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Research Paper

Assessing Land Use/Land Cover and Flood Hazard Vulnerability in the Core Niger Delta States, Nigeria.

Okocha, Sunny[1], Vincent E. Weli[2], O.S. Eludoyin[3], Morgan Nyekazi Amadi[4], G.T. Ariolu[5],

[1]*Disaster Risk Management, Department of Geography & Environmental Management Science, Faculty of Social Sciences, University of Port Harcourt, Nigeria or No 1 Allweather Road Owhipa Choba, Uniport Road, Rivers State, Nigeria. sunny_okocha2000@yahoo.com, +23407068620933.*
[2]*Geography and Environmental Management Science, Faculty of Social Sciences, University of Port Harcourt, Rivers State, Nigeria.*
[3]*Geography and Environmental Management Science, Faculty of Social Sciences, University of Port Harcourt, Rivers State, Nigeria.*
[4]*Nikkymor Process Safety Limited, mamadi@nikkymorconsultant.com.*
[5]*Obio/Akpor Local Government Council, Rivers State, Nigeria.*

ABSTRACT
The study used Land-Sat Tm of 30m of 2019 to classify flood vulnerable areas with respect to land use/land cover using Arc GIS 10.2. The result showed that mangrove had the highest spatial extent of (11970.00 km^2), followed by swamp forest/thick forest having 8626.08. The analysis also revealed that water bodies recorded 1068.27km^2 while the built-up area recorded 6301.91 km^2 and farmland/light forest having 7203.37 km^2. The spatial coverage of the area for moderate flood vulnerability covered 45.01% while high flood vulnerability was 55.97 %. The high vulnerability zone based on relief was between 43.73m and 192.22m while the moderate vulnerability was between 192.22m and 266.47m. The low vulnerability zone was between 266.47m and 340.72m. The analysis also revealed that the high, moderate and low vulnerability covered 33540.74 km^2 (94.52%), 1040.68 km^2 (2.93%) and 905.57 km^2 (2.55%) respectively. The river network and their levels of vulnerability results show that the buffer of 500m from the rivers (i.e., high flood vulnerability level based on the nearness to active channel) covered a spatial extent of 6250.15 km^2, the buffer of 1000m covered 5438.65 km^2 while the buffer of 1500m covered a spatial extent of 4503.73 km^2. Thus, the high vulnerability area covered 38.60%, moderate 33.59% and low covered 27.81%. The null hypotheses were tested at a 0.05 level of significance, using Pearson Product Moment Correlation (PPMC), the results of hypothesis show a moderately positive and statistically significant (r=.592, < .001). The finding reveals the low-lying nature of the area and proximity to the river bank makes it vulnerable to seasonal flood. The people are yet to recover from the effects of past floods, but trying to be resilient in their approach to flood hazard by applying some coping capacities like relocating to flood plain area, reconstructing houses with reinforced materials against the bricks and mud/thatch houses, raising of houses above annual flood levels, erecting temporal structures along river banks, creating water channels to ease evacuation of flooding areas, cleaning drainage outlets, construction of dykes using sand bags and fumigation of stagnant flood water against mosquito parasites. The study recommends public enlightenment campaign, early warming, preparedness and development of other safety measures to mitigate the likelihood reoccurrence of flood disaster.

KEY WORDS: GIS, GPS, LANDSAT, IMAGERY, ENVIRONMENT, VULNERABILITY.

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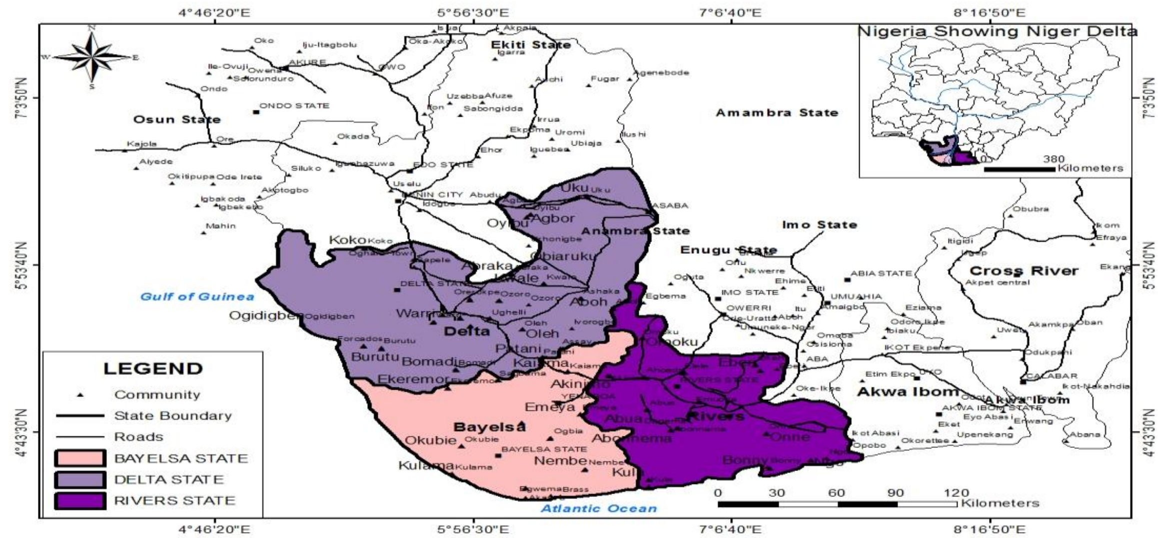
I. INTRODUCTION

