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Research Paper

Vulnerability of Flood Hazard Assessment in Selected Communities in Obio/Akpor Local Government Area of Rivers State

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Abstract
The Elevation of the study communities in Obio/Akpor local government area with respect to low lying and pockets of high elevation which plays a major role in the respective communities vulnerability to flooding. The study employed the use of Shuttle Radar Topographic Mission, Digital Elevation Model of 30 meters resolution in the Arc GIS 9.3 environment and classifies into regions of very to very low vulnerability in line with the classification by Theiler hammer and Klose (1999) using the variable of elevation to examine flooding areas in the selected communities. Elevation of the study area is generally low lying with pockets of high elevation in the southern part plays a very vital role in their vulnerability to flooding with a p value of less than 0.5 signifying very significant relationship between the community elevation and their vulnerability to flooding. Shuttle Radar Topographic Mission, Digital Elevation Model 30 meters resolution was employed in the Arc GIS 9.3 environment to classify into regions of very to very low vulnerability in line with the classification by Theiler hammer and Klose (1999) using the variable of elevation as determinant to flooding in an area. The study recommends continuous research activities to determine level of elevation in the study area. The study will assist in the developmental activities while consider proactive measures to control flooding areas in the environment.
Key Words: GIS, GPS, LANDSAT, IMAGERY, EVIRONMENT, VULNERABILITY.

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I. INTRODUCTION

Floods are natural hazards that has divested the world and its local communities with disastrous consequences with records of loss of human life, damage to properties, promote spread of diseases like cholera, malaria, high fever, injury of several degrees, promote infections to human like respiratory infection among others, damage of agricultural plants, disrupt social and cultural life style, disruption of essential services, damage to economic, social, political, environmental process and afterwards promote sociological and psychological effects. In Africa between 1900 to 2006 flood disaster has killed about (20,000) people and affected nearly forty million or more, and has caused damage estimated at 4billion US dollars (Genene et al. 2007).

Unplanned or planned urban areas without adequate protection of water ways like proper drainages, sand filling of water ways, buildings without layout to contain water due to rainfall are potential cause to flooding. Nigeria experience flood hazard and its disaster effects that displace more vulnerable people, damage properties and disrupt livelihood among others negative impacts. NEMA, (2009) posited that 20 percent of Nigeria population are at risk from one form of flooding.

The 2012 flood in Nigeria was an eye opener to Nigerians and Africa at large, as many affected communities were displaced, vulnerable person were seen scooping water or trying to safe some of their properties from damage or almost damage, series of losses ranging from loss of life, houses been submerged, agricultural crops washed out, and damage of government facilities were recorded during the 2012 massive flood disaster. (Amangabara, 2010) deposited that flood affects and displaced more people and caused more damage to properties than any other natural hazards in Nigeria.

