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Some Aspects of a Historic Flooding in Nigeria and Its Effects on some Niger-Delta Communities

Prekeyi Tawari-Fufeyin, Megbuwe Paul, Adams Omokhagbor Godleads*

Department of Animal & Environmental Biology, University of Benin, Benin City, Nigeria
*Corresponding author: adams.godleads@gmail.com

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Abstract In recent times, flooding has been a recurrent problem in most parts of the world. In Nigeria, there exist reports of flooding in some towns and cities during heavy downpours but none compares with the flood under review. Flood waters from Cameroun entered Nigeria through the Benue River, into the River Niger on its way to the sea. Lots of physical damages were recorded, including destruction of farmlands and houses. Economic life was halted, people displaced and some lost their lives. Although Cameroun released water from the Ladja dam between July 2nd and September 17th 2012, the waters remained in the Niger delta communities up till November 2012. In this study, towns were chosen from Bayelsa and Delta states for evaluation of the effects of the flood waters. Some physical and chemical parameters were determined, using standard methods. The results revealed that in all the communities, the flood waters were slightly acidic (5.4 – 6.9) and dissolved oxygen was high (3.9 – 6.9mg/l). The heavy metal Chromium was also high. Most of the physical and chemical parameters analyzed were higher in flood water than in Borehole and River Water but generally within allowable limits. Other challenges faced by the people included loss of houses, ponds, farmlands, traditional grounds and means of livelihood, destruction of herbs and vegetation, exposure to wild animals. Wild animals were not spared as their natural habitats were destroyed. Consequently some died, most migrated while some took shelter in abandoned houses. There was an imbalance in the ecosystem and general pollution of the affected communities. The inhabitants of the communities possibly benefitted from some positive aspects of the flood as skill acquisition centres, drugs and food were provided. There was evidence of cooperation and togetherness within the temporary camps erected for victims.

Keywords: *flood, water pollution*

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1. Introduction

Cities in developing countries are particularly vulnerable to climate change impacts, especially changes in rainfall because of the exposure to extreme weather events. Excessive rainfall leads to flooding especially in areas with poor natural drainage systems, areas where water inundates the capacity of the soil to contain water and in areas where poor land use practices prevents drainages from channeling excess water away.

Floods are defined as extremely high flows of river, whereby water inundates flood plains or terrains outside the water-confined major river channels. Flood hazard is measured by possibility of occurrence of their damaging consequences, conceived generally as flood risk, or by their impact on society, conceived usually as the loss of lives and material damage to society (Henry, 2006).

Flooding is one of the major environmental crises one has to contend with globally. This is especially the case in most wetlands of the world. The reason of this is the general rise in sea level globally, due to global warming as well as the saturated nature of the wetlands in the Niger Delta. Periodic floods occur on many rivers, forming a surrounding region known as flood plain. Rivers overflow for reasons like excess rainfall. The good thing about river overflows is the fact that as flood waters flow into the banks, sand, silt and debris are deposited into the surrounding land (Abowei and Sikoki, 2005).

There is a relationship between flood water, surface and ground water pollution. The water cycle of hydrologic cycle describes the movement of water on, above and beneath the earth’s surface. The quantity of water in the earth is fairly constant, meaning; water is almost never lost but transported from one location to another, transformed and made available for usage. From the water cycle, it can be deduced that when there is increased rain fall, some quantities dry up while others seep or infiltrate into the earth to remain as soil moisture or groundwater. There is also subsurface flow of water in the vadose zone and aquifers. Subsurface water may return to the surface (e.g. as a spring or by being pumped) or eventually seep into the rivers, seas and oceans. Water returns to the land surface at lower elevation than where it infiltrated, under the force of gravity or gravity induced pressures.

It therefore infers that in a flood incident, there is the tendency for pollutants to be taken from surface to subsurface especially in areas with low water table. Other possible effects include transport of eroded sediment and phosphorus from land to water bodies, increased salinity of water bodies from and erosion and transport of dissolved salts and from land and cultural eutrophication of lakes from excess nutrients washed off agricultural fields during runoff.

2. Statement of the Problem

Although flooding as a natural hazard is not new in the Niger Delta part of Nigeria because the inhabitants live in flood prone areas, indigenes have invented means of protecting themselves against flood hazards. The region with a population of over 3.8 million people is an economically important region in Nigeria due to her oil wealth. This however does not translate to direct wealth in the local areas and agriculture becomes the main stay of the residents. Crop cultivation and animal rearing can significantly be affected by flooding as has been seen in other flood incidents around the world.

