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Research Paper

Spatial Analysis of Flood Disaster Prone Areas and Vulnerable Levels in the Wetland of Obio/Akpor LGA, Rivers State, Nigeria

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Abstract
*The present study examined the spatial analysis of flood disaster prone areas and vulnerability levels in the wetland of Obio/Akpor LGA, Rivers State, Nigeria. Topographic data of the study area were computed and used to generate the flood prone areas while the poverty grid map was used to generate the flood exposure area and flood impacted areas in the ArcGIS environment. Descriptive statistics were used for the analysis. Findings revealed that the flood prone areas within the study area lies mostly at the heart of the study area affecting communities of Rukpokwu, Ozuoba, Nkpolu, Rumuigbo, Rumuokoro and Rumuekini. In addition, the vulnerability analysis based on elevation reveals that communities such as Ozuoba, Egbelu, Mgbuosimini, Rumuokwuta, Eliozu, Elimgbu, Rumibekwe, Rumuokuta, Iwofe and marked red are very vulnerable to flooding and categorized as very high; while communities such as Mgbuodenia, Elioparanwo, Alakahia, Eneka, Atali, and Rumuwegwu indicates very low vulnerability to flooding.It can be concluded that the flood prone and vulnerable areas are mostly at the heart of the study area which has been affecting communities such as Rukpokwu, Ozuoba, Npolu, Rumuigbo and Rumuokoro. The studied communities fell within the areas of Very High Flood and High Flood which increases their flood vulnerability in the wake of excessive rainfall. Analysis of flood vulnerability using elevation model gave a contrary or different view from the flood exposed regions***.*** *The study thus recommended thatinstitutional framework should be put in place to mitigate the impact of flooding.*

Keywords: *Flood prone. Vulnerability, ArcGIS, Topographic, Poverty grid map*

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I. Introduction

Natural disasters are occurring more often and with greater severity all around the globe, including Nigeria, as a result of climate change. Within the framework of the United Nations' International Decade of Natural Disaster Reduction (United Nations, 1989), vulnerability assessments are used to determine the potential for damage and loss of life from extreme natural events. They are important for proposing hazard reduction alternatives. In addition, it is important to look at the underlying causes of vulnerability to hazards or disaster events. One way of reducing the vulnerability of communities, people or areas within a country is to understand the types of threats that are possible or likely to occur. This can be done through the development of a better understanding of where people live, their conditions, what supporting infrastructure exists and how it is being used, as well as what infrastructure, systems and capacity are missing. Yet another facet to vulnerability assessment is searching for potential vulnerabilities and the prioritization of mitigation efforts.

Vulnerability defined as the potential for loss, is an essential concept in hazards which is not just poverty, but the poor tend to be the most vulnerable due to their lack of choices. The influences of both poverty and development process on people's vulnerability to disaster are now well established. Also important, vulnerability from a layman point of view is an individual and society's insecurity from natural and human – induced hazard. It could be broadly understood as the predisposition to be hurt should an event beyond a certain threshold of magnitude occurs and impacts the individual, society, its environment, asset and infrastructures (Jorn, 2006).Human vulnerability to environmental change is not new. More than 9,000 years ago, the

Sumerians of Mesopotamia started irrigating their lands to meet increased demand for food from growing population. Despite this, their civilization collapsed partly because of water logging and salinization (Mcknight, 1992). Class, ethnicity, gender, disability and age are some of the factors affecting people's vulnerability. They further noted that because vulnerability plays such an important part in why natural hazards become human disasters, it is worth spending time to examine the characteristics of vulnerability. Conditions of vulnerability are a combination of factors that include poor living conditions, lack of power, exposure to risk and the lack of capacity to cope with shocks and adverse situations. As noted earlier, poverty does not equal vulnerability but being poor makes people more vulnerable to disasters because poor people lack the resources (physical, social and knowledge based) to prepare for and respond to such threats and shocks as natural hazards. Poor people often get locked in a cycle of vulnerability. Because they are poor, they become vulnerable. Because they are vulnerable, they are at great risk in the face of a natural hazard, leading to disaster. Close analysis of disaster impact shows that the vulnerability of men and women to disaster, their capacities, and the options available to them differ in character and scale to their gender (Ariyabandu and Wickramasinghe, 2003). Ariyabandu and Wickramasighe (2005) suggested that although women are often more vulnerable to disasters than men (owing to conventional gender responsibilities and relations) they are not just helpless victims as often represented. Women have valuable knowledge and experience in coping with disasters.