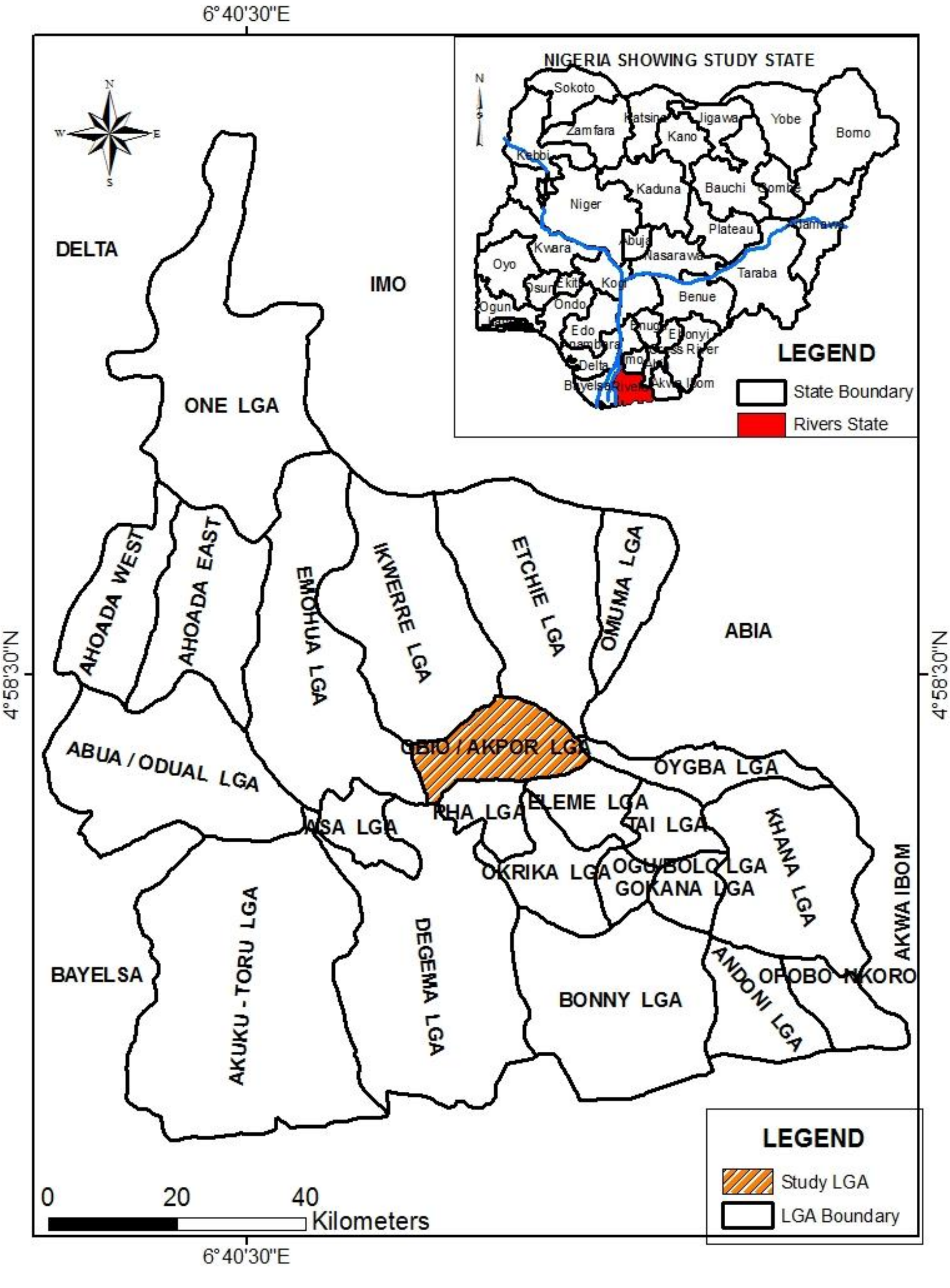
(The Nigeria voice, 6^{th} Nov, 2012) people are seen scooping water from their building or homes; these are common sights in metropolis during wet season. During the raining season roads and streets are not left out, as flood has caused a night mare to motorist and pedestrians. Experience has shown that most of the roads especially during the Nigeria flood disaster in 2012, some bridges and tired roads break up or covered up with water and motorist who are on aware sink, thereby making motorist and pedestrians walkers to take another routes to access Delta State to Port Harcourt along Emohua–Bayelsa-Delta road. Obio/Akpor is located in the Niger Delta region whose topography is almost classified as plain which makes the region vulnerable to flood events. This study therefore seeks to study vulnerability of flood hazard in the selected communities in Obio/Akpor Local Government Area of Rivers State.

Flood hazard has always been part of the environmental challenge that stimulate natural event and not isolated, most times flood occurs due to some deficiencies and weaknesses arising from the society, the deficiencies and weaknesses are induced by human activities with regards to unplanned infrastructural development program which sometimes fail to consider water ways as transportation channel whenever it rains heavily with high volume of runoff causing flooding.