Between June and September 2012, unprecedented rainfall was experienced in Cameroun and led to excessive flooding around the Ledja Dam such that the dam could not contain the quantity of water. Consequently there was a release of the dam walls between July 2nd and September 17th 2012. The resultant outcome was a flow of water to Nigeria through the Benue River and into the Seas through the Niger River. All eleven states transverse by both rivers were flooded, people were displaced, some animals were killed and economic activities were disrupted. Secondary effects are predictable and could be long lasting depending on the response of the affected communities.

3. Study Area

A variety of climates are found in Nigeria, ranging from tropical maritime climate characterized by the rainforest along the coastal and southern section to the tropical hinterland climate associated with the Sahel in the north eastern section of the country. Nigeria has a population of about 140 million within an area of 923,000 square kilometers. Over sixty per cent of the people directly their livelihood from the natural resources as farmers, cattle farmers and fishermen while the bulk of the urban population constitute the informal sector of the economic activities (Gwary, 2008).

In recent years, the total rainfall of the country was put at 1,410.6mm. Politically, Nigeria is made up of 36 states with the Federal Capital Territory at Abuja. The Benue river traverses four (4) of these states (Adamawa, Kogi, Niger and Benue) before joining the River Niger that empties into the Atlantic ocean through its delta.

This study was conducted in the Niger Delta region, covering two states, Bayelsa and Delta. Twelve towns were chosen based on accessibility during the flooding period. The geographic locations are shown in Table 1.

This study was undertaken to ascertain the physical and chemical properties of flood water and other drinking water sources and compare same with relevant international standards (WHO). The paper will also explore the physical and health effect on the inhabitants of the affected communities. Since flooding does not cause pains alone, an attempt will be made to assess the probable gains of the flood disaster on the inhabitants of the community using descriptive, statistical and on the spot observation.

Table 1. Study Towns

S/N	TOWN	NORTHING	EASTING
1	ASAMABIRI	5°09’55.12”	6°12’06.15”
2	BOMADI	5°09’45.98”	5°55’30.24”
3	IGBOGENE	5°00’48.64”	6°23’37.17”
4	KAIAMA	5°02’59.89”	6°05’00.28”
5	OKWAGBE	5°21’44.04”	5°47’36.29”
6	OPOROMA	4°48’03.16”	6°50’30.29”
7	PATANI	5°14’03.86”	6°11’39.93”
8	SAGBAMA	5°09’55.12”	6°12’06.15”
9	TUOMO	5°12’14.22”	5°47’47.30”
10	YENAGOA	4°55’40.86”	6°15’25.89”

