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Post Impact Studies Of The 2012 Flooding On The Environment And Health Of Oguta Residents, Southeastern, Nigeria

UMUNNAKWE Johnbosco Emeka[1], NNAJI Austin Osondu
Department of Environmental Technology, Federal University of Technology, Owerri
Imo State, Nigeria
jnboscokwe@yahoo.com[1]

***Abstract*—The menace of flooding ravaging Oguta Local Government Area of Imo state Nigeria has been a recurrent phenomenon since 1947. This research investigated the post impact of 2012 flooding on the environment and health of Oguta residents during the wet season of July 2015. This was achieved by identifying affected locations and investigating the degree of impacts at such locations. Both the positive and negative post impacts of the flood were examined through the use of questionnaires, direct field observation and by physico-chemical analysis of soil and surface water bodies. The respondents stated that negative impacts such as; loss of lives and properties, destruction of farmlands, poor drinking water, pollution of the environment, inaccessibility to healthcare services and deterioration of health condition due to waterborne diseases like malaria, cholera and diarrhea etc were prevalent during and after the flood. The positive impacts of the flood as stated by the respondents includes; improved fertility of the soil along flood plains and increased fish production. The result of questionnaires also revealed the prevalence of waterborne diseases such as Faecal Oral Infections manifesting as diarrhea, vomiting, typhoid fever, cholera and abdominal pain. The physico-chemical composition and microbial quality of 2 different water sources Oguta Lake and Awbana River were investigated using the United States Standard Methods for Examination of Water and Wastewater (SMEWW). Average values for surface water Nitrate (18.2, 58.7), Dissolved Oxygen (9.7, 6.1), Biological Oxygen Demand (6.2, 2.9), Alkalinity (196, 128), Iron (0.000, 1.522), Lead (0.125, 0.026), Aluminum (0.63, 0.49), Cadmium (0.109, 0.034), Cobalt (0.318, 0.405) from Oguta Lake and Awbana River respectively, were observed to be slightly above the background values or control extracted from study carried out before the flood and WHO standard for drinking water. It was also observed that average soil values for Chloride (2514.5, 4263.8), Iron (7.672, 14.727) and Copper (0.057, 0.062) for Oguta Lake and Awbana River respectively were above WHO standard. Microbial analysis carried out indicated the presence of coliforms, fecal contamination of the water and the presence of other pathogenic organisms with total plate count at Oguta (10cfu/100ml) and Awbana River (50cfu/100ml). Collected data were subjected to statistical analysis using the SPSS and Excel. Direct field observation revealed environmental impacts such as soil erosion, drainage blockage, poor crop stands indicative of high flow velocity of the flood, fertility of soil along flood plains is indicative of a positive impact of the flood event. Results of physico-chemical analysis generally show contamination of environment with heavy metals in the flood affected area. Finally this study concluded by making recommendations which includes free medical care to residents of affected area, use of proper agricultural practices to improve the soil fertility of the affected area and discouraging infrastructural development such as buildings, houses and open markets, along flood prone areas to mitigate and minimize the impact of flooding on lives and properties.**

Keywords—Oguta, Flood, Post impact, Physicochemical, Questionnaire, Analysis

1. INTRODUCTION

A flood is a body of water which rises to overflow land which is not normally submerged. Flooding is generally regarded as a devastating event worldwide [1] and has been reported as the most common environmental hazard in Nigeria [2]. Flood results from a number of causes, ranging from climatological events [3] to anthropogenic events [4] . General rise in sea level due to global warming, as well as the saturated nature of the wetlands are some often-mentioned causes of flooding. Flood occurs when ponds, lakes, river beds, soil and vegetations cannot absorb all the water, thereby forcing water to run off the land in quantities that cannot be carried within stream channels or retained in natural ponds, lakes and man-made reservoirs (dams). Flood can occur in rivers when the flow rate exceeds the capacity of river channel. The biggest and most destructive flood in the history of Nigeria was the 2012 flooding. Given that flooding have some negative impacts that stretches far beyond the time of the flood, and these impacts were made worse by the scale of the flood [5].

The 2012 flooding started in Plateau state in July, spread through Borno, Cross river, Ebonyi, Nassarawa, Bauchi, Gombe, Katsina and Kebbi states in August, hit Taraba, Benue, Niger, Kaduna and Kano in September, before affecting Delta, Bayelsa, Rivers and Imo states in September and October [6]. The flood lasted till early periods of December 2012. Many years after the waters of the flood have receded; the effects of the flood are still keenly felt, hence the need for this study to determine the post-impacts of the 2012 flood on the residents of Oguta after three (3) years.

The areas normally affected by flooding generally are areas that are on a flat or low lying areas located close to any river system. One of the areas in Imo state, Nigeria mostly affected by 2012 flood were *Oguta I* and *Oguta II* comprising different communities and riverine areas, such as *Orsu, Nnebukwu, Orsu Obodo, Opuoma, Ezi Orsu*.