Natural flood events in the 21st century is becoming a normal experience across most regions in the world whenever it rains heavily, in the geographic Niger Delta region and its selected states like Bayelsa, Delta and Rivers State floods hazard is eminent and has always been part of the integral of geologic history of the earth. It occurs along rivers, stream, lake, coastal areas, alluvial fans; ground area failure like subsidence influenced by structural measures or failed areas with surface runoff, local inadequacy or lack of proper drainage or blockage of drainages. Flood or flash flood occurs when its flows exceed the natural capacity without capability to retain the overflow of water which eventually spills over the natural or artificial embankment, is related to the extreme precipitation events and specific geomorphologic settings, when floods spills to the marginal urban and rural communities it can cause serious damages to tangible and intangible assets such as properties, livelihood, and loss to human life at the extreme impacts. The natural phenomenon, flood hazard has created need for national and international interest on how to proactively manage its sudden occurrences and consequence that comes after the incidents, some countries with sophisticated system or mitigation approach supporting level of preparedness also gets battered by flood events, take for instance notable countries like United states of America, India, China among other developed countries experience flood events, hence Nigeria is not exception to flood occurrence; the ugly incident of 2012 flood event in Nigeria according to National Emergency Management Agency affected 30 out of 36 States of Federal Republic of Nigeria with 7 million people terribly affected in 30 States, while 597, 476 houses destroyed, 2.3 million were displaced and 363 death recorded, the incident also affected large portion of farmland including other means of livelihood destroyed, animals also had their fair share with other biodiversity affected. The Punch Newspaper on May 27th, 2013 reported that the country lost about 500,000 barrels of crude oil as cumulative output per day arising from serious flooding, economic loss as detailed in the comprehensive Post Disaster Needs Assessment report conducted from November 2012 to March 2013, with the aid of World Bank and Global Facility for Disaster Reduction and Recovery, United Nations, Development partners and relevant Ministries, Departments and Agencies in their result estimated that a total value of infrastructure, physical and durable assets destroyed is put at $9.6bn, while the total value of losses across all sectors of economic activity was estimated at $7.3bn, combining the values of the sudden damages and losses at US$16.9bn. The implication of this report implies that no flood events in the history of Federal Republic of Nigeria have ever been so irresistibly catastrophic as notable effects or impacts on citizens arising from the ugly flood incident which technically can be linked to have jointly caused the extreme poverty level experienced by the people, lack of disaster risk management knowledge, low sources of livelihood, lack of insurance, weak institutions and problems with emergency response and early warning preparation could be traced as further key factors.

Study Area

The study area is located in Niger Delta region, and share part of the Delta in Niger River sitting directly on the Gulf of Guinea on the Atlantic Ocean in Nigeria, located within the coasted Southern Nigeria States, and stretched through latitude the 4^0 43' 30.''N and 5^0 53.40'' N while longitude 4^0 46' 20'' E and 8^0 16' 50'' E. The study area comprises Bayelsa, Delta and Rivers States as core Niger Delta States in (Map 1.1). The three States amongst others have electoral and economical values that sustain Nigeria as a nation, it was sometime called oil Rivers due to palm oil production and later called oil Rivers protectorate from 1885 until 1893 when it was expanded and became Niger coast protectorate, and also known as petroleum rich region. It can also be described as a center of international controversy over pollution, upon its geographical areas within 70,000km^2 (27,000 sq m) which make up part of 7.5%.



Map 1.1: Core Niger Delta

Source: Rivers State Ministry of Land and Housing

II. MATERIAL METHOD

The collected data were analyzed qualitatively and quantitatively, exploring PRA method in administering of questionnaires to selected communities, the aggregate were determine by the use of mean and standard deviation with respect to flood events of 2012 and 2018, and in consideration of state wise to arrive at the final weight to be classified/prioritized with regards to severity of vulnerability of flood hazard seeking the urgency of coping capacity/adaptive measures. The comparison of PRA of the both flood disasters will show the fluctuation in vulnerability, coping and adaptation of community. The household survey will be analyzed using MS Excel and SPSS to produce tables of mean and standards deviation for comparing different factors of the three selected states in Niger Delta.

To determine the land use/land cover classification of the area, supervised classification will be carried out on the imageries acquired from Landsat imagery data for the study area, GIS technique with respect to Arc GIS 10.2 and other geospatial and statistical tools will be used in this study to analyze land use/land cover and its dynamics in relation to flood vulnerability of communities in the study area. The analysis will be carried out in line with community elevation to the spatial extents of land use/land cover vulnerability and classification utilizing base maps, google maps, SRTM data of 30-meter digital terrain model, and satellite imageries alongside secondary data from literatures.

Frequency tables were constructed to indicate responses from each item used while inferential statistics, and Pearson Product Moment Correlation (PPMC) were used to analyze the Null hypotheses, the null hypotheses were tested at 0.05 level of significance. However, responses are coded, processed, and entered into the computer using Microsoft excels and word programmes.

III. RESULT AND DISCUSSION

This chapter addresses the presentation, analysis, and interpretation of data resulting from the field survey as expressed using the procedure and statistical tool as discussed above. The presentation and analysis of specific data were done in line with the objectives of the study.

A total of three hundred and ninety-nine (399) questionnaires were administered to respondents in the area of study. All the three hundred and ninety-nine (399) questionnaires were received adequately filled as follows Bayelsa 127(31.8%), Delta 163(40.9%) and Rivers 109(27.3), giving a percentage response of 100,0%. Mugenda (2003) argues that a response rate of 50 % or higher is adequate for data analysis. This implies that 100.0% response rates were very appropriate for data analysis.

First, the data showing the demographic characteristics of the respondents in the study area were presented and discussed. To classify flood vulnerable areas with respect to land use/land cover in the study area in the study States are analyzed, to identify the categories of vulnerabilities to flood hazard, physical, material, economic, social, organizational, political, attitudinal, & motivational that best describes the situation of the study area.

Furthermore, identify elements at risk and examine the variation of social, economic, human, attitudinal, political, natural and physical categories of vulnerability of communities in the study area, identify the types and level of capacities in the study area, determine the level of awareness of flood hazard, risk, warning system, preparedness measures and ability to use information to counter or reduce flood hazard in the study area and to identify the laws and policies which provide a formal basis for counter disaster action in the study states.

Finally, the chapter was concluded with a discussion of the findings of the previous study.

3.1 Flood Vulnerability Map

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

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

Table 3.1 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.

3.2 Study Population

The population of the study is targeted at the population of people living in the communities in Rivers, Delta, and Bayelsa States vulnerable to flood hazard, with respect to population census data as projected for 2006 and 2019. According to the state-wide 1991 national population census the ten communities selected from Bayelsa State population for the year 1991 is 23,136, year 2006 is projected for 33,200 and year 2019 have a projected population of 47,875, Delta State recorded 10,485 in 1991 national population census, 2006 year projection is 15,046 and 21,696 as projected for the year 2019 while Rivers State with population of 75,786 in 1991 census, 2006 as projected is 108,753 and 2019 year projected at 156,822 population. However, 2019 projected population state-wide in table 3.1 will be use to determine the respective sample size calculated as stated in table 3.3. The oil rich States are strategic among other states in Nigeria, and require proactive measures through community's participatory rapid assessment to identify the now capacities in order to recommend Disaster Risk Management approach in line with international best practices to help improve community's resilience.