The globe has seen a slew of catastrophic occurrences in the last few years. Countries from East Africa to Thailand were devastated by the 2004 Indian Ocean Tsunami, while Hurricane Katrina in 2005 had long-lasting effects on New Orleans. A massive earthquake struck Christchurch, New Zealand, in 2011, causing extensive damage to the city's infrastructure. A tsunami struck Japan shortly after the earthquake, decimating significant swaths of the country. Floods, bushfires, and storms, which have a quick beginning, are among the many natural catastrophes that have wide-ranging effects on persons and communities. There is general agreement that the frequency and severity of disasters are on the rise (Gencer, 2013). Evidence shows that the costs of natural disasters are rising and will continue to increase as a result of an ageing housing stock, rising concentrations of assets in disaster-prone locations, and population expansion (Australian Government Productivity Commission, 2014; World Bank, 2010). As society mobilises to deal with the aftermath of the catastrophe, these expenses will be both direct (such as damage to public and private property and infrastructure) and indirect (such as ripple impacts). Despite the fact that disasters are thought to boost a community's capacity for social control by uniting its members in the face of shared pain (Drabek&McEntire, 2003; Quarantelli, 2005).

In many parts of the world, disasters caused by natural hazards such as floods, droughts, heat waves and other weather-related phenomena have exacted a heavy toll in terms of loss of lives and the destruction of economic and social infrastructure, not to mention their negative impact on the environment. Climate change is expected to further increase disaster risks by increasing weather and climate hazards as well as the vulnerability of communities and/or people to natural hazards, particularly through ecosystem degradation, reduction in water and food availability, and changes to livelihoods (UNISDR, 2008). Floods are common natural disaster occurring in most parts of the world resulting in damages and loss of human life and livelihood sources, deterioration of environment and retardation to development (Wizor and Week, 2014).

In tropical regions, floods of high magnitude have resulted in serious consequences caused by heavy rainstorms, hurricanes, snow melt and dam failures (Jeb and Aggarwal, 2008). Coastal tropical regions such as the Niger Delta are crisis-prone (Shahidur, 2007; Islam et al., 2018). Considering the Niger Delta region of Nigeria, where the Obio/Akpor LGA falls within, had experienced major flooding in 2012 and 2017.

In Nigeria flood occurrence is not new. There have been incidences of flooding (Flash flood, urban floods, channel floods, back-swamp floods, coastal inundation etc) in the last 40 years with its consequences but the flood of 2012 took the nation by surprise. The 2012 flood according to the National Emergency Management Agency (NEMA) affected 30 of the 36 States of Nigeria, 7 million peopled were affected in these States, 597, 476 houses were destroyed, 2.3 million displaced and 363 death were reported with large track of farmland and other means of livelihood destroyed, animals and other biodiversity were also gravely impacted upon. The country also lost about 500,000 barrels of crude oil output per day due to the severe flooding. In terms of economic loss, the comprehensive Post Disaster Needs Assessment conducted from November 2012 to March 2013 with the support of the World Bank and Global Facility for Disaster Reduction and Recovery, United Nations, Development partners and relevant Ministries, Departments and Agencies put the estimated total value of infrastructure, physical and durable assets destroyed at $9.6bn. In addition to the challenges above is the threat from rising sea-levels with a global average of 3.2mm rise in sea level rise, Nigeria with over 853 km (530mi) of coastline with extensive low-lying areas, and heavily industrialized are more prone to flooding than ever before and large numbers of people have become vulnerable to this threat and face being evacuated in the face of extreme flood events either astronomical or meteorological. In the 2012 flood event, more than half a million were evacuated as internally displaced persons from the Nigeria Delta Region which was almost completed affected or submerged. Thus, the previous studies did not consider the flooding situation in a wetland especially in the developing country in which the present study is trying to investigate. The present study is examined the spatial analysis of flood disaster prone areas and vulnerable levels in the wetland of Obio/Akpor LGA, Rivers State, Nigeria.