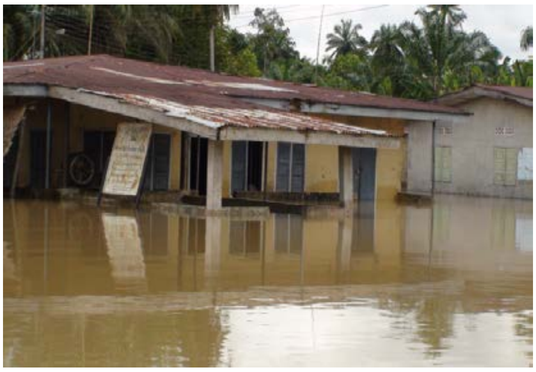

Plate 1. Submerged house

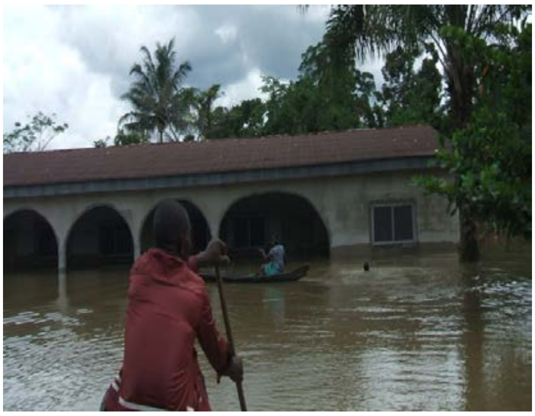

Plate 2. Showing adopted method of accessing Houses during the flood

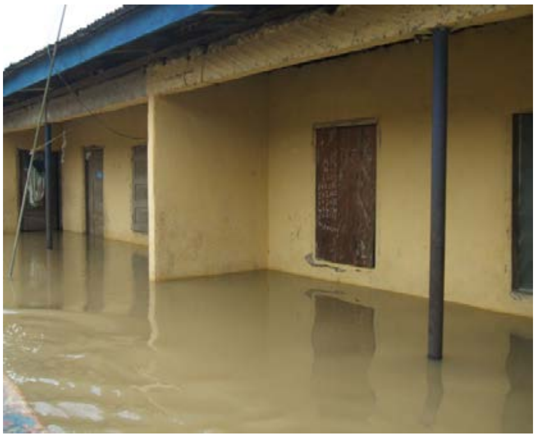

Plate 3. Community school flooded

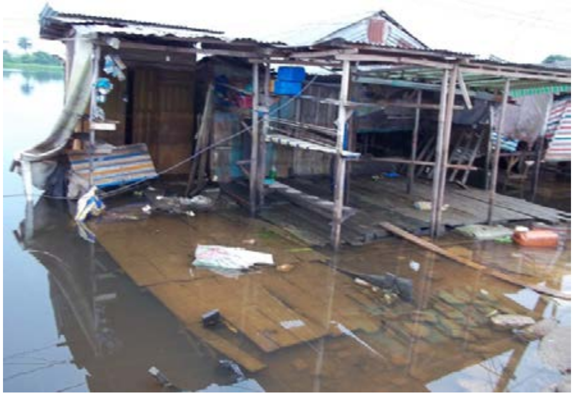

Plate 4. Local market stalls submerged

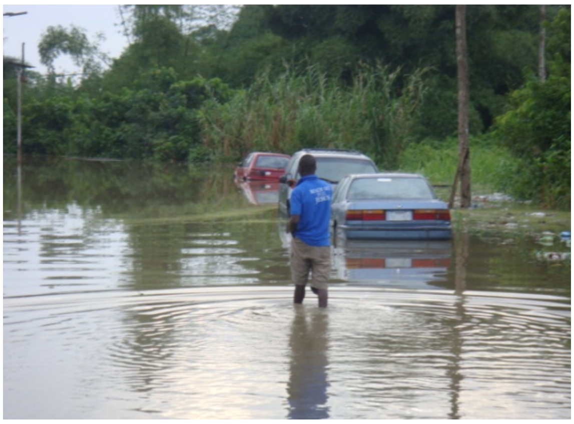

Plate 5. Access road cut off by flood

Plate 6. Collapsed building as a result of flood

4. Methodology

Flood water was taken from all communities sampled; River water was taken from Asamabiri, Patani, Tuomo and Akepebonou. Borehole water was taken from Asamabiri, Kaima, Sagbama, Patani, Bomadi, Tuomo, while well water was collected from Sagbama. The choice of source was based on the drinking water sources affected by the flood incidence. This means, in some of the communities affected, there were no boreholes, or rivers or wells, if however, these water sources were present in the affected areas, they were sampled.

Air tight cap, new, clean and dry plastic bottles (1.5L capacity) were used for sample collection for physical and chemical parameters, while sterilized 250ml bottles were used for the microbiological analysis. Each bottle was clearly marked for identification of the location, date and period of collection and care was taken to exclude external impurities during sample collection. The bottles for microbiological analysis were cleaned with detergent and rinsed with distilled water. 5ml of sodium thiosulphate was poured into each glass and covered with cap and aluminum foil. The bottles were placed in an oven for 45mins at 140^{O}C. Upon collection of samples, they were placed in ice cubes in coolers and transferred to the laboratory.

Both physical assessment and survey questionnaires were used to collect data on the impact of the flood on the livelihood of the community. A total of four hundred (400) structured questionnaires were distributed. This approach was used to estimate crop and animal losses, income effect, presence of displaced species in buildings as well as income effect and sustenance. These data were tabulated and analyzed using descriptive statistics and Analysis of Variance using Statistical Packages for Social Sciences (S.P.S.S) Version 2010.

All analyses were carried out using standard methodologies.

5. Results and Discussion

Table 2 and Table 3 show the results for physical and chemical and heavy metal analysis for borehole water in six communities sampled. The values highlighted in red represent World Health Organization (W.H.O.) standards for drinking water while those highlighted in blue represent the flood water values for the communities sampled. This comparison was made to ascertain the quality of borehole water for use as portable water and also compare the flood water values with the intent of assessing parameters of borehole water that may or could have been affected by flood water during the flood incidence.