Flooding has adverse effects not only on the environment and infrastructural facilities, but also on the health of individuals in the affected community. Serious health impacts identified to be associated with flooding are: injuries such as cuts, sprains, and lacerations; incidence of faecal-oral disease such as cholera; appearance of rodent-borne disease such as Leptospirosis (an infectious disease of human and animal that is caused by pathogenic spirochetes of the genus Leptospira); an increase in vector-borne diseases such as malaria; impairment of mental health manifesting in anxiety and depression; increase in post traumatic stress manifesting as sleep disturbances, irritability and anger.

As reported by Vanguard newspaper [7] the degree of harm caused by the rampaging flood to the hapless citizens and the environment is better imagined than seen. Two people were reportedly drowned in Oguta axis, fish ponds, cocoa plantations, farm lands, plantain, cassava, economic trees and crops were under water. The bridge connecting *Oguta* and *Egbuoma* was swallowed leaving over 1,000 homes sacked in *Oguta*. The multi million Naira *Erima Agwuagu* Plantation was in water. In view of the flooding, which occasioned the washing away and submersion of the crops and plants, the farmers lost their crops and had no hope of getting seedlings. Again, most people lost their houses where they lived, in addition to losing their ancestral homes. The water was polluted; people in the affected communities were exposed to the epidemic outbreak of malaria, typhoid fever, cholera and trauma. The cumulative effect of the 2012 flooding was that in the long term, residents would no longer have a place to live and there is the possibility of famine and starvation.

2. STUDY AREA

Location:

Oguta is located within latitude 5°42" N – 5°50" N and longitude 6°48" E - 7°02" E and it is located within the Anambra basin (Fig.1). Oguta is a town on the east bank of Oguta Lake in Imo State (south-eastern Nigeria) and shares boundaries with Anambra, Delta and Rivers States. Oguta is a socio-geographic community town with a surface area of approximately 2,025.75 square kilometres, with a projected population of 142,340,167,040 [8] and 20,466 after the 2012 flood [9]. The Metropolitan City of Oguta is blessed with

a Blue Lake, which happens to be the largest natural lake in Imo State and the second largest natural lake in Nigeria after Lake Chad.

Climate and Vegetation:

Oguta has a tropical climate, with significant rainfall in most months of the year and only a short dry season [10]. The average annual temperature in Oguta is 26.9° C according to Köppen-Geiger climate classification [11] with a precipitation of about 2129mm falls annually [10]. The driest month is December with a precipitation of 15mm and an average precipitation of 339mm. The dry season lasts from October to March and rainy season from April to September [12]. The warmest month of the year is March with an average temperature of 28.5° C. In August, the average temperature is 25.4° C which is the lowest all year round. The difference in precipitation between the driest month and the wettest month is 324mm, while the average temperatures vary during the year by 3.1° C (CLIMATE-DATA, 2014). The vegetation is typically tropical rain forest which plays a significant role in both physical and chemical weathering. The vegetation is characterized by shrubs, herbs layers, palm trees, bamboo trees and agricultural plants [13].

Weathering and Soil:

[14] observed that the topsoil is composed mainly of lateritic soil (iron-rich soil) due to oxidation through exposure to the atmosphere.

Geology and Hydrogeology:

Some part of Oguta is also characterized by the presence of Benin formation (Fig. 2) Benin formation comprises a thick sequence of poorly consolidated to unconsolidated sandstones that are friable and poorly to medium sorted [14]. The presence of Benin formation is a contributory factor to soil erosion [15]. The geology as outlined above controls the occurrence and distribution of ground water in the area. The sandy units form a prolific potential aquifer with groundwater regionally occurring under unconfined situations [16].

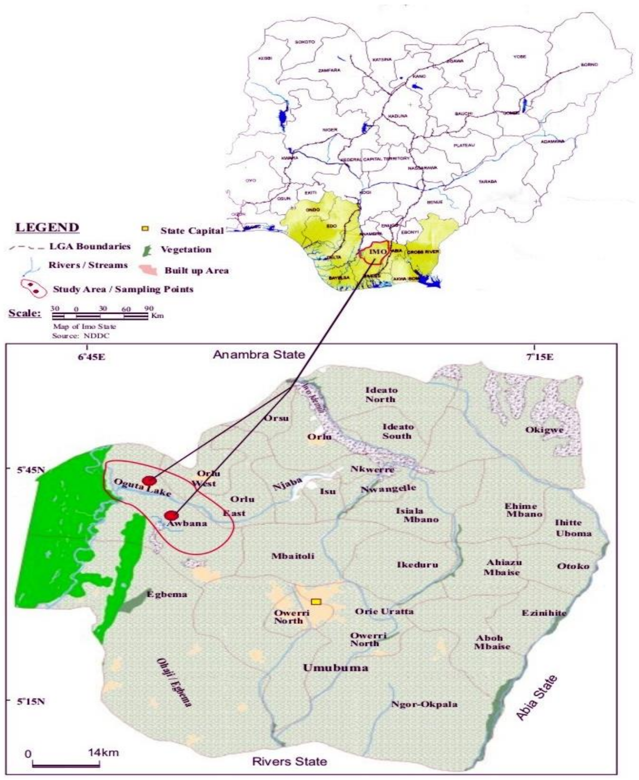


Fig. 1: Map of Nigeria showing Imo state and study area (Oguta)

