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Effect of Prolong Flooding on Groundwater Qualities in Selected Communities of Southern Ijaw and Yenagoa LGAs, Bayelsa State. Nigeria

V. Ozi and S.A. Ngah
*Institute of Geosciences and Environmental Management; Rivers State University, Nkpolu-Oroworukwo
PMB 5080, Port Harcourt, Nigeria

Abstract:- This study's aim was to evaluate the effect of prolong flooding on groundwater (borehole) qualities of selected communities of Southern Ijaw and Yenagoa LGAs in Bayelsa State Nigria. Sampling boreholes as groundwater in these communities, this study showed no difference in the pH of the groundwater for flood affected communities in Ogboloma, Okolobiri and Olodiama as against control pH (unaffected flood community) at Yenagoa. Electrical conductivity and TDS values of the groundwater for flood affected communities were below the control groundwater sampled. On the other hand, groundwater SO_4 level of the flood affected communities ranged from 2 mg/l to 4 mg/l while SO_4 value was not detected for the control groundwater at Yenagoa. Furthermore, groundwater NO_3 and PO_4 level for flood affected communities were lower than that of the control groundwater at Yenagoa. Iron (Fe), Chromium (Cr) and Lead (Pb) from the groundwater of flood affected and unaffected communities were all below 0.001mg/l. However, Copper (Cu) level from groundwater of flood affected communities were slightly higher than control groundwater at Yenagoa. The most significant effect of prolong flooding showed faecal coliform from the flood affected communities ranged from 1,100MPN/100ml to 2400 MPN/100ml while that of the control groundwater showed 7 MPN/100ml suggesting that prolong flood water may have eroded faecal matter into the groundwater of affected communities by 157 to 342 times.

I. INTRODUCTION

Flood is a natural disaster and integral component of natural cycle which often happens in multitude of ways and inundates areas and communities as well (Mmom and Aifesehi, 2013). Prior to 2012 flood in Nigeria there has been serious flooding occurring much more frequently in some parts of the world (Gobo and Abam, 1991). According to Amangabara and Gobo (2010), there is no reason to believe that flood will not continue to be a problem. Flooding occurs throughout Nigeria in the form of coastal, river, flash and urban flood. Bayelsa State in Nigeria is seen as one of the most susceptible states to flooding due to its location in the heart of the Niger Delta (Berezi *et al.*, 2019). According to Berezi *et al.* (2019), the 2012 floods and 2018 floods experienced in the Niger Delta states occasioned by the climate change pandemic had serious consequences on Bayelsa state especially the educational sector where schools were closed down for a period of four weeks. A number of environmental problems are linked with floods and may impact groundwater qualities negatively. In addition, Rahman *et al* (2018) evaluated the effect of physical and biological qualities of wells after submergence following December 2014 flood in Kelantan, Malaysia. Their results showed about 95% of the well were contaminated. Majority of the surface water have been polluted owing to industrial activities in the Niger Delta, as such most communities rely on the consumption of groundwater (borehole) for cooking, preparation of food, washing cloths and utensils, among others. Prolonged flooding can also pollute drinking water sources i.e., borehole not well sealed after construction. When borehole is submerged it is difficult for the flood affected community to find safe water for domestic purposes. The surface runoff created by floods in these communities when flowed over the ground, can picked up and transmitted the natural and man-made contaminants with unsafe concentrations (Hanaa *et al.*, 2000). The resultant effect of these include economic loss from soil inability to support optimum crop yield and waterborne diseases arising from consumption of contaminated water. Therefore, the aim of this study is to determine the effect of prolong flooding on groundwater qualities while its objective is to compare groundwater qualities of affected and unaffected communities in two LGAs of Bayelsa State, Nigeria.

II. STUDY LOCATION

Bayelsa State is geographically located within latitude 4° 60'N and 5° 05'N and longitudes 6° 20'E and 6°40'E (Figure 1.1). The state is bounded by Delta State on the north, Rivers State on the east and the Atlantic Ocean on the western and southern parts. The study area is part of the Niger Delta.