Within the table, borehole water values that had higher values than WHO standards were asterisked, flood water samples with higher values than borehole values were asterisked once but in cases where flood water parameters were higher than both borehole sample results and standards, they were asterisked twice.

Some communities affected during the flood incident consume river water as drinking water Tables 4 and 5 show the results for physical and chemical and heavy metal analysis for river water in five communities sampled. The values highlighted in red represent World Health Organization (W.H.O.) standards for drinking water while those highlighted in blue represent the flood water values for the communities sampled. This comparison was made to ascertain the quality of river water as portable water and also compare the flood water values with the intent of assessing parameters of river water that may or could have been affected by flood water during the flood incidence.

Within the Table, river water values that had higher values than WHO standards were asterisked, flood water samples with higher values than river water values were asterisked once but in cases where flood water parameters were higher than both river water sample results and standards, they were asterisked twice.

Table 2. Borehole water parameters compared with WHO standards and Flood water results

Location	Asamabiri													
water type	BH													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	6.18	28.2	15.32	26.04	5.1	0.62	8.31	0.34	2.21	0.84	0.07	<BDL	1.18	1.02
Flood water results	6.1	28.6*	454.13*	817.43*	3.86	0.58	8.37*	2.21**	110.92*	45.18*	3.94*	2.75*	29.78**	8.81*
Location	Kaiama													
water type	BH													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	6.66	28.4	717.2*	1,209.22*	3.3	0.31	8.11	0.97	198.58	59.72	1.11	3.16	18.94	13.29
Flood water results	7.18*	28.43	70.71	120.21	4.04*	0.52*	10.83*	3.19**	17.58	2.04	1.99*	0.13	10.13	3.12
Location	Sagbama													
water type	BH													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	6.18	28.2	15.32	26.04	5.1	0.62	8.31	0.34	2.21	0.84	0.07	<BDL	1.18	1.02
Flood water results	5.92	28.7*	130.33*	234.52*	3.68	1.1*	10.12*	2.37**	26.03*	7.51*	2.01*	0.93*	6.61*	2.42*
Location	Patani													
water type	BH													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	5.72	28.7	110.42	209.8	4.7	0.41	7.69	1.11*	32.07	2.21	0.06	0.01	5.49	3.31
Flood water results	5.71	28.3	67.31	121.16	3.6	1.05*	13.22*	2.43**	19.53	1.82	0.53*	0.07*	1.93	2.08
Location	Bomadi													
water type	BH													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	6.66	28.4	77.2	192	3.3	0.37	9.11	0.97	18.58	99.72	1.11	6.16	28.94*	43.29
Flood water results	7.21*	28.55*	70.4	119.69	3.9*	0.51*	11.81*	4.23*	17.995	1.99	2.02*	0.12	9.94	3.18
Location	Tuomo													
water type	BH													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	5.93	28.4	92.8	167.01	5.1	0.37	8.39	1.02	31.1	2.83	0.11	0.03	10.84	3.13
Flood water results	6.03*	28.7*	41.6	70.71	3.9	0.8*	10.08*	1.97*	8.84	2.39	1.14*	0.12*	2.65	2.77

Table 2 shows the physical and chemical parameters of water samples obtained from borehole in six communities and river water values in five communities affected. The results are compared to W.H.O. standards for drinking water and flood results obtained from the same sample locations.

Generally, pH is used to assess the level of acidity or alkalinity of water. Acidic water samples will increase the likelihood of corrosion of metal pipes and casing and subsequent release of heavy metal components. (Saeed and Attaullah, 2013). Highly alkaline water samples could induce swelling hair fibers, stomach upsets. (JohnBosco 2011) The results indicate that pH of borehole water was within WHO allowable limits in all six communities sampled. However, flood water samples had higher pH values in Kaiama, Bomadi and Tuomo than Borehole water but lower than pH values prescribed by W.H.O. This suggests that pH values of borehole water might not be significantly affected by the flood incidence. The results for river water were within allowable limits and flood water samples had lower pH values in all the communities sampled. The results indicate that in areas where flood water had higher values, the effect on borehole water might not be an increase or decrease in pH values beyond allowable limits. This agrees with the findings of Mmom and Aifisehi (2013) 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.