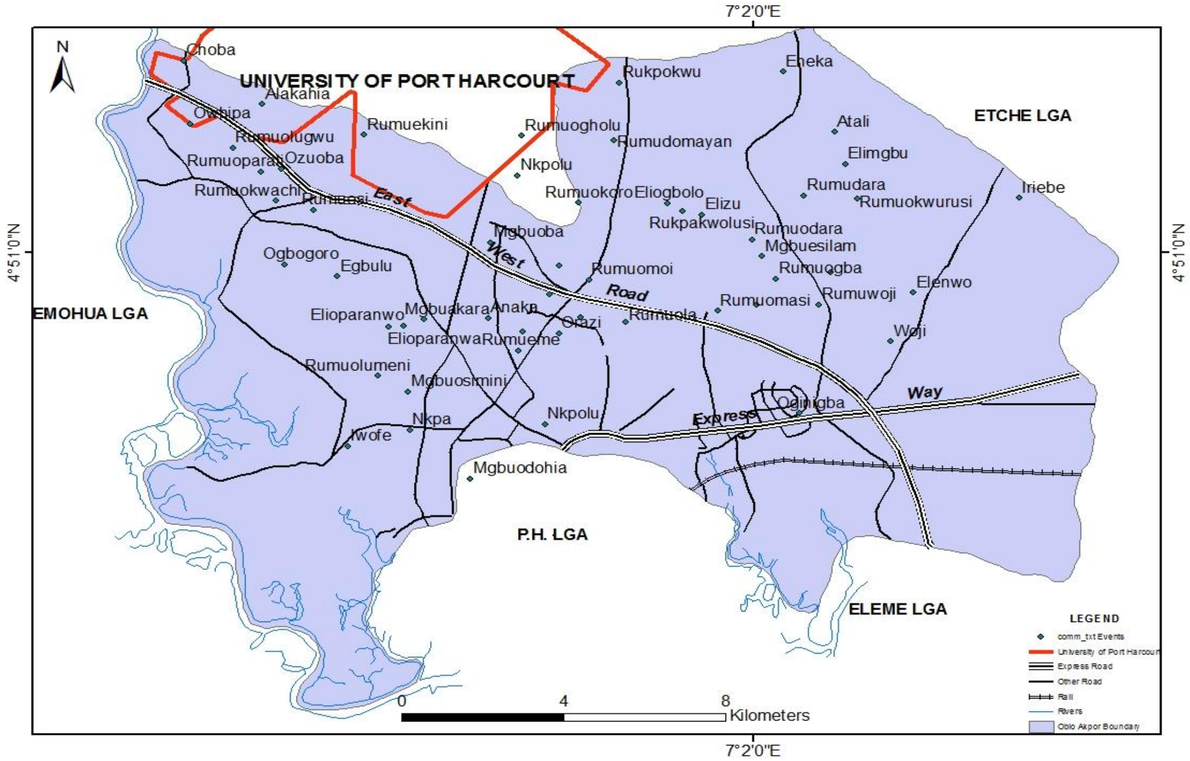
The high influence of flood vulnerability across twenty five States out of thirty six States in Nigeria during the 2012 flood disaster which impacted severely on Nigerians because of lack of vulnerability data, preparedness, physical and structural capacity which ought to be a guide to managing the ugly situation but fail, based on the above premise, the research seek to determine level of vulnerable communities and identifying there elevation above sea level with the use of GIS application and tools to assist in the future flood disaster planning by communities and respective government agencies with responsibility to managing flood events. The urban growth by way of structural development is moving at fast rate without authorities responsible considering management measures to curtain run-off According to the IPCC (2001) trend in precipitation has significantly increased globally over the 20^{th} century. In addressing the research some considerable question that arose was to what extent is global positioning effective to the vulnerability of the areas to flooding, how elevation affects the vulnerability of the areas to flooding. The aim was to determine flood vulnerability of the selected Communities in Obio/Akpor Local Government Area, with objectives to identify the global positioning of selected communities in the study area, to identify the impact of elevation on the vulnerability of the selected areas to flooding while the null hypothesis of the research looked at the Elevation of communities does not have any significant relationship with the vulnerability of the selected communities to flooding. Some significant of being useful to researchers that want to research further on the said topic, It will be useful to policy makers like national and state lawmakers towards recommending proactive measures of controlling flooding in the rural and urban system, a pathway to encourage capacities building on the flood prone communities in order reduce level of vulnerability of households and improve resilience of the people to flooding by all stakeholders.

STUDY AREA

The study area Obio/Akpor L.G.A and its selected communities in Rivers State represent one of the economic base of the nation located within latitudes 4° 45’E and 4° 60’E and longitudes 6° 50’E and 8° 00’E in the Niger Delta region of South-South, According to (National Bureau of Statistics, 2006) the census of 2006 records Obio/Akpor L.G.A with population size of 878, 890 compared to 1991 which records 263,017. The growth of the study area within 1991 to 2006 represents about 70% increase on population. The area is l00sq mil ($260Km^2$), Head quarter at Rumuodamaya. The study area is captured within $11,077Km^2$ (4,277sq mil) of area and density of $468/Km^2$ (1,210/sq mil) of Rivers State which has 23 local government area.



Source: Rivers State Ministry of Lands and Housing, Digitized by Author.
Figure 1. Rivers State Showing Study LGA



Source: Rivers State Ministry of Lands and Housing, Digitized by Author.
Fig 1.1 Map of Obio/Akpor L.G.A and Sampled Communities in Rivers State

II. MATERIAL AND METHODS

This study adopts a cross sectional where the researcher does not interfere amid the subject of investigation but observes the phenomena under consideration. Form the study plan the researcher studied flood hazard vulnerability in the study area. In this study adopting the cross sectional research design enabled the researcher to conduct series of observation on the subject matter. This allowed for the easy detection of possible developmental changes in the characteristic of the question of study both collectively and individually. This is because the design allows for study that extends over and beyond a single time frame making for avenue to establishing sequence of events (Chava& David, 2009). In this study, observation is conducted on vulnerability classification level on study communities and adopting this design gives an insight to proper evaluation of the phenomena in question as the studies does not go within one study or time frame rather it goes beyond a period or single time frame. This enabled the researcher to predict the trend in development and alteration in relation to vulnerability of the study area.

NATURE AND SOURCE OF DATA

The study utilized both the primary and secondary data. The primary data was derived from direct field measurement using the Global Positioning System to acquire information on the absolute position of communities and their elevation for the proper geo-referencing of base maps and other necessary analysis in the Geographic Information System (GIS) Environment.

The secondary data were derived from published articles, journals, srtm data, landsat imageries gotten from the global land cover facility Landsat TMprocessed in the GIS environment to delineate the land cover of the study area processed in to the WGS 1984 (UTM zone 32^0N) projection from the producer Global land cover facility (GLCF) for the purpose of this work. This data helped in the generation of the contour map of the study area as well as the vulnerability analysis of the study area.