II. Materials and Methods

The study was carried out in Obio/Akpor LGA, Rivers State, Nigeria with a special consideration of the wetland areas of the LGA. ObioAkpor LGA is one of the 23 local governments of Rivers state, found in the south southern part of Nigeria, otherwise called the Niger Delta Region of Nigeria, located approximately between latitude 4^0 45ˮ N through 4^0 56ˮ N and longitude 6^0 52ˮ E through 7^0 6ˮ E (Figure 1). It has a general elevation of less than 15.24m above mean sea level (Oyegun & Adeyemo, 1999). It is bounded by Ikwerre LGA to the north, Port Harcourt LGA to the south, to the east, Oyigbo LGA and to the West, Emohua LGA as shown in figure 1 & 2. Obio-Akpor, Port Harcourt and Eleme LGAs, make up the Port Harcourt metropolis which is on a firm ground and about 66km from the Atlantic Ocean (Oyegun & Adeyemo, 1999).It is one of the major centres of economic activities in Nigeria, and a major city in the Niger Delta said to be the richest LGA in Rivers State. Consequent on rapid urbanization and the rising industrial and commercial growth of the city of Port Harcourt, more goods and services are being made available, thus the springing up of petrol filling stations, to meet up with the demand of the growing population arises.Obio-Akpor LGA was created on the 3rd of May, 1989 out of the Port Harcourt LGA of Rivers state by the then Military administration of President Ibrahim .B. Babangida. It is mainly constituted by the Ikwerre ethnic nationality and has its LGA headquarters at Rumuodumanya(Mamma et al., 2000).