Table 3. Borehole heavy metals parameters compared WHO standards and Flood water results

Location	Asamabiri							
water type	BH							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	0.46	0.3	0.015	0.062	<BDL	<BDL	<BDL	<BDL
Flood water results	3.73*	1.9*	3.381**	1.054*	0.317*	0.062*	0.023*	0.011*
Location	Kaiama							
water type	BH							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	6.21	4.43	0.621	1.091	0.003	<BDL	<BDL	<BDL
Flood water results	1.66	1.06	0.77*	0.15	0.11*	0.01*	0.042*	0.0035*
Location	Sagbama							
water type	BH							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	0.46	0.3	0.015	0.062	<BDL	<BDL	<BDL	<BDL
Flood water results	1.03*	0.81*	0.103**	0.084*	0.001*	0.009**	0.005**	<BDL
Location	Patani							
water type	BH							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	1.82	1.06	0.052	0.147	<BDL	<BDL	<BDL	<BDL
Flood water results	0.97	0.35	1.172**	0.389*	0.052*	0.039**	<BDL	0.008*
Location	Bomadi							
water type	BH							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	6.21	4.43	0.621	1.091	0.003	<BDL	<BDL	<BDL
Flood water results	1.68	1.08	1.1**	0.3	0.11*	0.007**	0.04**	0.003*
Location	Tuomo							
water type	BH							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	2.15	1.19	0.152*	0.093	<BDL	<BDL	<BDL	<BDL
Flood water results	2.61*	1.23*	0.141	0.052	<BDL	0.023*	0.079*	0.028**

Temperature is an important physical parameter as it affects water consumption rates and plays a role in aquatic microorganisms' metabolism. However, no standard exist for suitable temperature for potable water. The slight elevated temperature recorded for all the sampling area might not be unconnected with the ambient temperature at the time of sampling and this is further confirmed by the temperature ranges of flood water in the areas.

Total Dissolved Solids measures the combined content of all inorganic and organic substances contained in liquid. Although not generally considered a primary pollutant as it is not deemed to be associated with health effects, it is used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of the presence of other chemical pollutants. The W.H.O. standard for TDS is 500mg/l and all sampled areas were below the recommended standard except in Bomadi borehole samples. The water table level in this sample area did appear to be close to the surface and could have been inundated with dissolved matter. The lower values observed in the flood water sample in the same area, indicates that the high value observed in Bomadi may have been unconnected with the flood incident. The findings of this research did not agree with that of Bariweni *et al* (2012) who stated that generally TDS should increase in surface water this is because river water sampled generally had Total Dissolved Solids within limits.

Table 4. River water parameters compared with WHO standards and Flood water results

Location	Asamabiri													
water type	RIVER													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	6.82	28.7	36.71	55.01	4.82	1.2	9.54	1.83	7.79	2.21	0.33	0.07	4.18	2.17
Flood water results	6.1	28.6	454.13*	817.43*	3.86	0.58	8.37	2.21**	110.92*	45.18*	3.94*	2.75*	29.78*8	8.81*
Location	SAGBAMA	5.92	28.7	130.33	234.52	3.68	1.1	10.12	2.37	26.03	7.51	2.01	0.93	6.61
water type	RIVER													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	7.28	28.5	37.14	59.42	4.9	1.1	8.89	1.46	6.83	1.94	0.29	0.13	3.97	2.41
Flood water results	5.92	28.7*	130.33*	234.52*	3.68	1.1	10.12*	2.37*	26.03*	7.51*	2.01*	0.93*	6.61*	2.42*
Location	Patani													
water type	RIVER													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	8.2	28.5	42.33	76.19	4.11	1.3	9.41	1.98	12.8	2.02	1.11	0.02	1.28	1.96
Flood water results	5.71	28.3	67.31*	121.16*	3.6	1.05	13.22*	2.43*	19.53*	1.82	0.53	0.07*	1.93*	2.08*
Location	Tuomo													
water type	RIVER													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	6.08	28.3	39.72	68.36	4.82	1.2	9.12	1.85	7.72	2.95	1.83	0.1	3.81	2.26
Flood water results	6.03	28.7*	41.6*	70.71*	3.9	0.8	10.08*	1.97*	8.84*	2.39	1.14	0.12*	2.65	2.77*
Location	Akepe-bonou													
water type	RIVER													
Parameters	pH	Temp (°C)	TDS (mg/l)	EC (µScm-1)	DO (mg/l)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Chloride (mg/l)	Sulphate (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)	Total Alkalinity (mg/l)	Hardness (mg/l)
WHO Standards	6.5-8.0	-	500	1000	6	50	500	<1	<250	<250	250	<50	20	500
Sample results	7.13	28.2	71.33	121.25	4.3	0.55	8.86	1.12	16.74	2.12	1.91	0.13	10.52	2.98
Flood water results	6.22	28.7*	78.6*	149.33*	4.6*	1.05*	9.76*	2.16*	24.21*	2.28*	1.76	0.19*	8.26	2.59