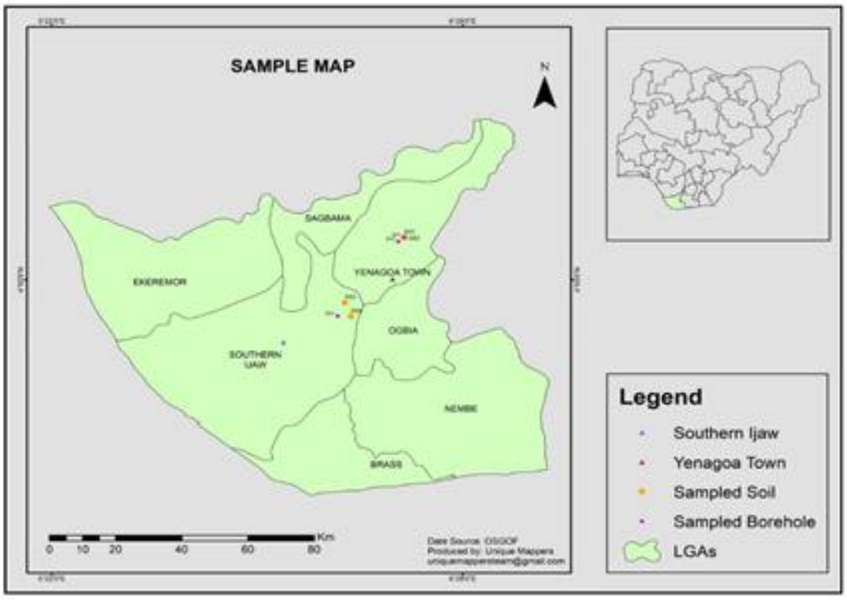
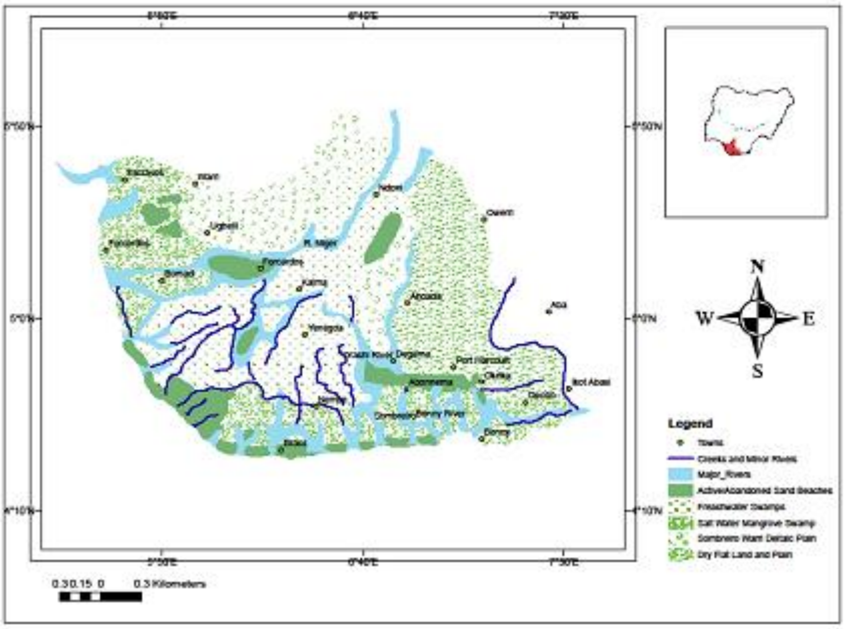


Fig. 1.1: Map of Bayelsa State Showing Study Location.

The geomorphology of the Niger Delta has been described by many researchers (Allen, 2004; Akpokodje, 1987). The topography of the area is essentially flat, sloping very gently seawards. The area is low lying (usually does not exceed 20m above sea-level) and is drained and criss-crossed by network of distributaries. The region is part of the meander belt is part of the Niger Delta sedimentary basin and has been categorised and modified after Akpokodje (1987) as freshwater swamp (Figure 3.2). The major aquiferous formation in the Niger Delta is the Benin Formation. The sands are fine to coarse-grained, gravelly, poorly sorted and sub-angular to well rounded. The main source of recharge is through direct precipitation with annual rainfall of 1500-4000mm (Karibo, 2004). Groundwater in the study area occurs principally under water table conditions except in the multilayered aquifer systems where the lower aquifers are confined (Ngah and Nwankwoala, 2013).



III. METHODS

Initial field survey of flood-affected communities in 2018 produced northing and easting for this study location (Table 3.1). Plastic bottles of 1.5 litre was used for sampling physico-chemical parameters of the groundwater. The sampled water was fixed by addition of 1:1 Analar (about 3ml) grade concentrated nitric acid to pH $\leq$ 2. The samples were stored in cooler, iced and transported to a Laboratory within 3 hours. To ensure integrity of representative samples, in-situ handheld equipment was used to measure fast changing parameters such pH, conductivity, TDS.