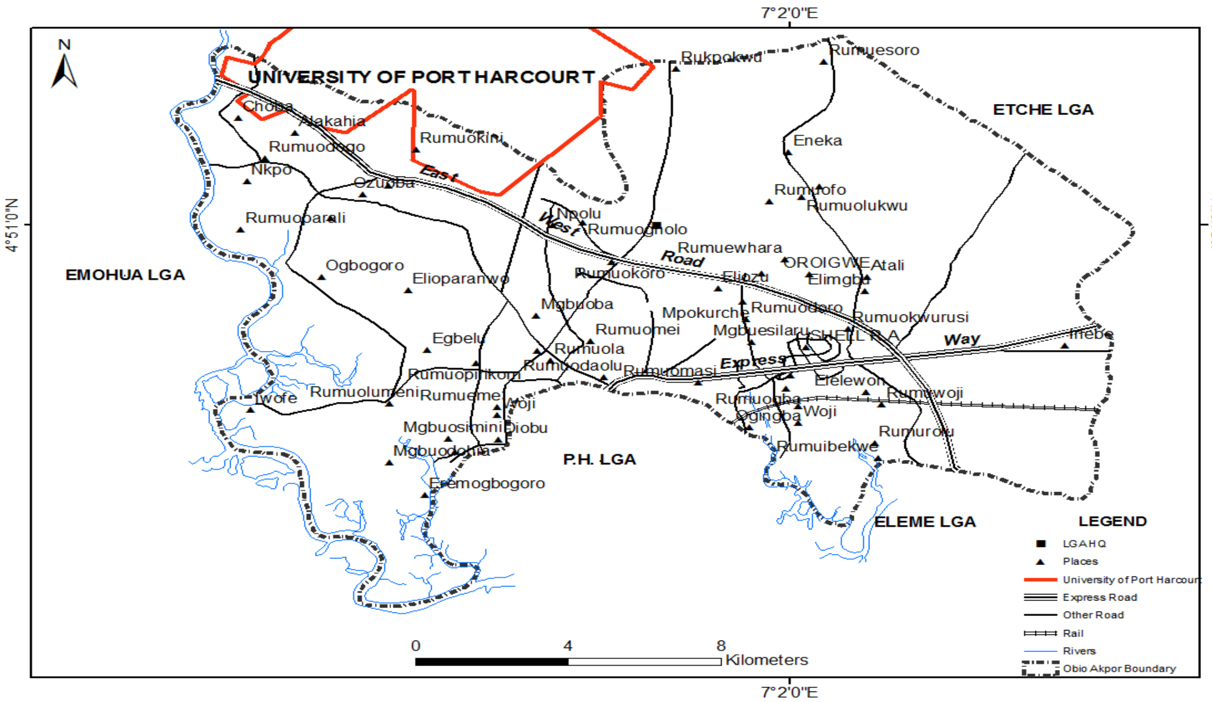

Figure 1. Study Area (Obio/Akpor LGA) showing Communities

The study area has a tropical monsoon climate with mean annual temperature of 28ºC and annual rainfall over 2500mm. The relative humidity is very high with an annual mean of 85%. The relief is generally lowland which has an average of elevation between 20m and 30m above sea level and the geology of the area comprises basically of alluvial sedimentary basin and basement complex. The vegetation found in this area includes raffia palms, thick mangrove forest and light rain forest. The soil is usually sandy or sandy loam underlain by a layer of impervious pan and is always leached due to the heavy rainfall. The study area is well drained with both fresh and salt water. The salt water is caused by the intrusion of sea water inland, thereby making the water slightly salty.Port Harcourt experiences a tropical humid climate with lengthy and heavy rainy seasons and very short dry seasons. The city is endowed with abundant sunshine and the average temperatures are between 25°C-28°C in the city (Ogbonna et al., 2007). The study area is dominated by low lying coastal plains, which structurally belongs to the sedimentary formation of the recent Niger Delta, with an elevation less than 15.24m (Oyegun and Adeyemo, 1999). Drainage of the study area is poor because of the presence of many surface water and heavy rainfall between 2000mm and 2400mm (Mmom and Fred-Nwagwu, 2013). However, Bonny River, New Calabar River, creeks and streams drain Port Harcourt Metropolis and all enter into the Atlantic Ocean through estuaries. The study area is underlain by the Coastal Plain sands having its place from the Pleistocenic Formation (Nwankoala and Warmate, 2014). The area is occupied by rainforest, freshwater swamp and mangrove swamp in some cases, which has been drastically modified by human activities. The vegetation is nourished with high rainfall and high temperature, which provide favourable condition for the growth of a varieties of tall and big trees like mahogany, Obeche, Afara and abundance of oil palm trees and several other species of economically valuable plants such as raffia palms, Abura, ferns and grasses (Eludoyin et al, 2014). The city is a major industrial centre as it has a large number of multinational firms as well as other industrial concerns, particularly business related to the petroleum industry (Hudgens, et al, 2003).

Information on the vulnerability classification and relief were obtained via satellite images through the process called digitizing. The height above mean sea level was determined through the use of Google Earth 2022 version and a Global Positioning System for ground truthing. These elevation values were called z – coordinate and were used in conjunction with the x and y coordinates to generate Digital Elevation Model (DEM) of the entire study area. The DEM also served as the relief/elevation map of the area.

Topographic map was scanned and imported into the Arc GIS 10.4 environment where it was geo-referenced to geographic coordinate system to generate the map showing the locations of each community in Obio/Akpor LGA. The elevation of each community was generated in the Google Earth 2022 version. The entire area was gridded into 5cm by 5cm in Arc GIS 10.4 and this was exposed to Google Earth 2022 version whereby the point data for elevation values were derived. The point data which was referred to as z values were now imported to ArcGIS 10.4 environment whereby their x and y coordinate were generated through the Script Avenue. The x, y, z data were used to generate digital elevation model (DEM) through interpolation method called Kriging. Thereafter, the flood disaster prone areas within the study area was analysed using the digital elevation model (DEM) and more importantly the data were also used to classify community/environmentto different flood vulnerability levels as generated from the digital topographic map of the study area.Structured questionnaire was administered to 400 persons in the study area as determined using Taro Yamane sampling method (Yamane, 1967). The questionnaires were subdivided into two parts; the first part deals with the socio – economic data of respondents which aided in assessing the socio–economic vulnerability of the people. The second and third part addresses vulnerability and coping strategies of the respondents'.Descriptive statistics were used for the data analysis.