Electrical conductivity or specific conductance measures the ability of a material to pass an electrical current and is affected by the presence of inorganic dissolved solids. Conductivity has a relationship with Total Dissolved Solids and can be affected by temperature with warmer temperatures having higher conductivity. Electrical conductivity is set at 1000µScm-1 by W.H.O. (2011). Of all sampled areas, Kaiama borehole had the highest conductivity (1,209 µScm-1). This is attributable to high dissolved matter from the flood water and the high dissolved matter present in borehole water. The specific conductance of flood water and river water sampled in all the areas were high but not beyond 1000 µScm-1 recommended by W.H.O. (2011).

Dissolved oxygen, (DO (mg/l) measures oxygen in water in its dissolved state, while Biochemical Oxygen Demand (BOD mg/l)) is a measure of the quantity of oxygen used up by living organisms in breaking up organic matter present in water. W.H.O. (2011) recommends a standard of 6mg/l and 50mg/l for D.O. and B.O.D. respectively. Factors that affect the dissolved oxygen in a water body include exposure to ambient oxygen, depth of water, temperature and type of water body (lake/stagnant pool or fast moving river), factors affecting the B.O.D. include the composition of organic matter present, the microbial load, oxygen presence and temperature. In all areas sampled, dissolved oxygen and biochemical oxygen demand were within allowable limits set by W.H.O. (2011). There were only a few areas where flood water samples had higher values than borehole and river water samples, however, these were not statistically significant (P<0.05) and might not have had a negative effect on these parameters.

Total Suspended Solids (T.S.S.) and turbidity indicate the amount of solids suspended in water whether mineral or organic. Total suspended solids measures the actual weight of material per volume of water while turbidity measures the amount of light scattered from a water sample. Total suspended solids and turbidity limits for drinking water as stipulated by W.H.O. (2011) is 500mg/l and <1 NTU respectively. Values in all locations sampled for borehole and river water were generally lower than flood water values indicating that flood water intrusion might potentially increase turbidity and Total Suspended Solids values in these water sources. However, there is a low chance of flood water elevating TSS and turbidity values beyond recommended limits except for turbidity of borehole water in Asamabari, Kaiama, Patani, Sagbama and river water in Asamabari.

Table 5. River water heavy metals parameters compared to WHO standards and Flood water results

Location	Asamabari							
water type	River							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	1.1	0.68	0.065	0.103	0.005	<BDL	0.002	0.008
Flood water results	3.73*	1.9*	3.381**	1.054*	0.317*	0.062**	0.023**	0.011**
Location	Sagbama							
water type	River							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	1.53	0.71	0.047	0.092	0.002	<BDL	<BDL	0.003
Flood water results	1.03	0.81*	0.103*	0.084	0.001	0.009**	0.005*	<BDL
Location	Patani							
water type	River							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	1.05	0.39	0.293	0.114	0.083	0.025	0.011	0.019
Flood water results	0.97	0.35	1.172*	0.389*	0.052	0.039**	<BDL	0.008
Location	Tuomo							
water type	River							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	1.37	0.61	0.212	0.109	<BDL	0.023	<BDL	0.014
Flood water results	1.08	0.74*	0.033	0.251*	0.017	<BDL	<BDL	<BDL
Location	Akepebonou							
water type	River							
Heavy metals	Calcium (mg/l)	Magnesium (mg/l)	Iron (mg/l)	Zinc (mg/l)	Copper(mg/l)	Chromium (mg/l)	Cadmium (mg/l)	Lead (mg/l)
WHO Standards	<1000	220 and 260	0.1	3	2	0.005	0.003	0.01
Sample results	1.63	1.02	0.089	0.034	<BDL	0.001	<BDL	<BDL
Flood water results	1.72*	0.23	0.092*	0.058*	0.023*	<BDL	<BDL	0.01*

Concentrations of chloride and sulphate ions vary considerably according to the mineral content of the earth in any given area. In small quantities, both chloride and sulphate ions add palatability to water and are desirable for this reason (O'Connor and John, (2004)). However, excessive concentration of either can make water unpleasant to drink. Chloride and sulphate in borehole and river water sampled were within regulatory limits of 250mg/l (W.H.O, 2011). Flood water values were higher in Asamabari, Patani, Sagbama and Akepebonou. These values could have been from waste water mopped from roads and waste water from car wash shops which have been reported to cause chloride and sulphate elevation in water. However, all values were within regulatory standards.