Table 3.1: Coordinates of Sampled Borehole

Community	Borehole Code	Northing	Easting
Ogboloma	BH1	5.041627	6.324020
Okolobiri	BH2	5.029958	6.307808
Olodiama	BH3	4.895633	6.221840
Yenagoa Town	BHC	4.918670	6.292338

The method and instrument employed for the analysis of groundwater (borehole) quality parameters (Table 3.2) are as below:

Table 3.2: Instrumental/Chemical Techniques Used for Analysis of Different Water Quality Parameters

S/N	Water Quality Parameter	Method Used
1	pH	pH Meter
2	Turbidity	Nephelometric Method
3	Electrical Conductivity	ASTM D1125
4	Total Dissolved Solids	ASTM D 1868
5	Iron	ASTM D3557-95
6	Nitrate	APHA 4500 – NO_3^-A
7	Sulfate	ASTM D516-95
8	Phosphate	ASTM D 515-95
9	Copper	ASTM D3557-95
10	Chromium	ASTM D3557-95
11	Lead	ASTM D3557-95
12	Fecal Coliform	Multiple fermentation tube technique

IV. RESULTS

The Physicochemical characteristics of groundwater (borehole) quality of prolong flood affected communities and unaffected community are presented (Fig. 4.1 – Fig. 4.9).