III. Results and Discussions

Flood Prone Area Assessment of Obio/Akpor LGA

Figure 2shows the map of the communities in Obio/Akpor LGA and the level/impact of flood in the various communities. The flood prone areas within the study area lies mostly at the heart of the study area affecting communities of Rukpokwu, Ozuoba, Nkpolu, Rumuigbo, Rumuokoro and Rumuekini. Other communities around this neighborhood show high to medium level of flood exposure which implies that there is high level flood exposure within the study area.The area colored red indicates communities of Very High Flood which are Rukpokwu, Eneka, Eliozu, Mgbouba, Npolu, Rumuaghaolu, Rumuokoro andRumuekini.The area colored orange indicates communities of High Flood which are Rumuola, Rumuodaolu, Rumuogba, Woji, Rumuibekwe and Rumuokwurusi.The area coloured yellow indicates communities of Medium flood, although further research has proven that no community falls within this zone. The area coloured light green indicates communities of Partial flood, although further research has proven that no community falls within this zone.The area coloured green indicates communities that are not flooded in the Local Government Area which are Rumuesoro, Rumuowegwu, Rumuofo, Rumuewhara, Rumundara, Oroigwe, Atali, Elimgbu, Mpokurche, Rumuodoro, Mgbuesilaru, Shell R.A, Elelewon, Rumuwoji, Rumurolu, Rumubiakani,Ogingba, Choba, Alakahia, Rumuodogo,Nkpo, Rumuoparall, Rumuokwachi, Ogbogoro, Elioparanwo, Egbelu, Rumuokwuta, Rumueme, Woji, Mgbuosimini, Mgbuodohia, Eremogbogoro, Iwofe and Rumuomei.Therefore the studied communities fell within the areas of 'Very High Flood' and'High Flood'.Plates 1 to 3 show the level of flood inundation across communities in the study area. Plate 1 is an area around Rumuekini were developing sites have been abandoned and other adjacent buildings evacuated due to the flood situation. Plate 2 shows the flooded community around Rukpokwu was residential building has been abandoned and evacuated while plate 3 shows a flooded road along Nkpolu closed from motorist.