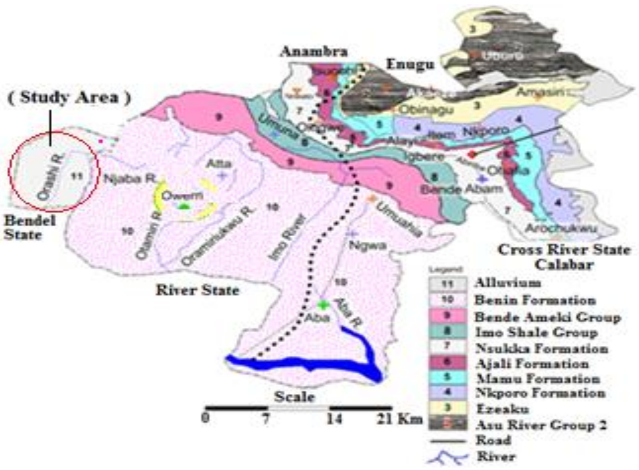


Figure 2: Geological Map of Imo River basin, showing the Study Area

3. RESEARCH METHODOLOGY

The methods adopted for the post impact of the 2012 flood on Oguta residents involvecd the use of questionnaires, direct field observation and by sampling and physico-chemical analysis of soil, sediments and surface water bodies. Collected data were subjected to statistical analysis using the SPSS and Excel packages. Questionnaire administration was used to generate primary data from respondents in the study. A total of 95 questionnaires were distributed to respondents in some affected villages of *Oguta I* (*Ngegwu and Lake side*) and *Oguta II* (*Awa-omamma, Ezi-orsu, and Orsu-obodo*) in Oguta Local Government Area of Imo State, 90 copies were retrieved from respondents. In order to collate salient information on the diseases prevalent during the 2012 flooding in Oguta, an interview session was held with the Matron at the General Hospital, Oguta . The field observation and footage of the 2012 flood event in affected areas of Oguta were viewed with the aid of video images captured using the Sony Digital camera during the flood in October 2012. The samples (water, soil and sediments) used for the analysis during the study, were collected from 2 different study locations in Oguta Local Government Area: Oguta Lake and Awbana River. The results of physico-chemical analysis of Oguta and Awbana River from a similar study conducted before the flood in 2012 was used as background values (control). This is to accurately compare the present level of contamination in Oguta Lake and Awbana River, three (3) years after the flood.

The samples collected for physico-chemical analyses were placed in 2 liters sterilized plastic containers. The containers were washed with detergents, rinsed with distilled water and 75% alcohol, finally rinsed with de-ionized water, to ensure that the containers are physically and chemically clean. At each sampling point, the containers were rinsed three times with the water sample to be analyzed and sealed appropriately. All physico-chemical and biological variables were analysed in the laboratory Analyses were done approximately 24 hours after collection of the samples. The results from the study were compared with the background values and WHO standards for drinking water and soil quality.

pH was determined using hand held pH meter (model HI98107 - HANNA).The pH meter probe was inserted into the lake and river 10 minutes after the meter was switched on and the stable reading was recorded. The temperature of each sample was taken at sampling point by the use of thermometer (Brannan nitrogen filled, England). This was done by inserting the thermometer into the Lake and river. Conductivity was determined with HANNA Conductivity meter Model HI 9835. The system was allowed to stabilize and the reading was recorded [17]. EC is expressed as µS/m. Turbidity was determined by photometric method using HACH DR/2010 spectrometer at a wavelength of 860nm and programme number 750. The value was then digitally displayed in mg/l.

The BOD was measured using the Dissolved oxygen $(DO)_1$ determined with the oxymeter at the sample locations. Water sample was directly collected into BOD amber glass bottle (free of air bubbles), kept below 4°C in a cooler, transported to the laboratory and stored in the refrigerator until analysis (within 24 hours). The BOD bottles were incubated at 20°C in the dark for 120 hours and the amount of oxygen consumed was measured. The biochemical oxygen demand was calculated after five days (BOD 5), using the formula:

BOD_5 = Initial DO –Final DO x Dilution factor

Total Solids refers to matter suspended or dissolved in water or wastewater, and is related to both specific conductance and turbidity. Empty beaker was initially weighed, 50mL of the water sample was measured and poured into the weighed beaker and heated gently to dryness at about 70°C. This was then cooled and reweighed. The process was repeated until a constant mass was obtained and the value recorded [17].

Potassium and sodium were determined by standard procedure using flame photometer, while Cd, Cu, Pb, Fe, and Co were determined after digestion with HCl using a Buck scientific Model AVG 210 flame atomic absorption spectrophotometer - AAS (UNICAM Model 969 AA). This involved direct aspiration of the water samples into an air/acetylene or nitrous oxide/acetylene flame generated by a hollow cathode lamp at a specific wavelength peculiar only to the metal programmed for the analysis. For every metal investigated, standards and blanks were prepared and used for calibration before samples were aspirated.