Water from open wells and rivers are likely to have elevated nitrate and phosphate levels. Nitrate results from wastes from aquatic organisms and products of decomposition. Presence of nitrate in water can interfere with the ability of red blood cells to carry oxygen with infants more at risk of nitrate poisoning than older children. Ecologically, presence of nitrate and phosphate can lead to eutrophication which promotes excessive growth of algae. There is also the likelihood of anoxia and anoxic effect resulting from reduced oxygen during plant death and decay, this could further lead to death of invertebrates, fish and shell fish. In the present study, phosphate and nitrate values were higher in flood water in Asamabari, Kaiama, Patani and Bomadi. There is a low risk of ill effect from these nutrients because they were generally lower than the recommended limits set by W.H.O. (W.H.O, 2011).

Heavy metals are elements with atomic mass number greater than 20 and density above 3.5g/cm^3. They are found naturally in the earth and become concentrated as a result of human activities. The heavy metals calcium, magnesium, iron, zinc, copper, chromium, cadmium and lead were measured in water sources in the study area and flood water. Although flood water had slightly higher concentration of some of the metals studied than borehole and river water, this was not statistically significant ($P<0.05$). Only chromium concentration was consistently higher in flood water than borehole and river water. Chromium is an odorless and tasteless gas found naturally in rocks, plants, soil and volcanic dust with most common forms being trivalent and hexavalent chromium. Some uses include making steel and other alloys, dyes, pigment, leather and wood preservation. The metal is a nutritionally essential element in humans and added to vitamins as dietary supplements and has relatively low toxicity but a likely carcinogen (USEPA, 2013).* Presence of this metal might be connected to release to the environment and inadequate waste disposal practices in the study areas.

6. Effects of the Flood Incident on Livelihood Patterns

Table 6. shows the main livelihood patterns of the inhabitants of the sampling area obtained after issuance of structure questionnaires

Major Source of Livelihood	Frequency	Percentage
Farming	205	51.25
Fishing	92	23
Trading	58	14.5
Paid employment	38	9.5
Others	7	1.75
Total	400	100

The table above indicates that majority of the inhabitants had livelihood sources directly dependent on the environment. (54.25%) being farmers and fishermen combined. The flood incident markedly affected farming activities as arable land was submerged in water. Fishing Rivers had overflowed banks and prevented accessibility thereby preventing fishing.

7. Upside of the Flood Incident

Flood incidents though disastrous come with ‘disguised blessings’. This study attempted to evaluate the possible benefits directly accruable to the disaster. On the spot assessment and structured interview aided data collection.

Fish and crabs were frequently caught in compounds inundated with flood without necessarily setting out fishing nets and boats. There is also a general agreement that when the flood eventually subsides, new spawning areas are unearthed and abundance of water leads to a surge in fish and aquatic populations. This could have a significant effect in helping to cushion the effects of this disaster.