Table 3.2 Population of ten selected communities per state

S/No	Selected States	**Communities Population 1991 Census, Nigeria**	**Communities 2006 Population Projection Based 2.9% Growth Rate NPC Standard @ 15 Years**	**Communities 2019 Population Projection Based 3.4% Growth Rate NPC Standard @ 13 Years**
1	Bayelsa	23,136	33,200	47,875
2	Delta	10,485	15,046	21,696
3	Rivers	75,786	108,753	156,822

Source: Author's computation, 2019.

3.3 Sampling Technique

The simple random sampling technique will be utilized to enhance the administering of certain copies of the structured questionnaires to community's household heads of population affected by 2012 and 2018 flood disasters within the local government areas in the Niger Delta selected States, to achieve this purpose the lottery method will be applied.

3.3.1 Sample Size Determination

The Taro Yamani formula that enhances equal opportunity of selection shall be adopted and put in use to determine the research study sample size in relation to the study area population households, the calculated sample size will give an idea of a certain numbers of the study area population to be administered with questionnaires focused in achieving the research objectives without bias.

Taro Yamani formula is written as thus:

$n = N/1+N*(e)^2$ …………… 1

Where:

n = sample size

N = population

1 = 1 is constant

e = error limit or margin of error or level of precision at 5% or $(0.05)^2$
Applying the formula,
Bayelsa State:
n = 47875/1+47875(0.05)
n = 47875/1+47875 (0.0025)
n = 47875/120.6875
n = **397**
Delta State:
n = 21696/1+21696(0.05)
n = 21696/1+21696 (0.0025)
n = 21696/55.24
n = **393**
Rivers State:
n = 156822/1+156822(0.05)
n = 156822/1+156822 (0.0025)
n = 156822/393.055
n = **399**
Total Sample Size
397+393+399 = **1189**

To determine the sample communities in the three selected states in Niger Delta, the proportional method will be applied as written bellow:
$n_h = (N_h/N) * n$ ……………… 2
Where n_h is the sample size for stratum *h*,
N_h is the population size for stratum *h*,
N is the population size,
n is the total sample size, Applying the formula,

Table 3.3: the computed population and sample size relative to flood affected communities in the selected Niger Delta States

S/No	Study State	Sample Communities	Communities Population 1991 Census, Nigeria	Communities 2006 Population Projection Based 2.9% Growth Rate NPC Standard @ 15 Years	Communities 2019 Population Projection Based 3.4% Growth Rate NPC Standard @ 13 Years	Communities Sample Size Calculation	Communities Expected Sample Size
1	**Bayelsa**	Egwe-ama	8,105	11630.675	16771.4334	139.0769796	139
2		Ipiirgbene	392	562.52	811.15384	6.72648686	7
3		Ayama	226	324.31	467.65502	3.878025588	4
4		Dokungbene	781	1120.735	1616.09987	13.4014955	13
5		Trofani	2,326	3337.81	4813.12202	39.91277663	39
6		Adagbabiri	2,490	3573.15	5152.4823	42.72691909	43
7		Odonni	5,056	7255.36	10462.2291	86.75795297	87
8		Anibeze	288	413.28	595.94976	4.941908714	5
9		Asamabiri	2,617	3755.395	5415.27959	44.90616355	45
10		Ogilagbene	855	1226.925	1769.22585	14.67129149	15
			23136	33200.16	47874.6307	397	397
1	**Delta**	Tsekelewu	3,169	4547.515	6557.51663	118.7808298	119
2		Opuama	921	1321.635	1905.79767	34.52103004	35
3		Jakpa	1,252	1796.62	2590.72604	46.92761087	47
4		Ebrohimi	427	612.745	883.57829	16.00486409	16
5		Udo	391	561.085	809.08457	14.65550787	15
6		Abala Uno	2,088	2996.28	4320.63576	78.26266094	78
7		Ubulu	143	205.205	295.90561	5.359942775	5
8		Abala Obodo	1,011	1450.785	2092.03197	37.8944206	38
9		Abala Osuimili	382	548.17	790.46114	14.31816881	14
10		Utchi	701	1005.935	1450.55827	26.27496423	26
			10,485	15045.975	21696.296	393	393
1	**Rivers**	Utu	907	1301.545	1876.82789	4.775195946	5
2		Utuechi	1,309	1878.415	2708.67443	6.891655451	7
3		Okarki	5,332	7651.42	11033.3476	28.07204497	28

4	Okparaki	1,229	1763.615	2543.13283	6.47046948	6
5	Omoku	38,962	55910.47	80622.8977	205.1280975	205
6	Ndoni	5,728	8219.68	11852.7786	30.15691553	30
7	Nkpolu-Rumuigbo	1,660	2382.1	3434.9882	8.739608899	9
8	Rukpokwu	5,080	7289.8	10511.8916	26.74530916	27
9	Ogbogoro	9,360	13431.6	19368.3672	49.27875861	49
10	Eneka	6,219	8924.265	12868.7901	32.74194442	33
	Total	**75786**	**108752.91**	**156821.696**	**399**	**399**