Total coliforms and Fecal coliforms were determined [18]. The membrane filter (MF) technique was used to determine bacterial indicators in 100ml sample. In this technique, 100ml of water sample was passed through a membrane filter (pore size 0.45 μm) that traps bacteria on its surface. This membrane was placed on a thin absorbent pad that has been saturated with a specific medium designed to permit growth and differentiation of the organisms being sought. On the other hand, total bacterial counts were counted by using pour plate method as Colony Forming Unit (CFU) per 100 ml.

For the determination of K, Ca, Mg and Na, 2g of prepared soil was scooped into an extraction flask. 20ml of extracting solution containing 1percent lanthanum (wt./vol.) was added to the extraction flask and the concentrations were obtained in the soil extracts with the atomic absorption/emission spectrometer. The concentration (ppm) in the soil was converted in the extract solution to ppm (mgk/kg), multiplied by 10.

For the determination of Zn, Fe, Mn or Cu in the soil ,10g of soil was scooped without pressing the soil against the side of the container. The measured volume of soil was added to a 50ml Erlenmeyer flask and tapped the scoop on the funnel or flask to remove all of the soil from the scoop. Soil samples were air dried and crushed to pass a 10-mesh stainless steel sieve. Contents were filtered through Whatman No. 42 filter paper and refiltered when extract was cloudy. The samples high in extractable Fe had a yellow color. Samples on the AA or DCP spectrometer unit were read using appropriate standards and instrument settings and concentration was reported as: ppm in soil = ppm in extract x 2.

4. RESULTS AND DISCUSSION

From the result of direct field observation , as the heavy rainfall persisted, the depth of the flood water increased by the hour. The areas affected during the flood includes; farmlands, *Oguta lake*, *Oguta* market (*Afia-afor* market), *Awbana* river, *Ngegwu*, *Oguta* General Hospital, the *Oil* Mill, Shell(SPDC) flow station, *Agbaruku* Camp, *Amadi* School I, among others. These affected areas were submerged and flooded with water. Also, the Shell Petroleum Development Company (SPDC) oil well location was flooded, resulting to oil spill and operations shut down. The level of devastation caused by the 2012 flood in no fewer than 15 communities in Oguta Local Government Area of Imo State was no doubt a herculean task. More than 65 persons who lived in a settlement of 123 settlements were sacked by the flood

Plate 1: Oguta residents relocating from their homes in 2012

Plate 2: Dead animals and movement of timber by Oguta residents in 2012

Plate 3: Evacuation of properties from flooded homes by Oguta residents in 2012

Plate 4: Flooded homes and farmlands of Oguta residents in 2012

Plate 5: Temporal rescue camp and tents for rural farmers (Oguta) in 2012

Plate .6: Eroded soil in 2015 caused by 2012 flood in Oguta.

Plate 7: Debris deposits and drainage blockage in 2015 caused by 2012 flood in *Oguta* Market

Plate 8: Poor crop yield in 2015 caused by 2012 flooding in *Oguta*

Plate 9: Improved fertility of the soil & agricultural productivity along flood plain in *Oguta*

The retrieved questionnaires from respondents of the sampling area, showed the following livelihood patterns and frequency; 25(28%) farmers, 14(15%) fishing folks, 26(29%) traders, 10(11%) employees and 15(17%) for other means of livelihood (Fig. 1). This proves the fact that the major residents in the study location are traders and farmers.

Statistic analysis shows that the t-stat value (-9.63) is less than the critical t-value (2.78) at 0.05 alpha levels, hence, we reject the null hypothesis and conclude that there is a relationship from the 2012 flood on the livelihood pattern of Oguta residents as some respondents stated that some residents were involved in fishing practice during the flood.

Table 1: Questionnaire responses

Issues contested	Respondents (Yes)	Respondents (No)
A) Negative		
Loss of lives and properties	72	18
Destruction of farmlands	84	6
Destruction of records and documents	67	23
Soil erosion	78	12
Poor drinking water quality	85	5
Pollution of the environment	55	35
Inaccessibility to healthcare services	80	10
Deterioration of health condition due to waterborne diseases	55	35
B) Positive		
Improved the fertility of the soil along flood plains	87	3
Increased Fish production	24	66
Supply of relief aid by Government & Organizations.	29	61

In Oguta lake and Awbana river, the physicochemical parameters for water were pH (8.9, 7.4), Temp (30.2, 28.9°C), Conductivity (28, 15μS/cm),Turbidity (10.28, 28.68NTU), Dissolved oxygen (9.7, 6.1), COD (9.92,4.64), BOD (6.2, 2.9), TDS (18.20, 9.75ppm), Total solids (300, 300mg/l), Total hardness(1, 2.6), TSS(281.8, 29.25mg/l), Salinity(32.88, 427.9mg/l), Alkalinity(196, 128), Chloride (18.2, 236.9mg/l), Nitrate (18.2, 58.7mg/l), Nitrate-nitrogen(4.1, 13.2mg/l), Sodium (7.869, 8.025ppm), Iron(0.00, 1.522ppm), Copper(0.057, 0.062ppm), Lead(0.125, 0.026ppm), Magnesium(18.138, 17.973ppm), Aluminium(0.63, 0.49ppm), Cadmium(0.109, 0.034ppm), Cobalt(0.318, 0.405ppm), Total faecal count(20, 50ml) and Total E.coli count(10, 30ml).