The digital elevation model acquired from the Shuttle Radar Topographic Mission (SRTM) was used to generate the topographic map of elevation of 30 meter resolution and this was cross checked using the information derived using the Global Positioning System (GPS).

III. METHODS OF DATA COLLECTION

The Digital Elevation of the study area was derived from the Shuttle radar topographic mission (SRTM) data and this was used to derive the contour of the study area which was further analyzed in the geospatial environment. The elevation of the communities derived from the GPS was used to verify the accuracy of the SRTM derived data alongside the x, y coordinate of the communities as derived using the GPS. This was done after the geo ratification of base maps using the GPS data derived from the field. The vulnerability map of the study area to flooding was geo calculated and processed using Arc GIS 9.3 spatial analysis food extension in line with Theiler classification of relief determinant of flooding of an area while the contour map of the study area was created from digital elevation model of 30m by 30m resolution which helped in the delineation of areas liable to flooding sequel upon the classification of flood vulnerability levels.

IV. METHOD OF DATA ANALYSIS

Flood Vulnerability Map

Analysis on the topographic determination of vulnerability to flooding was carried out using the 30 meter digital topographic model acquired from the srtm data over the study area and was analyzed alongside Thieler 1999 elevation classification of vulnerability over a surface. Vulnerability to flooding was analyzed using the SRTM data in the ArcGIS extension of spatial analysis tools. The extension enables the spatial analysis of areas prone to flooding giving a specific calibration of environmental (topographic) parameter. Given this parameters that is elevation classes, the modeling of areas and communities vulnerable to flooding within the study area was delineated and communities exposed enumerated in line with their level of exposure.

Table 2. Selected communities and their Latitude and Longitude

Community	Latitude	Longitude
Alakahia	4.88687	6.9244
Nkpa	4.8058	6.9572
Rumuokwachi	4.86289	6.9274
Ozuoba	4.8708	6.9286
Ogbogoro	4.84707	6.9293
Mgbuodohia	4.79365	6.9706
Egbulu	4.84405	6.94103
Elioparanwa	4.83142	6.9525
Rumuosi	4.88115	6.9413
Rumuekini	4.897	6.941
Rumuopirikom	4.83031	6.98212
Mgbuoba	4.8525	6.975
Nkpolu	4.80723	6.9871
Elizu	4.8594	7.0219
Rumuodalu	4.83381	6.995
Woji	4.82788	7.0637
Rumubiokani	4.83688	7.03399
Rumuokwurusi	4.86343	7.0564
Rumuolugwu	4.87612	6.9179
Elenwo	4.83999	7.0688
Choba	4.8978	6.9069
Owhipa	4.88208	6.9084
Rumuoparali	4.87016	6.92396
Rumuogholu	4.87907	6.9819
Rumuokoro	4.8624	6.9946
Rumuokwuta	4.8395	6.98819
Rumuola	4.83278	7.005
Rumuolumeni	4.81932	6.95
Rumueme	4.82566	6.9812
Mgbuosimini	4.81541	6.9567

Rumuigbo	4.84682	6.9902
Nkpolu	4.8691	6.98109
Iwofe	4.8018	6.9433
Rumuomasi	4.83546	7.0254
Eliogbolo	4.8622	7.0142
Rumuodara	4.85325	7.033
Mgbuesilam	4.84921	7.0353
Oginigba	4.81	7.0435
Rumuibekwe	4.845	7.0506
Rumuwoji	4.837	7.0478
Elimgbu	4.872	7.0537
Atali	4.88	7.0514
Eneka	4.895	7.0399
Rukpokwu	4.904	7.0003
Iriebe	4.872	7.1133
Rumudomayan	4.878	7.0025
Rumuomoi	4.8432	6.9969
Rumudara	4.8642	7.0446
Rukpakwolusi	4.8603	7.0176
Rumuogba	4.8435	7.0383
Orazi	4.8299	6.99017
Elioparanwo	4.83181	6.95577
Anaka	4.83369	6.9745
Mgbuakara	4.8333	6.9603

Source: Authors Field Work

For the study the vulnerability index developed by Gornitz (1990) which was further adjusted in 1999 by Thieler& Hammer – Klose was adopted to delineate flood vulnerability within the study area. In doing this flood vulnerability classification of 5 classes was utilized and shown in table 3.1

Table 2.1 Elevation indicator of Vulnerability to Flooding

Variables	CATEGORIES				
	5	4	3	2	1
Vulnerability Index)	Very Low	Low	Moderate	High	Very High
Relief (m)	>6.01	4.01-6	3.01 - 4	1.01-3	0 - 1

Source:Adapted from Thieler & Hammer-Klose, (1999)