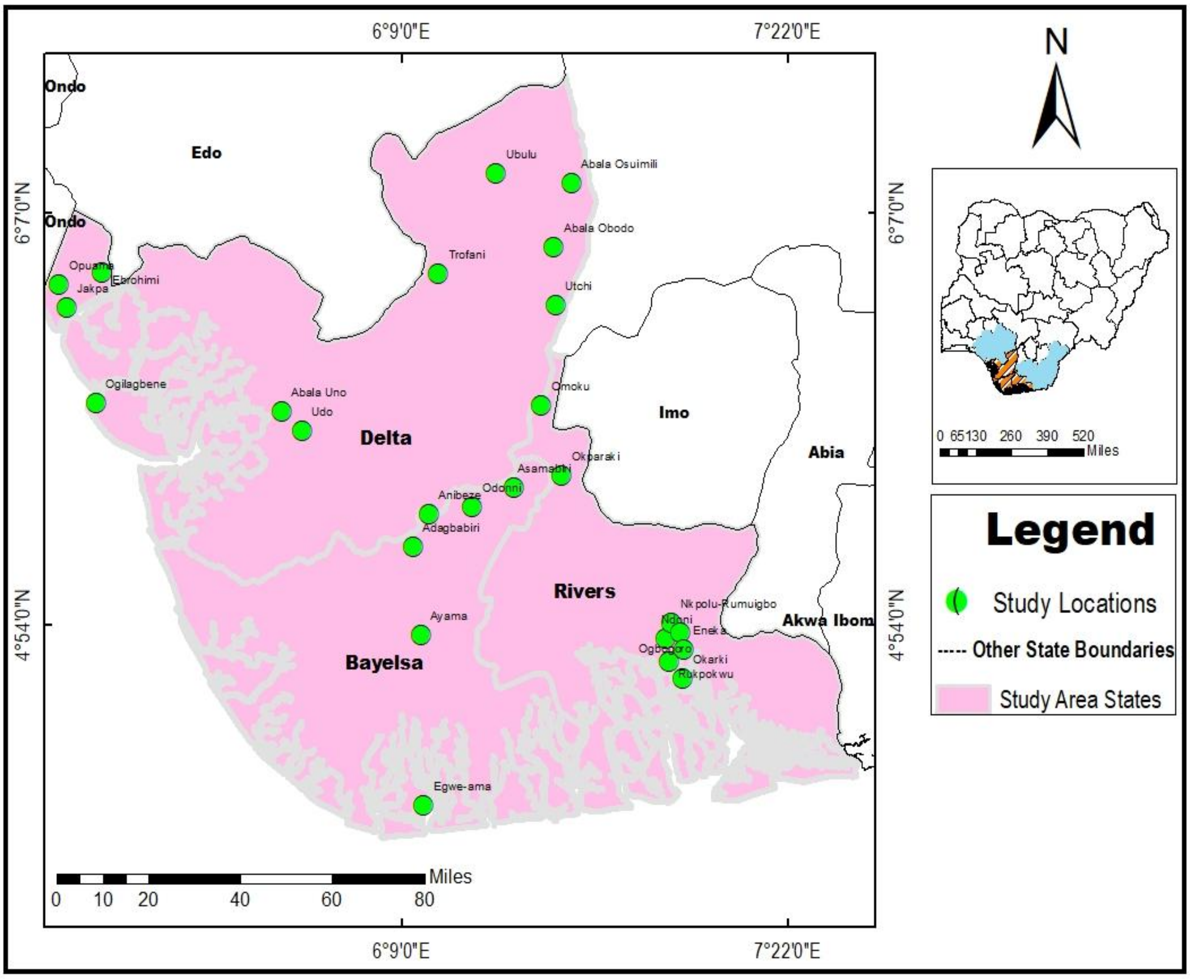
Source: Author's Computation, 2019.

Applying the principle of stratified systematic sampling since the sample size of 1189 will consume time, resources and energy to cover during household questionnaire sampling, the researcher will adopt further the stratified systematic sampling method by adding the 2019 population of the three study states as 47875+ 21696+156822 = 226,393 and divide with the cumulative sample size of 1189 to determine head of house to be sample as 190. Since 190 sample size is not good enough, three communities as representative of each state was considered for the purpose of sampling and computation of their population using Taro Yamani formula which arrived at 399 sample size while the proportional method was used to determine the communities sample.

Table 3.4: the computed population and sample size relative to flood affected nine representative communities in the selected Niger Delta States

Source: Author's Computation, 2019.

S/No	Study State	Sample Communities	Communities Population 1991 Census, Nigeria	Communities 2006 Population Projection Based 2.9% Growth Rate NPC Standard @ 15 Years	Communities 2019 Population Projection Based 3.4% Growth Rate NPC Standard @ 13 Years	Communities Sample Size Calculation	Communities Expected Sample Size
1	**Bayelsa**	Trofani	2,326	3337.81	4813.12202	39.91277663	39
2		Adagbabiri	2,490	3573.15	5152.4823	42.72691909	43
3		Asamabiri	2,617	3755.395	5415.27959	44.90616355	45
		Total	**7,433**	**10666.36**	**15380.88**	**127.5459**	**127**
1	**Delta**	Jakpa	1,252	1796.62	2590.72604	46.92761087	47
2		Abala Uno	2,088	2996.28	4320.63576	78.26266094	78
3		Abala Obodo	1,011	1450.785	2092.03197	37.8944206	38
		Total	**4,351**	**6243.69**	**9003.39**	**163.085**	**163**
1	**Rivers**	Rukpokwu	5,080	7289.8	10511.8916	26.74530916	27
2		Ogbogoro	9,360	13431.6	19368.3672	49.27875861	49
3		Eneka	6,219	8924.265	12868.7901	32.74194442	33
		Total	**20.659**	**29645.7**	**42.749**	**108.766**	**109**
	Grand Total Expected Sample Size						**399**



Map 3.2 Study Area Locations

3.1 Socio-Economic Characteristics of Respondents

Respondents‟ gender ratio in table 3.1 was included to gain a perspective on the assessment of vulnerability and capacity of flood hazard in selected states in the Niger Delta.

Table 3.1: Gender of the Respondents

States	Gender		
	Male	**Female**	**Total**
Bayelsa State	85(21.3%)	42(10.5%)	**127 (31.8%)**
Delta State	134(33.6%)	29(7.3%)	**163 (40.9%)**
Rivers State	76(19.0%)	33(8.3%)	**109(27.3%)**
Total	**295 (73.9%)**	**104 (26.1%)**	**399(100%)**

Source: Researcher's Fieldwork, 2021

The results show a total of three hundred and ninety-nine 399(100.0%) with 85(21.3%) male and 42(10.5%) females in Bayelsa, 134(33.6%) male, 29(7.3%) female in Delta and 76 (19.0%) male, 33(8.3%) females in Rivers responded to the instrument. The majority were males who contributed 295 (73.9%) and females contributed only 104 (26.1%). Everyone participated in the study by completing the questionnaire. This implies that there are more males than females in the study areas.

3.2 Years Lived in the Community

The participants were asked for how long they had been living in the studied communities and their responses are as summarized in table 3.2 below.

Table 3.2: Duration of Stay in the Area

State	(Years)			
	1-5	**6-10**	**10 and above**	**Total**
Bayelsa State	17(4.3%)	38(9.5%)	72(18.0%)	127 (31.8%)
Delta State	22(5.5%)	44(11.0%)	97(24.3 %)	163 (40.9%)
Rivers State	9(2.3%)	32(8.0 %)	68(17.0%)	109(27.3%)
Total	**48(12.0%)**	**114(28.6 %)**	**237(59.4%)**	**399(100%)**

Source: Researcher's Fieldwork, 2021

Table 3.2 revealed the duration respondents have lived in their respective community as follows: 1-5years 17(4.3%), 6-10 years 38(9.5%), 10years and above 72(18.0%) for Bayelsa State, Delta State: 1-5 22(5.5%), 6-10 44(11.0%) and above 10years 97(24.3%) while for Rivers 1-5years 9(2.3%), 6-10years 32(8.0%) and above 10years 68(17.0%).