The background values for surface water in Oguta lake amd Awbana River in a study research before the flood, recorded pH (5.92, 6.30), Temp (26.8, 26), Conductivity (19.95. 30.20), Dissolved oxygen (7.1, 7.20), BOD (2.95, 0.70), TDS (17.02, 14.30), Total hardness (11.59, 8.20), Alkalinity(22.10, 6.60), Chloride (1.0, 1.08), Nitrate (1.40, 0.12), Sodium (4.6, 5.30), Iron (0.02, 0.005), Magnesium (1.12, 0.38), Total E.coli count (196.4, 100), Copper (not detected) and Lead (not detected).

In Oguta lake and Awbana river, the physico-chemical parameters for soil were pH (5.9, 5.6),Temp (25.6, 25.5°C),Conductivity(127, 30μS/cm),Porosity(17.04, 11.9%), Organic matter (2.2, 4.0%),Chloride (2514.5, 4263.8mg/l), Sodium (8.505, 1.4794ppm), Iron (7.672, 14.727ppm), Copper (0.119, 0.671ppm), Lead (0.081, 0.046ppm), Potassium(6.3439, 7.4620), Calcium(14.673, 16.2158ppm), Magnesium (18.281, 16.402ppm), Aluminium (0.72, 0.65ppm), Cadmium(0.246, 0.022ppm), CEC(0.243, 0.279mq/100g).

The physicochemical parameters for sediments in Oguta were pH (6.1, 5.8),Temp (26.60, 25.9°C),Conductivity(5.00, 3.00μS/cm), Organic matter (2.6, 11.2%), Chloride (2496.3, 2769.6mg/l), Sodium (8.564, 8.950ppm), Iron (10.897, 15.008ppm), Copper (0.117, 0.630ppm), Lead (0.246, 0.025ppm), Magnesium (18.551, 18.106ppm), Aluminium (0.58, 0.76ppm), Cadmium(0.169, 0.024ppm), Potassium(0.8245, 0.9136), Calcium(7.509, 8.232ppm), CEC(0.237, 0.225mq/100g)

Table 2: Result of physico-chemical parameters of water from study area and background values

	PARAMETER	OGUTA LAKE 2015	BACKGROUND VALUES (MARCH 2012)	AWBANA RIVER	BACKGROUND VALUES (MARCH 2012)	WHO STANDARD
1	pH	8.9	5.92	7.4	6.30	6.5 -9.0
2	Temperature, ^0C	30.2	26.8	28.9	26	> 40
3	Conductivity, µS/cm	28	19.95	15	30.20	1400
4	Turbidity, NTU	10.28	20	28.68	50.30	5
5	Dissolved Oxygen, mg/L	9.7	7.1	6.1	7.20	>40
6	COD, mg/L	9.92	-	4.64	-	-
7	BOD, mg/L	6.2	2.95	2.9	0.70	-
8	Total Dissolved Solids, ppm	18.20	17.02	9.75	14.30	250
9	Total Solids, mg/L	300.00	-	300.00	-	500
10	Total Hardness, mg/L	1	11.59	2.6	8.20	150
11	Total Suspended Solids (Non-filtrate), mg/L	281.8	-	29.25	-	50
12	Salinity, mg/L	32.88	-	427.9	-	-
13	Alkalinity	196	22.10	128	6.60	200
14	Chloride. Mg/L	18.2	1.0	236.9	1.08	250
15	Nitrate(NO^-_3), mg/L	18.2	1.40	58.7	0.12	50
16	Nitrate-Nitrogen (NO_3 – N), mg/L	4.1	-	13.2	-	10
17	Sodium, ppm	7.869	4	8.025	5.30	200
18	Iron, ppm	0.000	0.02	1.522	0.05	0.3
19	Copper, ppm	0.057	Nd	0.062	Nd	1.0
20	Lead, ppm	0.125	Nd	0.026	Nd	0.05
21	Magnesium, ppm	18.138	1.12	17.973	0.38	220 -260
22	Aluminium, ppm	0.63	-	0.49	-	0.05-0.2
23	Cadmium, ppm	0.109	-	0.034	-	0.005
24	Cobalt, ppm	0.318	-	0.405	-	-
25	Total Faecal Count, cfu/100ml	20	-	50	-	0
26	Total E.Coli Count, cfu/100ml	10	196.4	30	100	10