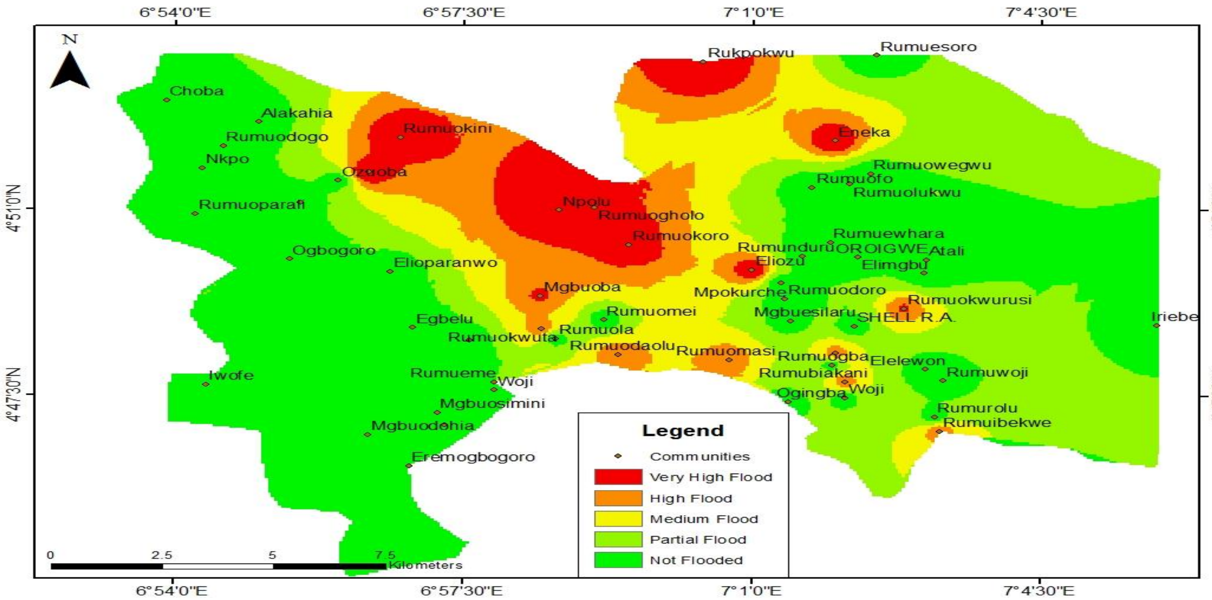

Figure 3. Flood prone areas in the study area

Classes of flood vulnerability of the community/environment in the study area

Flood vulnerability classes in Figure 3 using elevation model gave a contrary or different view from the flood exposed regions. Flood vulnerability was very high or is very high within the southern part of the study area instead of the impacted region which is in the central part of the study area. From the elevation model of flood vulnerability it can be deduced that flood occurrence in the study area is mostly tied to other factors other than elevation this has made the believe that flooding as it occurs in the study area is mostly an anthropogenic factor rather than physical factor of flood exposure. The impact of this flood was agreed almost across all communities to have impacted strongly on the people.The vulnerability analysis based on elevation as shown in the map reveals that communities such as Ozuoba, Egbelu, Mgbuosimini, Rumuokwuta, Eliozu, Elimgbu, Rumibekwe, Rumuokuta, Iwofe and marked red are very vulnerable to flooding and categorized as very high. Communities such as Rumuomei, Ogbogoro, Rumurolu, Choba, Nkpolu, Rumueme, Rumuoparafi, Rumuokoro, Rumubiakani and marked orange are also highly vulnerable areas but not as much as the areas marked red. While communities such as Mgbuodenia, Elioparanwo, Alakahia, Eneka, Atali, Rumuwegwu and marked green indicates very low vulnerability to flooding