The overall results on duration of stay in the area indicated that 48 (12.0%) of the respondents from the three sampled States had lived for 5 years and below while 114 (28.6%) had lived for a period of 6-10 years. On the other hand, the majority 237 (59.4%) of the respondents had lived for 10years and above. This revealed that the years respondents lived in their present community may be adequate for them to give reliable information on the history on flood vulnerability in the study areas.

3.3 Level of Education

Respondents' level of education is important to indicate their ability to respond satisfactorily to questionnaires and reduce incidents of uncertainty or no opinion responses (Malhotra 2004).

Table 3.3 Level of Education

State	Education Level				
	Primary	**Secondary**	**Graduate**	**Others**	**Total**
Bayelsa State	7(1.8%)	62(15.5%)	56(14.0%)	2(0.5%)	127 (31.8%)
Delta State	5(1.3 %)	58(14.5 %)	73(18.3%)	27(6.8%)	163 (40.9%)
Rivers State	11(2.8%)	25(6.3%)	59(14.8%)	14(3.5%)	109(27.3%)
Total	**23(5.8%)**	**145(36.3%)**	**188(47.1%)**	**43(10.8%)**	**399(100%)**

Source: Researcher's Fieldwork, 2021

The results presented in Table 3.3 show the educational qualifications of the respondents across the three sampled States of Niger-Delta Region. Accordingly, Bayelsa 7(1.8%), Delta 5(1.3 %), and Rivers 11(2.8%) which is 23(5.8%) of the entire respondents are holders of FSLSC certificate; 145(36.3%) with Bayelsa 62(15.5%), Delta 58(14.5%) and Rivers 25(6.3%) have SSCE certificate; 188(47.1%) with Bayelsa 56(14.0%), Delta 73(18.3%) and Rivers 59(14.8%) had bachelor's degree while the remaining 43(10.8%) are had other qualification with Bayelsa 2(0.5%), Delta 27(6.8%) and Rivers 14(3.5%) respectively.

Table 3.4 Main Occupation of Respondents

State	Farming	Fishing	Business men/women	Civil servant	Student	Total
Bayelsa State	34(8.5%)	11(2.8%)	41(10.3%)	24(6.0%)	17(4.3%)	127 (31.8%)
Delta State	41(10.3%)	7(1.8%)	54(13.5%)	37(9.3%)	24(6.0%)	163 (40.9%)
Rivers State	36(9.0%)	13(3.3%)	39(9.8%)	12(3.0%)	9(2.3%)	109(27.3%)
Grand total	**111(27.8%)**	**31(7.8%)**	**134(33.6%)**	**73(18.3%)**	**50(12.5%)**	**399(100%)**

Source: Researcher's field work, 2021

Table 3.4 shows that 111(27.8%) of the respondents engage in crop farming, 31(7.8%) engage in fishing, 134(33.6%) are into business, 73(18.3%) are civil servants and 50(12.5%) are students. This show that business and farming activities are the major sources of livelihood of the dwellers in the study area.

Table 3.5 Household Monthly income before the flood disaster

Source: Researcher's field work, 2021

State	0-5,000	6,000-10,000	10,000-20,000	20,000-50,000	80,000-100,000	100,000 and above	Total
Bayelsa State	2(0.5%)	11(2.8%)	17(4.3 %)	25(6.3%)	55(13.8 %)	17(4.3 %)	**127 (31.8%)**
Delta State	0(0.0%)	2(0.5%)	19(4.8 %)	51(12.8%)	79(19.8%)	12(3.0%)	**163 (40.9%)**
Rivers State	0(0.0%)	5(1.3%)	13(3.3%)	26(6.5%)	52(13.0%)	13(3.3%)	**109(27.3%)**
Grand total	**2(0.5%)**	**18(4.5%)**	**49(12.3%)**	**102(25.6%)**	**186(46.6 %)**	**42(10.5%)**	**399(100%)**

Table 3.5 shows the percentage responses of the respondent's income before the flood.
The percentage scores indicates that most of the respondents, 46.6% earn between 80,000-100,000 monthly while 25.6% earn between 20,000-50,000. However, 12.3% of the respondents earn between 10,000-20,000; 10.5% earn 100,000 and above and 4.5% earn 6,000-10,000 respectively. The least monthly income of the respondents (0-5,000 constitute 0.5%.

Table 3.6 Monthly income of the respondents after the flood disaster

State	0-5,000	6,000-10,000	10,000-20,000	20,000-50,000	80,000-100,000	100,000 & above	Total
Bayelsa State	12(3.0%)	30(7.5%)	72(18.0%)	9(2.3%)	4(1.0%)	0(0.0%)	127 (31.8%)
Delta State	9(2.3%)	46(11.5 %)	83(20.8%)	21(5.3%)	3(0.8%)	1(0.3 %)	163 (40.9%)
Rivers State	7(1.8 %)	27(6.8 %)	57(14.3%)	16(4.0%)	2(0.5%)	0(0.0 %)	109(27.3%)
Grand total	**28(7.0 %)**	**103(25.8 %)**	**212(53.1%)**	**46(11.5%)**	**9(2.3%)**	**1(0.3%)**	**399(100%)**

Source: Researcher's field work, 2021

Table 3.6 result show that within 1-12 months after the flood, the average income of 212(53.1%) of the respondents was between 10,000-20,000 while 103(25.8%) of the respondents earned between 6,000-10,000. The percentages of respondents earning between 20,000-50,000 was 46(11.5%), 28(7.0%) of the respondents earned between 0-5,000, 9(2.3%) of the people earned between 80,000-100,000 while only 1(0.3%) of the respondents earned above 100,000. From the findings, it is clear that income of the respondents reduced after the flood when compared with the people income before the flood.

3.1.1 Flood vulnerable areas with respect to land use/land cover in the study area

3.1.1 Land use/Land cover Vulnerability

The land use map vulnerability to flood was determined according to the vulnerability levels assigned to each land use identified in the Niger Delta. Table 3.7, Figure 3.3 and Figure 3.4 explain the types of land use observed and the spatial coverage of each of them. The mangrove had the highest spatial extent (11970.00 km^2), followed by swamp forest/thick forest having 8626.08. The analysis also revealed that water bodies recorded 1068.27km^2 while the built-up area recorded 6301.91 km^2 and farmland/light forest having 7203.37 km^2.
The analysis further showed that the spatial coverage of the area for moderate flood vulnerability covered 45.01% while high flood vulnerability was 55.97 % (Table 3.7).