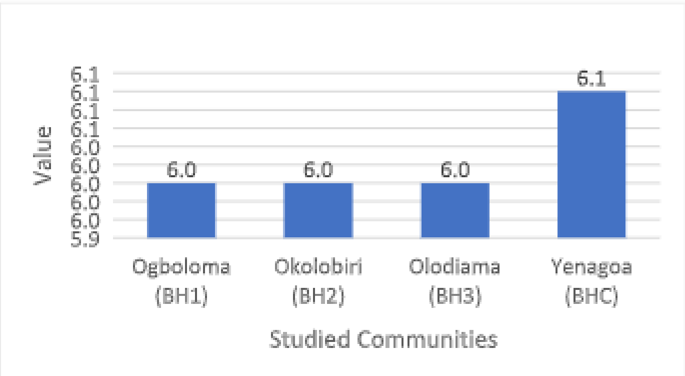


Fig. 4.1: Groundwater pH of Flood Affected and Unaffected Communities

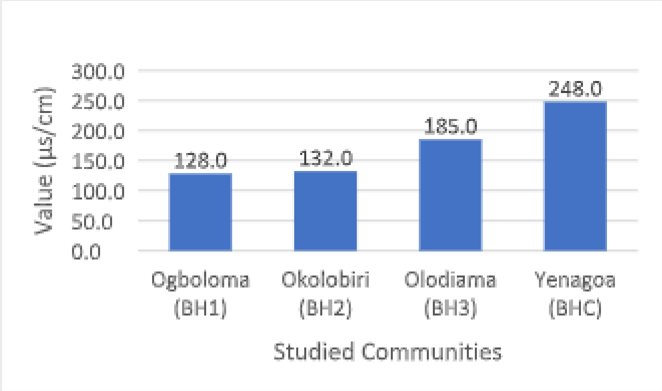


Fig. 4.2: Groundwater Conductivity of Flood Affected and Unaffected Communities

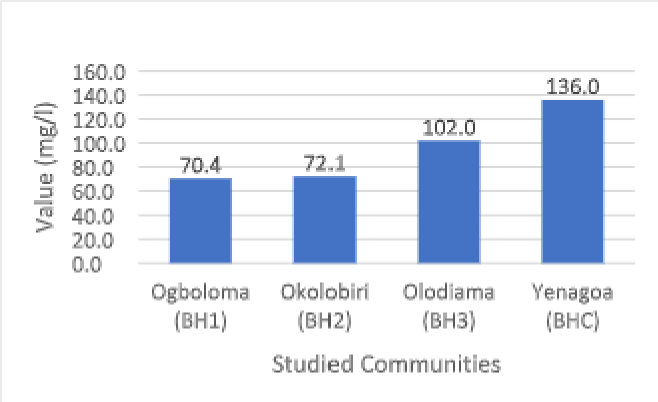


Fig. 4.3: Groundwater TDS of Flood Affected and Unaffected Communities

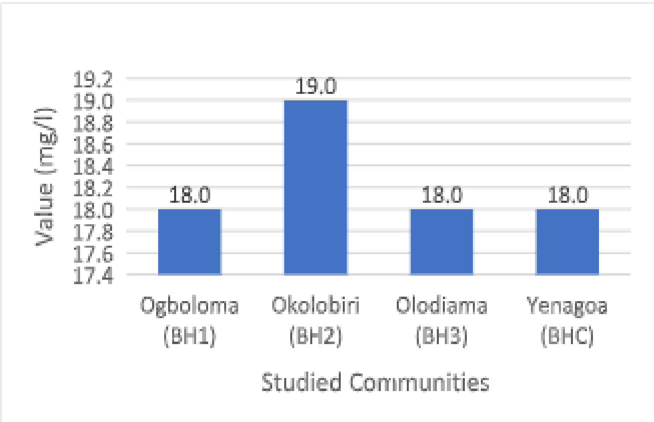


Fig. 4.4: Groundwater Turbidity of Flood Affected and Unaffected Communities

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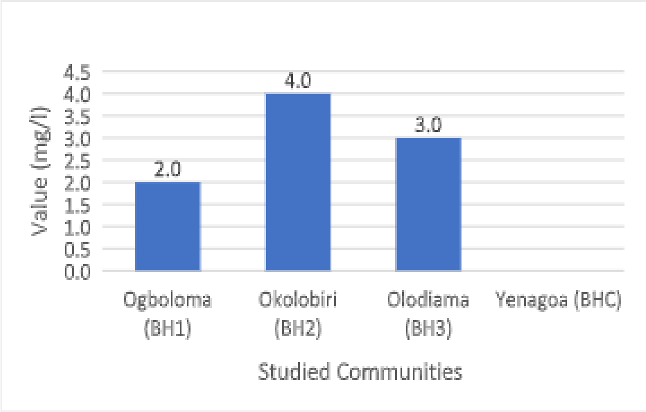