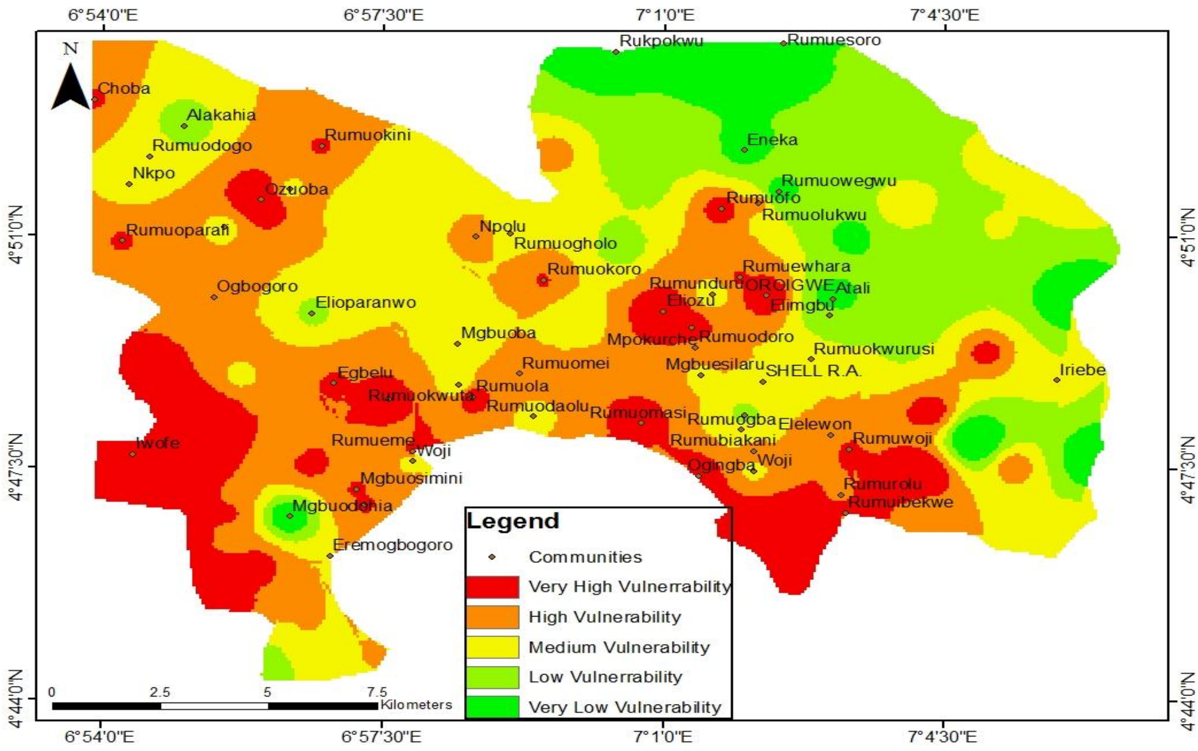

Figure 3. Flood vulnerability classes across the study area

Perception towards Flood Impacted Communities in ObioAkpor LGA

Table 1 presents the perception towards flood impacted communities. It is revealed in the analysis that flood impacted across the study area as discovered from the respondents. It is shown that most of the respondents agreed that the incidence of flood has highly impacted their communities except for Mgbuoba Community and RumuomasiCommunity where they did not agree or disagree that flood has created much impact in their community.

Table 1. Flood incidence has impacted your communities

Communities	SA	A	D	SD	WA	R
Nkpolu	4	2	2		3.25	Agreed
% count	50	25	25		100	
Elelewo	4				4	Agreed
% count	0				100	
Rumuodara	18	6			3.75	Agreed
% count	75	25			100	
Eliozu	3			1	3.25	Agreed
% count	75			25	100	
Mgbouba	6		3	3	2.75	Disagree
% count	50		25	25	100	
Rumuolumeni	15			5	3.25	Agreed
% count	75			25	100	
Ozuoba	18	9	9		3.25	Agreed
% count	50	25	25		100	
Rukpoku	12	4			3.75	Agreed
% count	75	25			100	
Rumuahaolu	16	16			3.5	Agreed
% count	50	50			100	
Eneka	12	4			3.75	Agreed
%	75	25			100	
Rumuibekwe	6			2	3.25	Agreed
% count	75			25	100	
Rumuodara	12	6	6		3.25	Agreed
% count	50	25	25		100	
Rumuogba	18		6		3.5	Agreed
% count	75		25		100	
Rumuokoro	3		1		3.5	Agreed
% count	75		25		100	

Rumuokwurusi	8	4	4		3.25	Agreed
% count	50	25	25		100	
Rumuokwuta	9	18			3.3	Agreed
% count	33.3	66.7			100	
Rumuomasi	32		16	16	2.75	Disagree
% count	50		25	25	100	
Rumuosi	4	12			3.25	Agreed
% count	25	75			100	
Rumuekini	12	12			3.5	Agreed
% count	50	50			100	
Rumuobiakani	20	10		10	3	Agreed
% count	50	25		25	100	

SA-Strongly Agree; A – Agree; D – Disagree; SD – Strongly Disagree; WA – Weighted Average; R - Remark

IV. Discussion of Findings

The study area lies mostly at the heart of the study area affecting communities of Rukpokwu, Ozuoba, Nkpolu, Rumuigbo and Rumuokoro. Other communities around this neighborhood show high to medium level of flood exposure. The studied communities fell within the areas of 'Very High Flood' and 'High Flood' which increases their flood vulnerability in the wake of excessive rainfall and other flood inducing factors.Analysis of flood vulnerability using elevation model gave a contrary or different view from the flood exposed regions. Communities such as Ozuoba, Egbelu, Mgbuosimini, Rumuokwuta, Eliozu, Elimgbu, Rumibekwe and marked red are very vulnerable to flooding and categorized as very high. Flood occurrence in the study area is mostly tied to other factors other than elevation. Most of the communities agree that the incidence of flood has highly impacted their communities except for Mgbuobacommunity and Rumuomasi were they do not agree or disagree.

V. Conclusion and Recommendations

It can be concluded that the flood prone and vulnerable areas are mostly at the heart of the study area which has been affecting communities such as Rukpokwu, Ozuoba, Npolu, Rumuigbo and Rumuokoro. The studied communities fell within the areas of Very High Flood and High Flood which increases their flood vulnerability in the wake of excessive rainfall. Analysis of flood vulnerability using elevation model gave a contrary or different view from the flood exposed regions**.**The study thus recommended thatinstitutional framework should be put in place to mitigate the impact of flooding; and there is need to build up resilience for vulnerable segments of the flood prone areas and carry out proactive planning for integrated management and development in non–vulnerable areas.

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