They put forward a vulnerability index formula to represent

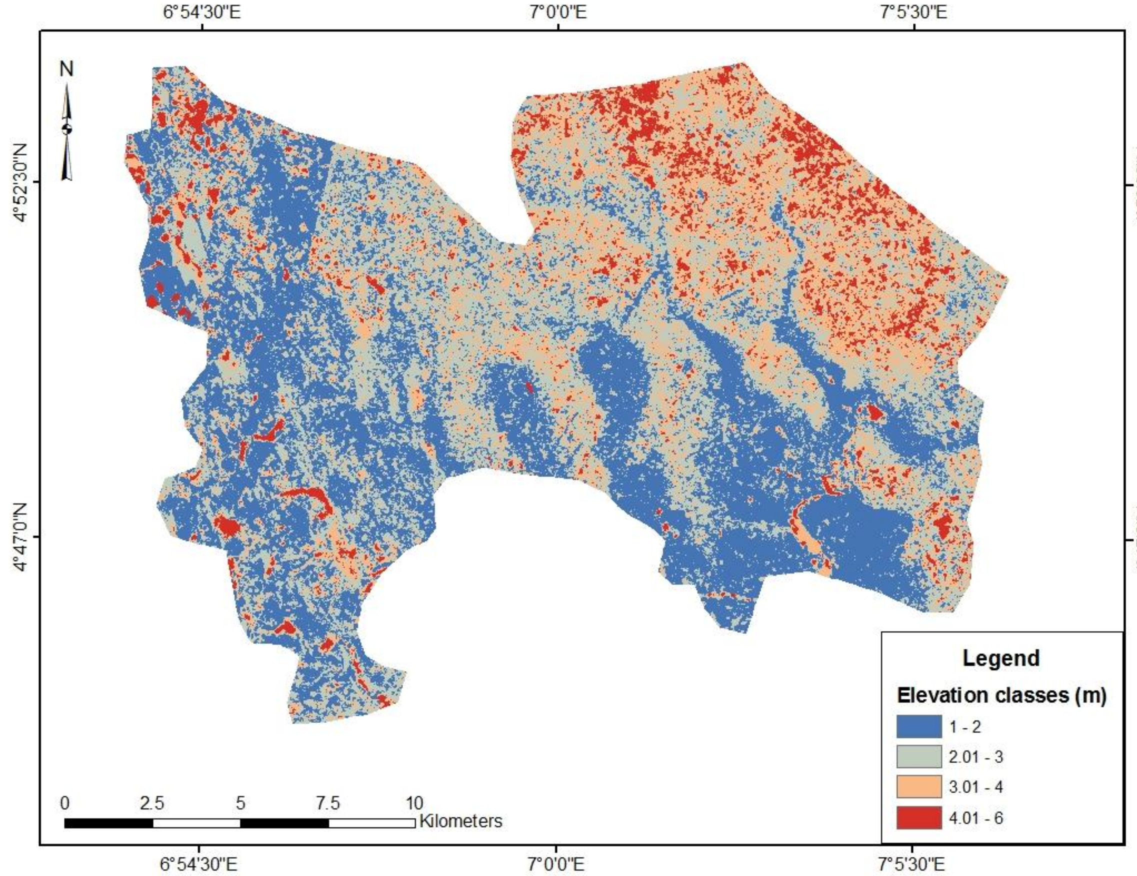
$$VI = \sqrt{\frac{Rx_1}{{}^{Count}{}_{Var}}} \quad ....(3.1)$$

where VI = vulnerability index, R = Relief, x_1 and ${}^{Count}{}_{Var}$ - represents the variables that are taken in to account. From the definition and classification of vulnerability to flooding using Thieler& Hammer – Klose classification relief which is defined as the low lying areas of the study area enhances the vulnerability of a region to flooding in the wake of climate and environmental changes. This is because the lower a region is to the water table the more prone it is to flooding as saturation is easily attained in the wake of flood event.

V. RESULT

The presentation of data and analysis of result derived from this study. The classification of selected communities' vulnerability to flooding, contour mapping and Digital elevation modeling and map in meters is to be presented in this chapter. The attribute data calculated from the spatial features and tabulated for analysis alongside the result for testing of formulated hypothesis.