Table 3.7 Land use and Landcover Vulnerability

Land use	Vulnerability Level	Vulnerability Remark	Spatial Extent (sq. km.)	Percentage (%)
Built Up Area	3	High	6301.91	17.92
Waterbodies	3	High	1068.27	3.04
Mangrove	3	High	11970.00	34.04
Farmland/Light Forest	2	Moderate	7203.37	20.48
Swamp Forest/Thick Forest	2	Moderate	8626.08	24.53
Total			**35169.59**	

Source: Researcher's field work, 2021

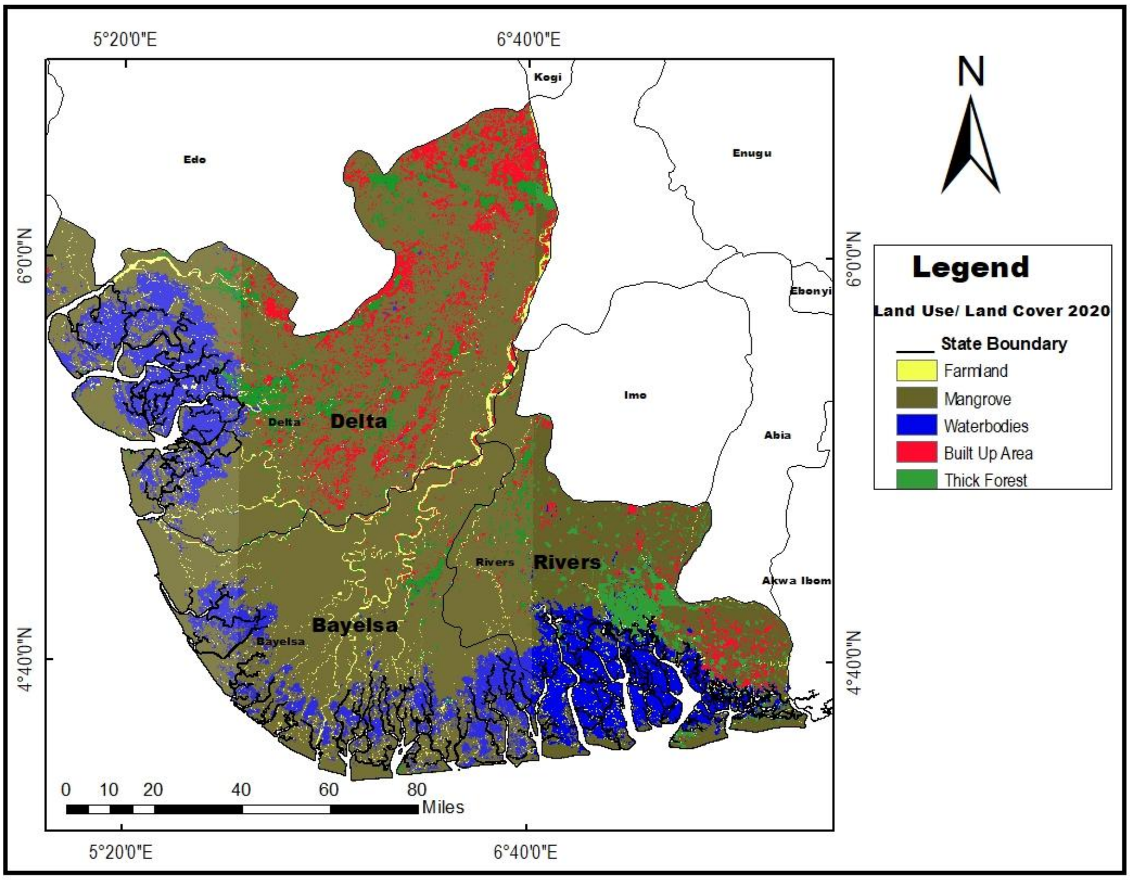


Figure 3.3 Land use/Land cover of the Study Area

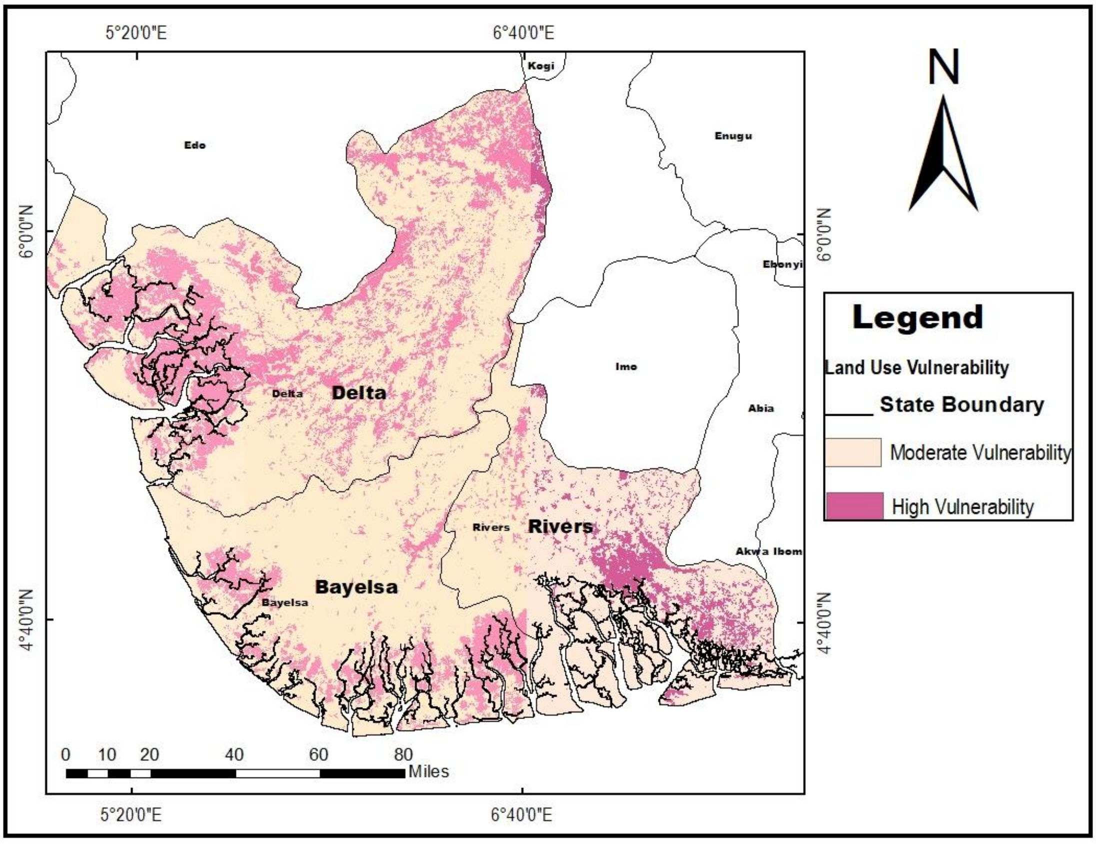


Figure 3.4 Land use Vulnerability to Flood

Relief Map of the Study Area

The Relief or Topography Map of the Study Area is shown in Table 3.8, Figure 3.5 and Figure 3.6. It shows that the high vulnerability zone based on relief was between 43.73m and 192.22m while the moderate vulnerability was between 192.22m and 266.47m. The low vulnerability zone was between 266.47m and 340.72m. The analysis also revealed that the high, moderate and low vulnerability covered 33540.74 km^2 (94.52%), 1040.68 km^2 (2.93%) and 905.57 km^2 (2.55%) respectively.

Table 3.8 Relief of the Study Area

Relief (m)	Vulnerability Level	Vulnerability Remark	Spatial Extent (sq. km.)	Percentage (%)
43.73-80.86	3	High	13989.10	39.42
80.86-117.98	3	High	15799.64	44.52
117.98-155.10	3	High	3160.96	8.91
155.10-192.22	3	High	591.04	1.67
192.22-229.35	2	Moderate	347.83	0.98
229.35-266.47	2	Moderate	692.85	1.95
266.47-303.60	1	Low	534.60	1.51
303.60-340.72	1	Low	370.57	1.04
Total			**35486.59**	**100.0**