Fig. 4.5: Groundwater SO 4 of Flood Affected and Unaffected Communities

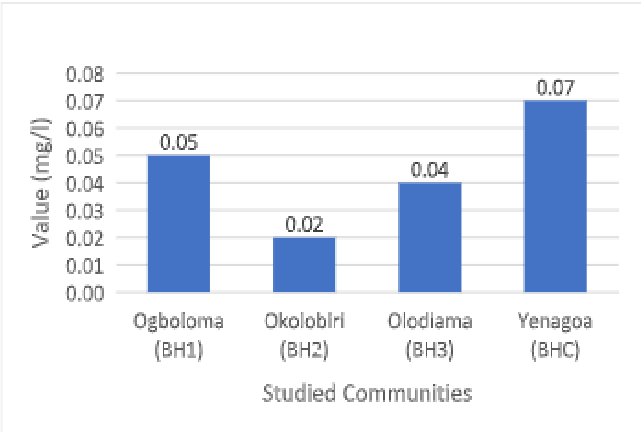

Fig. 4.6: Groundwater NO 3 of Flood Affected and Unaffected Communities

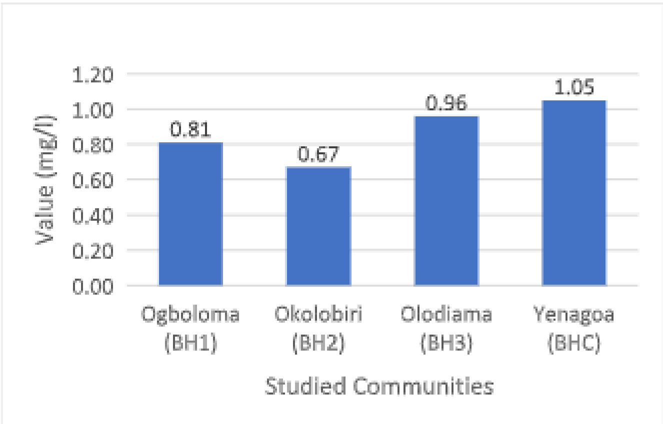

Fig. 4.7: Groundwater PO 4 of Flood Affected and Unaffected Communities

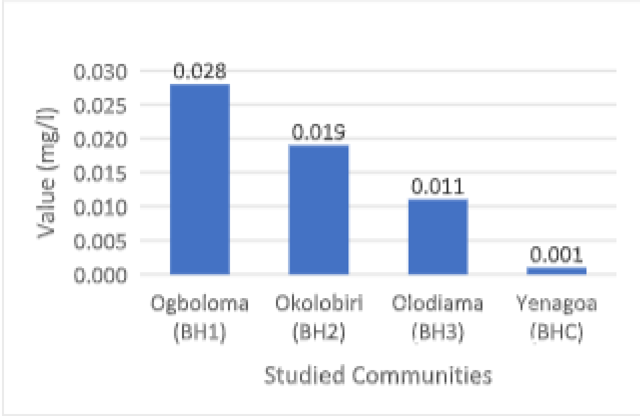

Fig. 4.8: Groundwater Cu of Flood Affected and Unaffected Communities

Iron (Fe), Chromium (Cr) and Lead (Pb) in the groundwater of flood affected and unaffected communities were below 0.001mg/l. The level of faecal coliform in groundwater of flood affected communities ranged from 1,100MPN/100ml to 2400 MPN/100ml while that of the groundwater in Yenagoa recorded a value of 7MPN/100ml (figure 4.9).

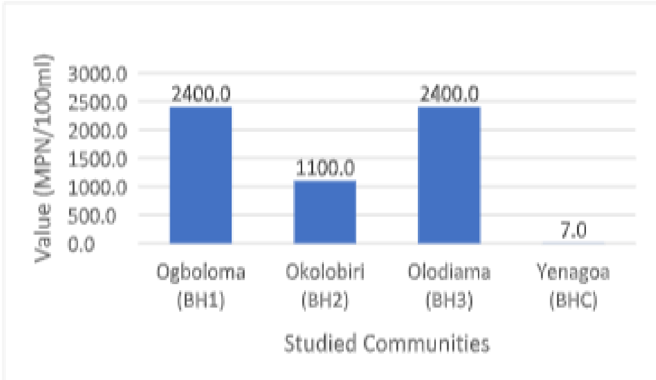

Fig. 4.9: Groundwater Faecal Coliform of Flood Affected and Unaffected Communities

V. DISCUSSION

No difference was found in the pH of the groundwater for prolong flood affected communities as the values from Ogboloma, Okolobiri and Olodiama were 6.0. The control pH (unaffected flood community) at Yenagoa was 6.1. In all the studied location including the control station, value of pH falls slightly from World Health Organisation Standard (WHO, 2004) of 6.5 to 7.5 and Nigerian Standard for Drinking Water Quality (NSDWQ, 2007) of 6.5 to 8.5. Udom *et al* (2018) however, reported slight pH value ranging from 6.4 to 7.1 in some communities different from the researcher's studied communities which are in the same geographical zone and state. On the other hand, Mmom and Aifesehi (2013) reported 50% of the samples they studied from the same geographical zone with this study have pH values within the WHO standard limits of between 6.5-8.0, Low pH of groundwater in meander belt of Niger Delta ranged from 3.84-7.72 with mean 6.17 (Amangabara, and Ejenma. 2012). The low pH of the region's groundwater can be attributed to both the nature of the recharge water, catchment geology and its evolutional history.

Conductivity of the groundwater ranged from 128µs/cm at Ogboloma for flood affected communities while at Yenagoa the control, the conductivity of the groundwater recorded a value of 284µs/cm. It has been observed that borehole electrical conductivity values for flood affected communities were below the control borehole sampled. Previous studies showed electrical conductivity in the same geographical area ranges from 54 to 110µs/cm, with a mean value of 80.6µS/cm (Udom, *et al*., 2018). However, in study of the same region high values of conductivity has been recorded which showed significant deviation from this study as well as deviation from the WHO acceptable limit of 1000 µS/cm.

Total dissolve solids (TDS) of the groundwater ranged from 70.4mg/l at Ogboloma to 102mg/l at Olodiama for flood affected communities while in Yenagoa the groundwater TDS recorded a value of 136mg/l. It was equally observed that TDS from the groundwater of the flood affected communities were lower than that of the control borehole at Yenagoa. Mmom and Aifesehi (2013) found TDS with value higher than 1000 mg/l as against desirable value of 600 mg/l for TDS is proposed by WHO (2011) on the basis of acceptability of drinking water. Furthermore, there had been significant increase of Total Dissolved Solids (TDS) (up to 2900mg/l) in groundwater of Bayelsa (Angaye *et al*., 2015).