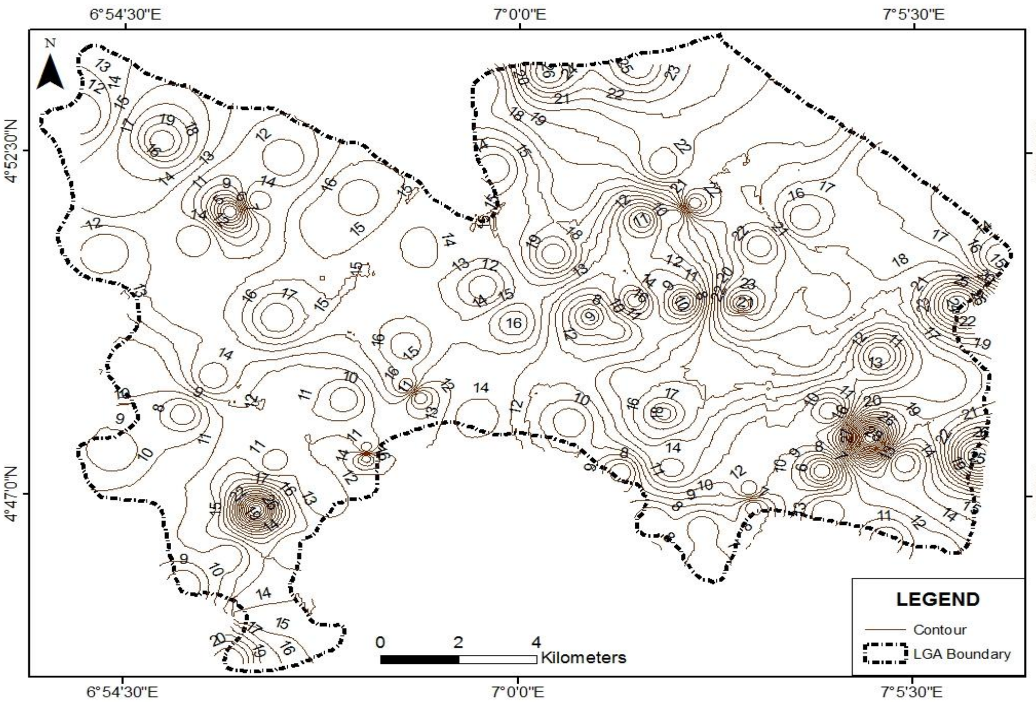
VULNERABILITY MAP AND ANALYSIS
This includes elevation map, contour map, vulnerability ranking map and analysis.



Source: Author's Analysis

Figure 3. Digital Elevation Map of Obio/Akpor LGA

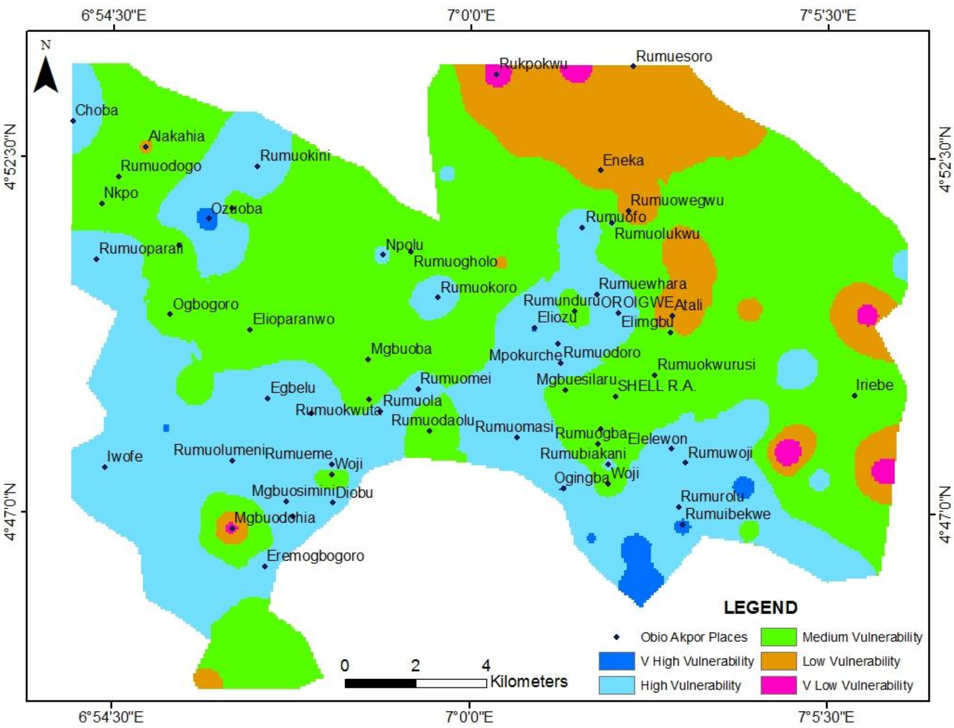
From the analysis as shown in the figure 4.3, the elevation of the study area was classified in to four classes. This classification enabled the understanding of the terrain of the study area. This analysis revealed that the study area is generally low lying with pockets of high elevation in the southern part of the study area and most dominantly in the northern part of the study area. Within the southern part of the study area are elevations of classes falling between 1 to 2 meters above mean sea level while in the northern part of the study area are elevation classes within the corridor of 4 and above 6 meters above mean sea level. in the central study area are elevation classes of 2 to 4 meters above mean sea level though with pockets of this elevation class scattered all over the study area.



Source: Author's Analysis

Figure 3.1 Line Joining Communities with Equal Elevation

The figure 4.4 shows the lines of joining communities with same or equal elevation. This is mostly referred to as coutour lines and these lines were derived from the DEM of the study analyzed using the ArcSWAT and ArcGIS extension. The contour was drawn at an interval of 2meters above mean sea level showing a contour peak of 28meters above mean sea level. The contour lines were developed from the raster surface using the spatial analysis function of the ArcGIS.