Nd = not detected

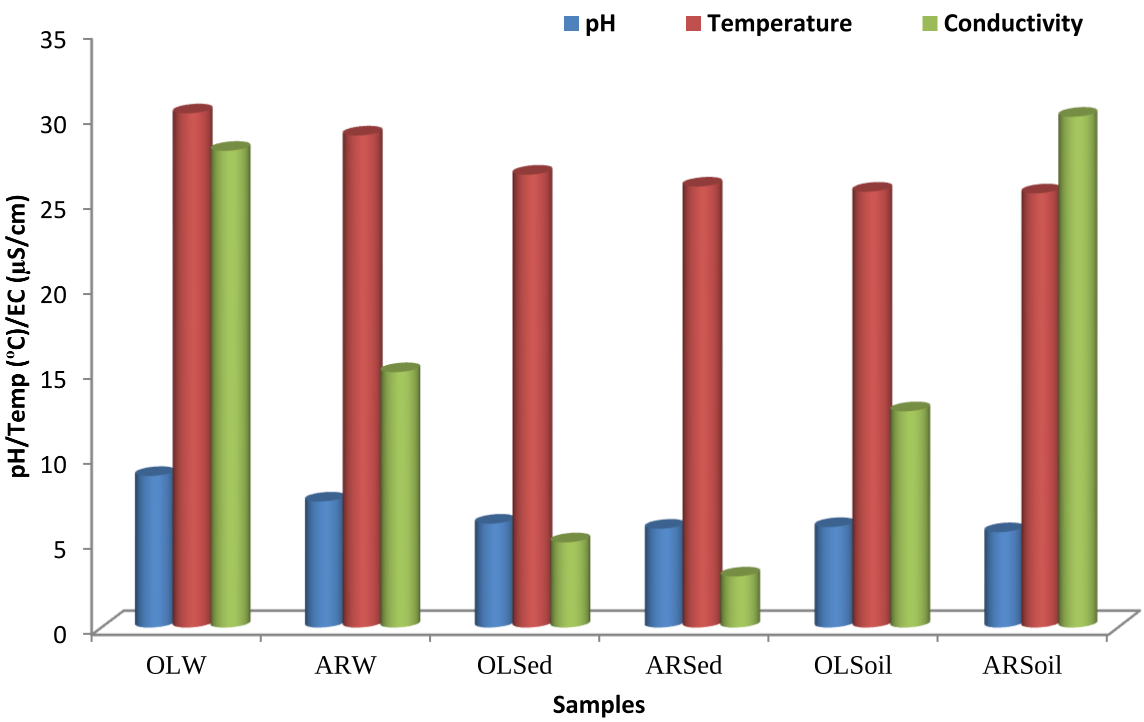
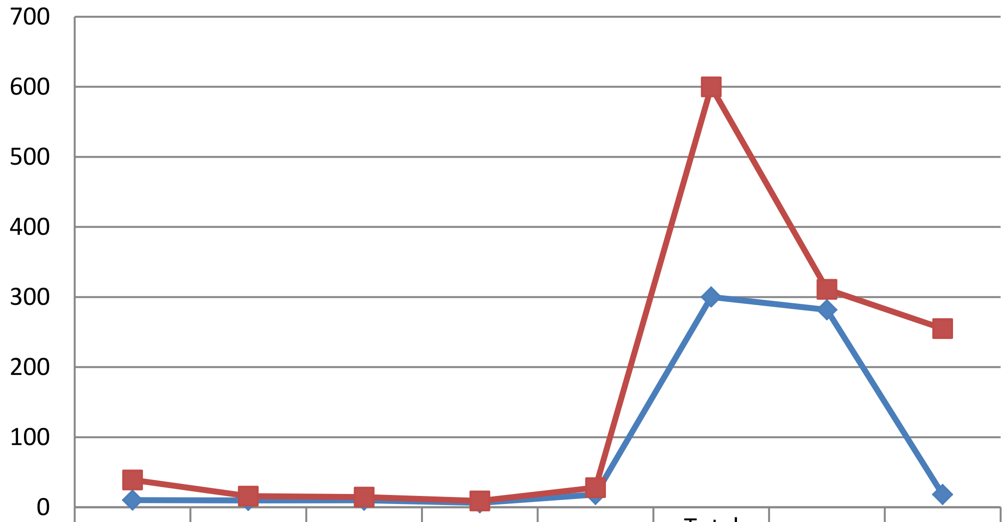


Fig. 1 Spatial variations in levels of physicochemical parameters of water, soil and sediments from Oguta Lake & Awbana river

OLW = Oguta Lake Water,ARW = Awbana River Water,OLSed = Oguta Lake Sediments,ARSed = Awbana River Sediments,OLSoil = Oguta lake Soil,ARSoil = Awbana River Soil



	Turbidity	DO	COD	BOD	TDS	Total solids	TSS	Chloride
ARW	28.68	6.1	4.64	2.9	9.75	300	29.25	236.9
OLW	10.28	9.7	9.92	6.2	18.2	300	281.8	18.2

Fig. 2 Spatial variations in levels of chemical parameters of water from Oguta Lake & Awbana River