Groundwater turbidity value for flood affected communities ranged from 18mg/l at Ogboloma, Olodiama and Yenagoa (control) to 19mg/l at Okolobiri. It can be inferred that no clear-cut trend for turbidity from the flood affected communities and the control borehole. Similar study conducted in the same region showed that the concentration of total dissolved solids in all the sample locations ranges from 24 to 150mg/l, with a mean value of 89.23mg/l. (Udom, *et al*., 2018).

Sulphate (SO_4) value of the groundwater for communities affected by prolong flooding ranged from 2mg/l at Ogboloma to 4mg/l at Okolobiri. On the other no detection of groundwater SO_4 was found for the control in Yenagoa. It can be inferred that the prolong flood may have influenced the borehole SO_4 level of the affected communities as no value was detected for the control borehole at Yenagoa. Mmom and Aifesehi (2013) noted the desirable limit for sulfate ions in drinking water should be less than 250 mg/l by WHO guidelines. Higher concentration level of sulfate imparts bitter taste and offensive odour (smell) to drinking water and causes scale in water pipes (Mmom and Aifesehi, 2013).

Groundwater nitrate (NO_3) ranged from 0.02mg/l at Okolobiri to 0.05mg/l at Ogboloma for flood affected communities while in Yenagoa the groundwater NO_3 recorded a value of 0.07mg/l. It can be inferred that borehole NO_3 level for flood affected communities were lower than that of the control groundwater at Yenagoa. Similar concentration of NO_3 had been studied and ranged from 0.42 mg/l at Tunu location 2 to 2.54 at Tunu location 4 (Ngah & Agbogunleri, 2018). They also found no relationship between the depth of borehole and the value of nitrate in the studied locations. Udom *et al* (2018) found nitrate concentration levels in the sampled locations ranges from 0.0 to 2.7mg/l, with a mean value of 0.96mg/l.

Groundwater concentration of phosphate (PO_4) for flood affected communities ranged from 0.67mg/l at Okolobiri to 1.05mg/l at Yenagoa (control groundwater sample). It can be inferred that borehole PO_4 level were lower for flood affected communities than at the control location. Udom *et al* (2018) found concentration level of phosphate in a study area ranged from 0.02mg/l to 0.19mg/l, with a mean value of 0.12mg/l.

Iron (Fe), Chromium (Cr) and Lead (Pb) in the borehole of flood affected and unaffected communities were below 0.001mg/l. Copper (Cu) level from the borehole of flood affected communities ranged from 0.011mg/l at Olodiama to 0.028mg/l at Ogboloma while the control groundwater at Yenagoa the value was less than 0.001mg/l. Similarly, Udom *et al* (2018) reported concentration of copper 0.00 to 0.12 mg/l.

The level of faecal coliform in groundwater of flood affected communities ranged from 1,100MPN/100ml to 2400 MPN/100ml while that of the groundwater in Yenagoa recorded a value of 7MPN/100ml. This very high value of 1,100MPN/100ml to 2400 MPN/100ml suggested that prolong flood water which contain faecal matter may have found their way into the borehole of affected communities. These values are extremely high as compared to 60.33 MPN/100ml to 69.00 MPN/100ml (Ohimain *et al*, 2013).

VI. CONCLUSION AND RECOMMENDATION

This study found no difference in the pH of the groundwater for prolong flood affected communities in Ogboloma, Okolobiri and Olodiama as against control pH (unaffected flood community) at Yenagoa. It can be inferred from this study that the prolong flood may have influenced the borehole SO_4 level of the affected communities as no value was detected for the control borehole at Yenagoa. Iron (Fe), Chromium (Cr) and Lead (Pb) in the borehole of flood affected and unaffected communities were below 0.001mg/l. However, Copper (Cu) level from the borehole of flood affected communities ranged from 0.011mg/l at Olodiama to 0.028mg/l at Ogboloma which were slightly higher than control groundwater at Yenagoa with value less than 0.001mg/l. The most significant effect of prolong flooding showed faecal coliform from the flood affected communities ranged from 1,100MPN/100ml to 2400 MPN/100ml while that of the control groundwater showed 7 MPN/100ml suggesting that prolong flood water may have eroded faecal matter into the groundwater of affected communities by 157 to 342 times.

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