Source: Author's Analysis

Figure 3.2 Vulnerability ranking of the Study Area

Communities' elevation is believed to be the major determinant of the proneness of a place to flooding along side presence of water bodies (IPCC, 1996; Oyegun, 2007; Tol, Klein and Nicholla, 2008; and Vaughan, 2008). The elevation of the study area was determined using the SRTM data in the ArcGIS environment with a form of ground trotting done to ascertain the accuracy of the said data. Classification of the study area in to elevation strata was carried out alone side the definition and classification of elevation determinant to flooding of an area developed by gornitz (Thieler and Hammer-Klose 1999). The analysis was carried out and from the findings it was revealed that communities that fell in the class depicted with the colour blue represent very high vulnerable areas hence in the event of flooding of the study area communities within this classification need be paid much attention to. Next in this category is the area represented by the colour sky blue which represents high vulnerable area in the event of flooding of the study area. From this it is seen in terms of hierarchy of attention required by habitats of these areas, those of the blue and sky blue needs most attention in the event of flooding. This is because in line with the onions framework, the people natural base of survival will be impacted which include both the social and economic platform of their survival. The areas depicted with the colour medium apple represent areas with medium vulnerability which indicates that in the wake of flooding, the physical or natural base of the environment is not completely destroyed rather, the social and economic resource base of the people will be affected but not the physical or natural base hence in the case of flood event, the people whose assets were damaged or destroyed can be replaced thereby indemnifying them. The brown colour represented in the analysis shows areas in the study area that are not very prone to flooding and the communities involved. The analysis shows that very few communities would not be easily affected by flooding in the wake of flood event. Finally the colour pink represents areas in the study area that will almost not experience flooding in the study area. Even if there are flood event in the study area, very little damage can be incurred in the area.

HYPOTHESIS TESTING

The hypotheses of this research stated as follows:

Hypotheses1 which states that elevation of communities does not have any significant relationship with the vulnerability classification of the communities to flooding in the study area was tested using the student t test analytical tools as shown in table 4.6, 4.7 and 4.8.

Table 3.3 Community Elevation and their Vulnerability Classification

NAME	ELEVATION (m)	Vulnerability Classification
Alakahia	2	High
Nkpa	3	Moderate High
Rumuokwachi	2	High
Ozuoba	1	Very High
Ogbogoro	2	High
Mgbuodohia	3	ModerateHigh
Egbelu	3	ModerateHigh
Elioparanwo	4	Low
Rumuosi	2	High
Rumuekini	1	VeryHigh
Rumuopirikom	3	ModerateHigh
Mgbuoba	3	ModerateHigh
Nkpolu	3	ModerateHigh
Eliozu	3	Moderate High
Rumuodaolu	4	Low
Woji	2	High
Rumubiokani	5	Very Low
Rumuokwurusi	3	Moderate High
Rumunduru	2	High
Rumuofo	4	Low
Rumuowegwu	4	Low
Rumuolukwu	3	Moderate High

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Rumuesara	3	Moderate High
Elelenwo	5	High
Rumurolu	2	High
Choba	2	High
Rumuodogo	3	ModerateHigh
Rumuoparali	5	Very low
Rumuogholu	2	High
Rumuokoro	4	Low
Rumuokwuta	3	Moderate High
Rumuola	4	Moderate High
Rumuolumeni	2	High
Rumueme	2	High
Woji	4	Low
Diobu	3	Moderate High
Mgbuosimini	2	High
Amatangbolo	2	High
Eremogbogoro	3	Moderate High
Iwofe	2	High
Rumuomasi	2	High
Mpokurche	3	ModerateHigh
Rumuodara	2	High
Mgbuesilaru	4	Low
Rumuibekwe	3	Moderate High
Oginigba	4	Low
Rumuibekwe	2	High
Rumuwoji	4	Low
Elimgbu	4	Low
Atali	4	Low
Rumuewhara	3	Moderate High
Eneka	4	Low
Rukpokwu	5	Very Low
Iriebe	3	Moderate High

Source: Author's Analysis

Table 3.4 Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Vulnerability Class	2.70	54	.964	.131
	Community Elevation	3.00	54	1.009	.137

Source: Author's Analysis

Table 3.5 Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Vulnerability Classification & Community Elevation	54	.892	.000

Source: Author's Analysis

From the analysis of the relationship between community elevation and their vulnerability to flooding, it is obvious that community elevation plays a very vital role in their vulnerability to flooding with a p value of less than 0.5 signifying very significant relationship between the community elevation and their vulnerability to flooding. The test for relation between elevation and vulnerability to flooding reveals a very high correlation of .89 signifying that over 80 percent of community vulnerability to flooding could be induced by their elevation.