Plate 7. Crab within a flooded compound

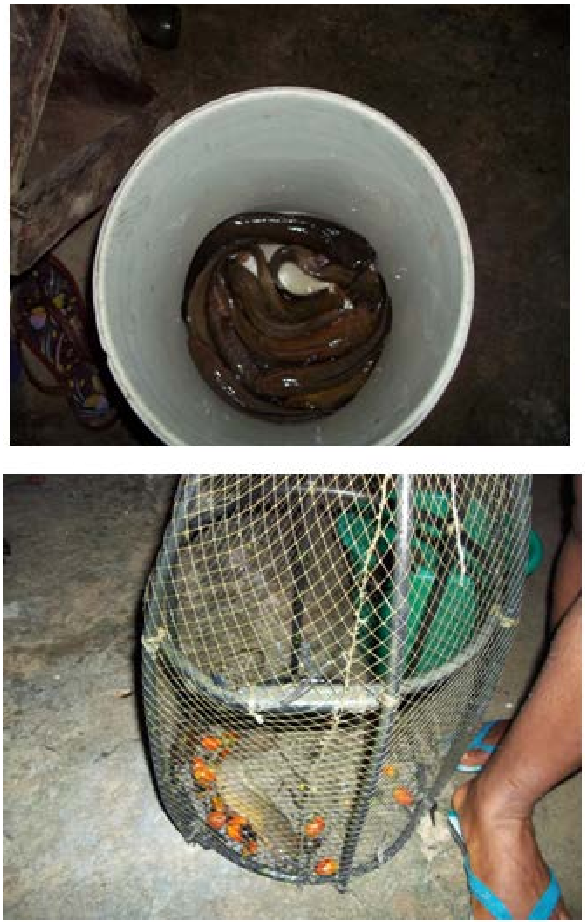

Plate 8. A and B: Fish caught within a flooded compound

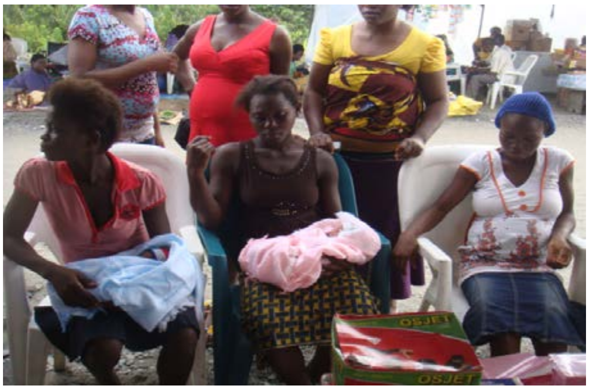

Plate 9. Babies born within settlement centres

Plate 10. Food and other relief materials donated by an indigenous Non-Governmental Organization

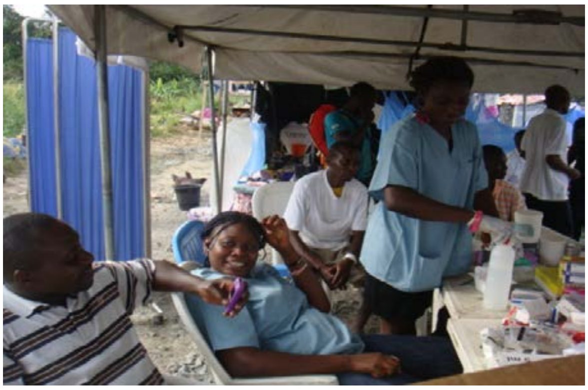

Plate 11. Relief workers dispensing drugs to internally displaced persons

Plate 12. Children of affected families brought together during camping

Other areas where the flood incident proved beneficial was in social togetherness and cooperation as seen in neighbors sharing spaces, foods, clothing and other household items. Donor agencies and public spirited individuals latched on to the opportunity to provide relief materials, food, drugs and even soft skill acquisition/training to help cushion the effect.

8. Summary and Conclusion

This present study has shown that this region suffered devastating events due to the flood. Physical and chemical parameters of flood water analyzed indicated a likelihood of effect on the potable water sources of the communities sampled.

The study did not reveal any significant or drastic effect on the water sources as most of the parameters measured were within allowable limits set by the World Health Organization.

Physical structures such as houses, roads and bridges were destroyed leading to a halt in socio-economic activities in the areas.

However, in terms of effects on the livelihood of the inhabitants of the areas, it was reported that the incident had a negative impact on majority of the inhabitants as over 50% of them had their key livelihood sources impacted.

There was an upside to the flood incident as reported, as social bond and neighborliness was enhanced, this led to a cooperation amongst victims to share common resources, some donor agencies latched on to the opportunity to provide training on skills to help cushion the effects, and some aquatic species were found within areas that were flooded, there also exists a possibility of a surge in aquatic species once the water level dropped, these were harvested and served as food. Drugs and other relief materials as well as food were made available to the victims in sufficient quantities throughout the duration.

On the basis of this research, it is necessary to study strategically and technically the possibility of occurrence of natural disasters such as flood so as to prepare adequately and propose adequate policies.

The following recommendations are proposed:

- Need for wholesome drinking water sources for inhabitants of the area.
- Key stakeholders including Local and Regional Governments should as a matter of urgency revamp and equip emergency response services which can further ameliorate the effects of flooding.
- Need for a proper town planning to factor in drainage systems within these areas which will help to channel flood water quickly.
- The root cause of the present flood incident was traced to a released dam outside the shores of the country, there is need for creation of more dams and inter-governmental collaboration and knowledge sharing.

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