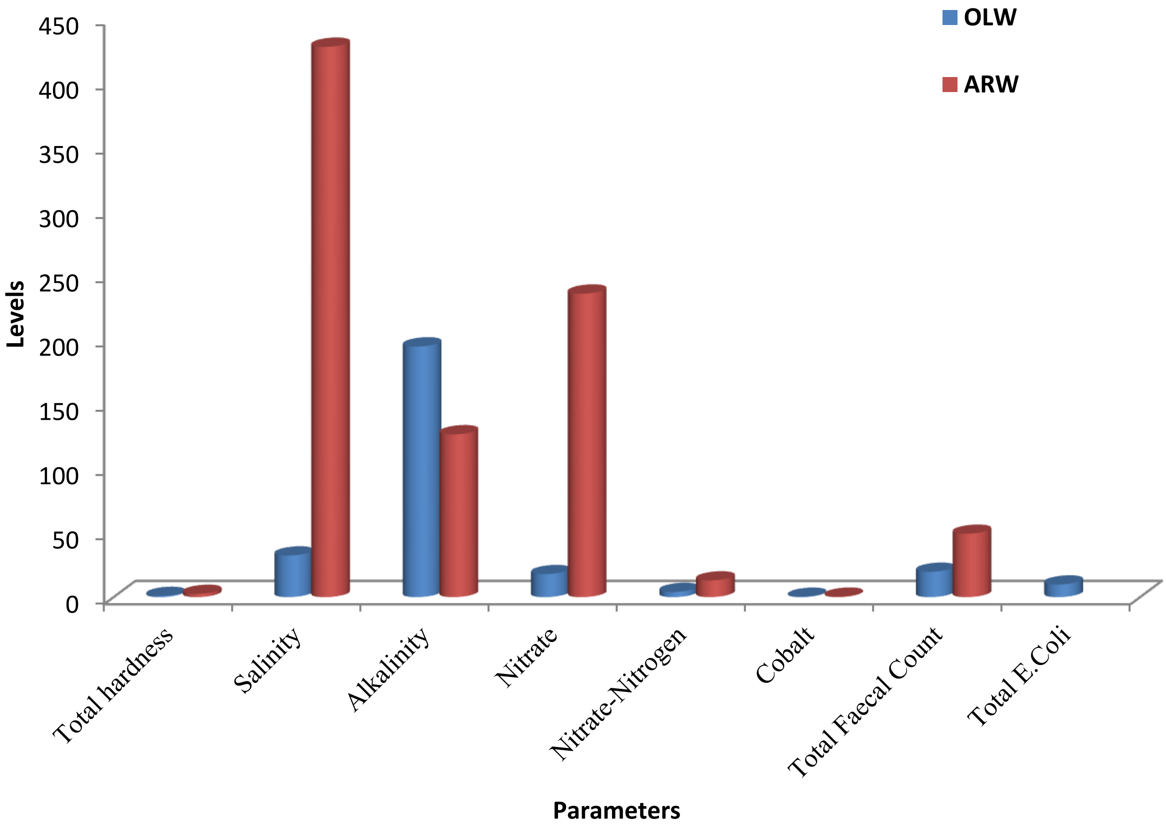


Fig. 3: Levels of chemical parameters in water samples of Oguta lake and Awbana River

DISCUSSION

In the Oguta Lake, the pH values were between basic and alkaline range. Water with a pH > 8.5 could indicate that the water in Oguta Lake is hard [22]. Hard water does not pose any health risk, but can cause aesthetic problems. The result is consistent with the findings [19] in Akwa Ibom State of Nigeria. The pH of Awbana River is within the WHO standard which agrees with the findings of [20], who studied the effect of flood water in Orashi Province in Niger delta and reported pH values were within allowable limits in almost all areas sampled. In study areas, EC value in Awbana river and Oguta lake was 15 µS/cm and 28 µS/cm respectively indicating a very low level of ionic concentration activity due to few dissolved solids. Electrical conductivity depends on the amount of dissolved ions and the ability of a substance to conduct an electric current at a specified temperature usually 200C or 250C [21]. In the study area, Turbidity ranged from 10.28NTU and 28.68NTU for Oguta Lake and Awbana River, indicating a high level of turbidity. Turbidity itself is not a major health concern, but high turbidity could interfere with disinfection and provide a medium for microbial growth. It may also indicate the presence of microbes (U.S. EPA Office of Water, Current Drinking Water Standards).

The DO levels of the surface waters in the area ranged from 6.1mg/l to 9.7mg/l which is within WHO regulatory limits of 5mg/l. The oxygen level of the study area is quite favorable for the survival of aquatic life such as fish, hence the increased fish production level. The BOD recorded in this study ranged from 2.9mg/l – 6.2mg/l (Table 4.3) and were all below WHO limits of 5-9mg/l. This is indicative of low biological activity and minimal organic load in the sample areas. In this study, it was observed that TSS in Oguta Lake measured above WHO standard at 281.8mg/l and Awbana River measured below WHO standard at 29.25mg/l. Hence, the effect of high TSS observed in Oguta Lake as an environmental effect is as a result of urban runoff, soil erosion and agricultural activities carried out in the study area. High TSS can cause problems for industrial use, because the solids may clog or scour pipes and machinery. In this study, Lead levels measured at 0.125ppm and 0.026ppm for Oguta lake and Awbana river respectively. This is higher than WHO standard of 0.005ppm and thus will pose adverse health effects to residents. High concentration of lead in water is capable of reducing growth and development, cancer, organ damage in males (sterility), nervous system damage [23]; [24]; [25]. In this study, Cadmium levels were 0.109ppm and 0.034ppm for Oguta Lake and Awbana River respectively. This is higher than WHO standard of 0.005ppm and thus will pose adverse health effects to residents. The test for coliform showed that all the samples of water tested positive for the presence of coliform bacteria although at different levels. The standard for good water permits not more than 10 coliform per 100 ml of water [22]. The presence of coliform is an indication of fecal contamination of the water or the presence of other pathogenic organisms. These microbial compounds are found in rich loads in all the water samples portraying high level of pollution from sewage as well as decomposition of organic materials and debris from 2012 flood. In study areas, results show that the concentration of nitrate ranges from 18.2-58.7 mg/l in Oguta Lake and Awbana River respectively. The result in Awbana River indicates that the quantity of nitrate in study sites is unacceptable and poses threat on the health of inhabitants. Higher level of nitrate ions may cause an unusual illness; ingestion of such water also affects health of pregnant women and blue-baby syndrome in infants (Self & Waskom, 2008). From the results, Iron ions in Awbana River, Lead ions & Cadmium in Oguta Lake, Cobalt & Aluminum in both study areas, were slightly above the WHO contaminant limit. Chloride measured 2514 mg/l and 4263.8 mg/l for Oguta Lake and Awbana River respectively. Thus, the soil samples had higher concentration of chloride. Chloride is an essential micronutrient and all crops require chloride in small quantities. However, it is often associated with salinity damage and toxicity. High chloride concentration could contaminate lakes and rivers or streams adversely affecting fish and aquatic communities [26]; [27].