VI. DISCUSSION OF FINDINGS

The elevation of the study area as classified in to four classes revealed that the study area is generally low lying with pockets of high elevation in the southern part of the study area and most dominantly in the northern part of the study area. Within the southern part of the study area are elevations of classes falling between 1 to 2 meters above mean sea level while in the northern part of the study area are elevation classes within the corridor of 4 and above 6 meters above mean sea level. in the central study area are elevation classes of 2 to 4 meters above mean sea level though with pockets of this elevation class scattered all over the study area. The contour was drawn / developed from srtm raster surface using the spatial analysis function of the ArcGIS at an interval of 2meters above mean sea level shows a contour peak of 28meters above mean sea level in the study area. From the elevation of the study area determined using the srtm data in the ArcGIS environment with a form of ground trotting done to ascertain the accuracy of the said data and the classification of the study area in to elevation strata alone side the definition and classification of elevation determinant to flooding of an area developed by gornitz (Thieler and Hammer-Klose 1999). it was revealed from the analysis in figure 4.5 that communities that fell in the class depicted with the colour blue represent very high vulnerable areas hence in the event of flooding of the study area communities within this classification need be paid much attention to. Next in this category is the area represented by the colour sky blue which represents high vulnerable area in the event of flooding of the study area. Finally the analysis shows that very few communities would not be easily affected by flooding in the wake of flood event.

Finally, it is obvious that community elevation plays a very vital role in their vulnerability to flooding with a p value of less than 0.5 signifying very significant relationship between the community elevation and their vulnerability to flooding. The test for relation between elevation and vulnerability to flooding reveals a very high correlation of .89 signifying that over 80 percent of community vulnerability to flooding could be induced by their elevation.

VII. CONCLUSION

The pressure man puts on the environment via exploitation globalization and so on has resulted in an undue effect on the global environment. Biophysical limits on what is available for human use are real and there are strong signals that these limits are close to being reached or have already been exceeded. This has resulted in growing demand for food, feed, fuel, fiber and raw materials creates local and distant pressures for land cover change. Unplanned or planned urban areas without adequate protection of water ways like proper drainages, sand filling of water ways, buildings without layout to contain water due to rainfall are potential cause to flooding. From the analysis Elevation of the study area is generally low lying with pockets of high elevation in the southern part plays a very vital role in their vulnerability to flooding with a p value of less than 0.5 signifying very significant relationship between the community elevation and their vulnerability to flooding. From this it is seen in terms of hierarchy of attention required by habitats of these areas, those of the blue and sky blue needs most attention in the event of flooding. This is because in line with the onions framework, the people natural base of survival will be impacted which include both the social and economic platform of their survival. There is also the need for regular research activities to find out the pattern land cover changes in the area. This would guide developmental activities from encroaching in to the swamp and wetland environment.

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APPENDIX

NAME	ELEVATION (m)	Vulnerability Classification	Ranking
Alakahia	2	High	4
Nkpa	3	Moderate High	3
Rumuokwachi	2	High	4
Ozuoba	1	Very High	5
Ogbogoro	2	High	4
Mgbuodohia	3	Moderate High	3
Egbelu	3	Moderate High	3
Elioparanwo	4	Low	1
Rumuosi	2	High	4
Rumuekini	1	Very High	5
Rumuopirikom	3	Moderate High	3
Mgbuoba	3	Moderate High	3
Nkpolu	3	Moderate High	3
Eliozu	3	Moderate High	3
Rumuodaolu	4	Low	2
Woji	2	High	4
Rumubiokani	5	Very Low	1
Rumuokwurusi	3	Moderate High	3
Rumunduru	2	High	4
Rumuofo	4	Low	2
Rumuowegwu	4	Low	2
Rumuolukwu	3	Moderate High	3
Rumuesara	3	Moderate High	3
Elelenwo	5	High	4
Rumurolu	2	High	4
Choba	2	High	4
Rumuodogo	3	Moderate High	3
Rumuoparali	5	Very low	1
Rumuogholu	2	High	4
Rumuokoro	4	Low	2
Rumuokwuta	3	Moderate High	3

Rumuola	4	Moderate High	3
Rumuolumeni	2	High	4
Rumueme	2	High	4
Woji	4	Low	2
Diobu	3	Moderate High	3
Mgbuosimini	2	High	4
Amatangbolo	2	High	4
Eremogbogoro	3	Moderate High	3
Iwofe	2	High	4
Rumuomasi	2	High	4
Mpokurche	3	Moderate High	3
Rumuodara	2	High	4
Mgbuesilaru	4	Low	2
Rumuibekwe	3	Moderate High	3
Oginigba	4	Low	2
Rumuibekwe	2	High	4
Rumuwoji	4	Low	2
Elimgbu	4	Low	2
Atali	4	Low	2
Rumuewhara	3	Moderate High	3
Eneka	4	Low	2
Rukpokwu	5	Very Low	1
Iriebe	3	Moderate High	3