species	Species
Arctocoriixinterrupta	Buttikoferi cichlid
Damselfly	Kribensis cichlid
Ranatrafusca	Cobra
Aeshnabrevistyla	Crocodile
Nepa species	Peacock cichlid
Helobatalarvalis	Python
Coccinell species	Perch
Water penny	Percafluviatillis
Argyronta aquatic	Cat fish
Water strider	Moorei cichlid
Lethocerusamericannus	Cobalt zebra cichlid
Leech	Borleyi cichlid
Water mite	Venustus cichlid
Antipodochlorabraueri	
Orectochilusorbisonorum	
Acroneuriacycorias	

6. Conclusion

This inventory demonstrates the need for all the lakes and rivers in Opiagu to be studied in greater detail particularly in the area of biodiversity. This would help in formulating policies that would protect the plants and animal species in these lakes and develop these lakes for tourism purposes.

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