The reduced groundcover from Benin formation and impact of 2012 flood makes the soil more prone to erosion (Plate 4.7). This has effect of pollution on the water with increased sediment, making it unsuitable for both human and animal consumption and threatening high value ecosystems and the plant and animal species they support.

After the 2012 flooding event, a large quantity of debris were deposited in the market and along drainage systems resulting in environmental pollution (Plate 4.8). This is due to the fact that flood water carry a lot of debris as well as wastes, and when the flood water reduced in depth, the debris are deposited in the flood affected area and flood plains.

The farm lands and plants are experiencing toxicity, leaf drops and reduced crop yields as a result of high chloride contents in the soil and water of study area. (Plate 4.9). Some of the heavy metals that impacted the environment include; Lead and Copper which were not detected in the background values (Table 4.7) but detected in this study. These heavy metals resulted to the stunted growth of plants in the study area.

Large quantities of fecal coliform bacteria in the water are not harmful according to some authorities, but may indicate a higher risk of pathogens being present in the water. Some waterborne pathogenic diseases that may coincide with fecal coliform contamination include infections, fecal oral infections (FOIs), typhoid fever, cholera, vomitting, viral and bacterial gastroenteritis.

The 2012 flood in Oguta brought many benefits, such as recharging ground water, making soil more fertile and increasing nutrients in soils along flood plains. The Flood waters provided much needed water resources for the area and killing pests in the farming land. The flood particularly played an important role in maintaining ecosystems in the river corridors; a key factor in maintaining floodplain biodiversity (Plate 4.10).

The residents of Oguta LGA are exposed to severe health risk such as; diarrhea, typhoid fever and malaria due to high level of total suspended solids, turbidity, chloride, nitrate and alkaline as measured in this study.

Residents in Oguta LGA, who experienced the 2012 flooding feel cut off, since their environment have more chances of being an epidemic of illness due to distance to health centers and aids. There are also impacts on mental health of isolation due to the flood prone environment.

CONCLUSION AND RECOMMENDATION

During the 2012 flooding, it was reported that two people drowned in Oguta Lake, all riverine areas inundated, cocoa plantations, ponds, farmlands, economic trees were destroyed. Over 138 farm settlements were destroyed, livestock/domestic animals died and almost 8000 persons rendered homeless. The spread of waterborne infections and diseases were predominant.

The results of observations on water quality based measurements indicates that the major water sources Oguta Lake and Awbana River in Oguta LGA used by the residents for industrial and domestic purposes did not meet the recommended standards for turbidity, Nitrate(NO^-_3), Aluminum, heavy metals (Iron, Lead, Cadmium, Cobalt) and microbial fecal counts in water, underscoring the need for regular checks and on these water sources. From the interview session and questionnaire respondents, it is imperative to say that the effect of the 2012 flood is still prevalent on the residents though at a minimal level. A wide variety of fatal diseases such as; Cholera, Typhoid fever, Diarrhea, Vomiting, Malaria, Ascariasis, and Faecal Oral Infections associated with poor water quality are still prevalent in Oguta. The Post impact of 2012 flood on the environment is Soil erosion and Loss of nutrients on farm lands due to agricultural run offs and element toxicity. In conclusion, this study shows that the 2012 flood still has keen health and environmental effects on the residents of Oguta LGA even after 3 years.

In other to mitigate impacts of future flood events and tackle the environmental impact of 2012 flood in

Oguta Local Government Area, crop rotation and reforestation, agricultural practices are required. crop rotation**,** reforestation, In ensuring uninterrupted provision of safe drinking water, the most important preventive measure to be implemented following flooding, in order to reduce the risk of outbreaks of water-borne diseases include; free medical care / access, health education, legislative/administrative measures. There is need for all the flood management agencies from the National level; National Emergency Management Agency (NEMA) with its State (SEMA) and Local Government Area (LEMA) counterparts to rise to the challenge of ensuring sustainable hazard reduction of flooding in the vulnerable communities in Oguta LGA, so as to ensure environmental and health development of residents.

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