Source: Researcher's field work, 2021

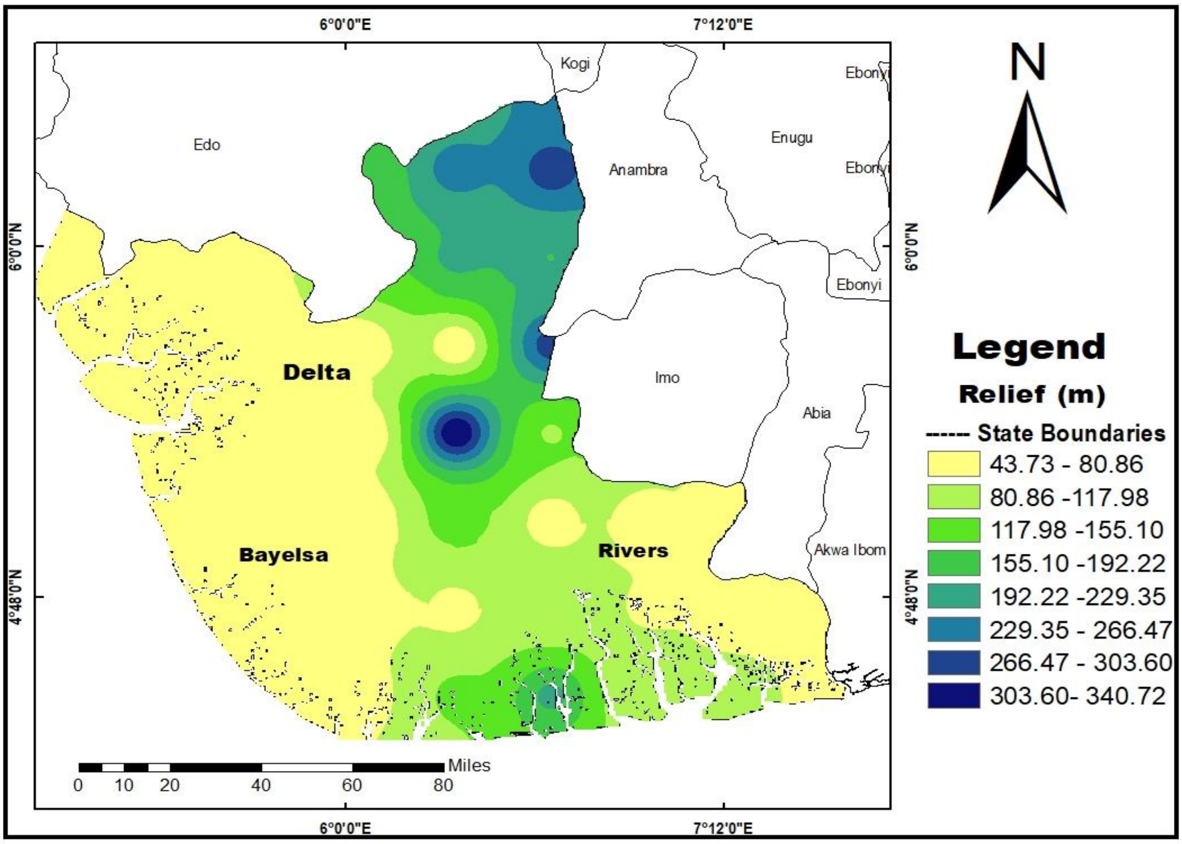


Figure 3.5 Relief Classes of the Study Area

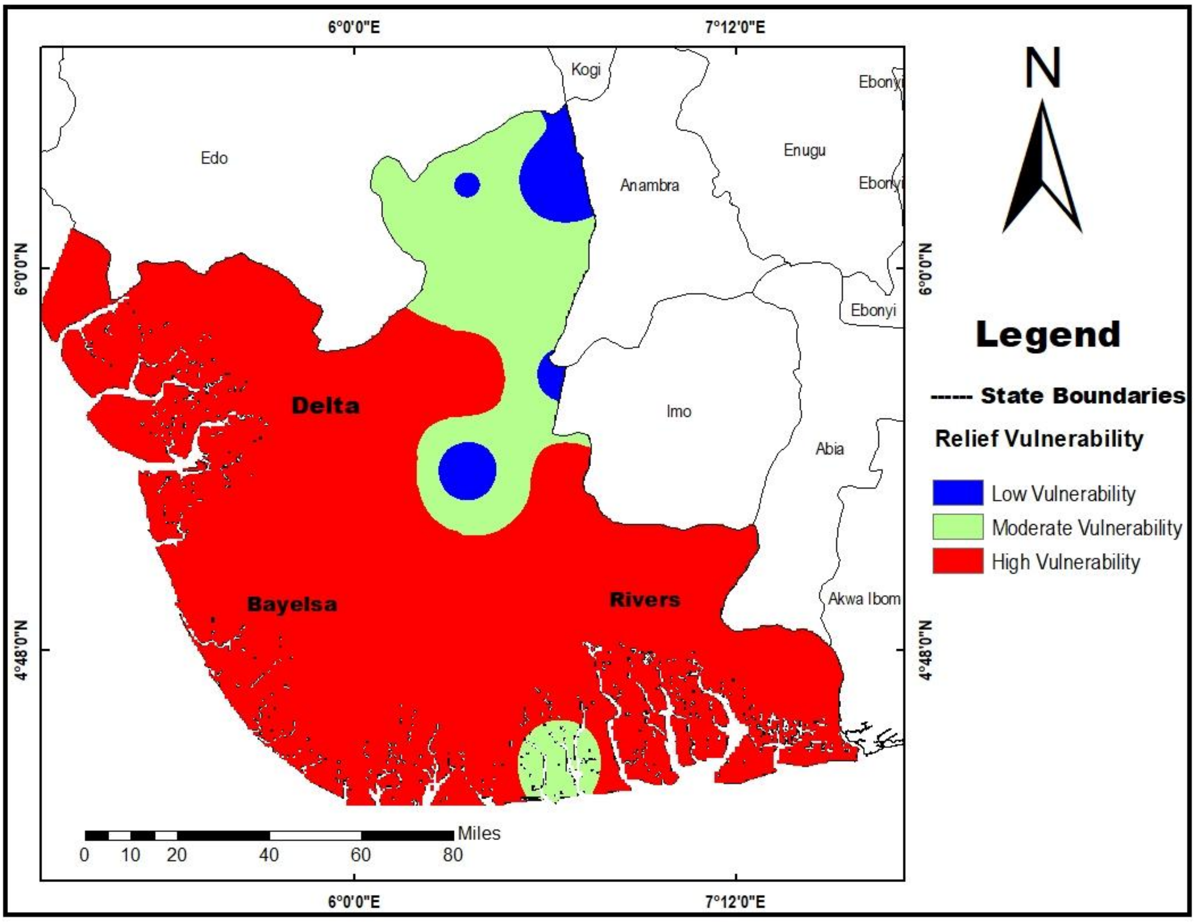


Figure 3.6 Relief Vulnerability to Flood

Drainage Vulnerability Map

Table 3.9 and Figures 3.7 describe the river network and their levels of vulnerability map of the study Area. The results show that the buffer of 500m from the river s (i.e., high flood vulnerability level based on the nearness to active channel) covered a spatial extent of 6250.15 km^2, the buffer of 1000 m covered 5438.65 km^2 while the buffer of 1500m covered a spatial extent of 4503.73 km^2. Thus, the high vulnerability area covered 38.60%, moderate 33.59% and low covered 27.81%.

Table 3.9 Drainage Vulnerability Map

Drainage through River (m)	Vulnerability Level	Vulnerability Remark	Spatial Extent (sq. km.)	Percentage (%)
500	3	High	6250.15	38.60
1000	2	Moderate	5438.65	33.59
1500	1	Low	4503.73	27.81
Total			**16192.53**	**100.0**

Source: Researcher's field work, 2021

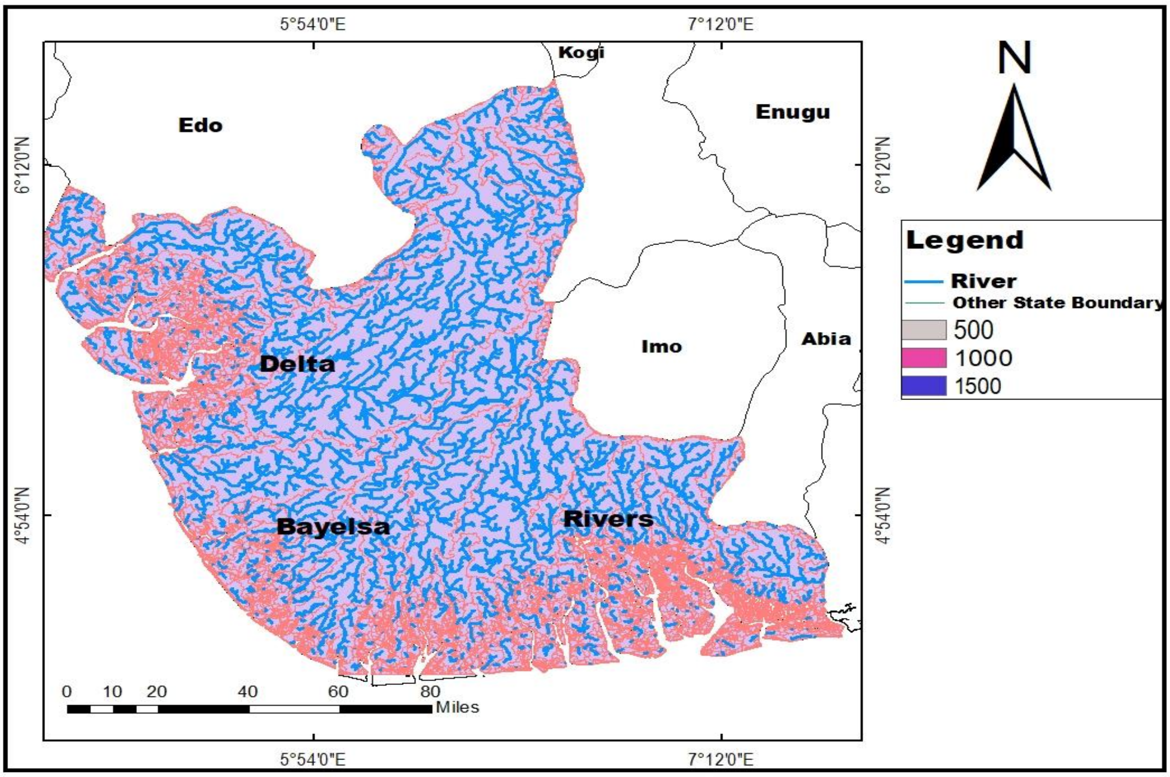


Figure 3.7 Drainage Map of the Study Area

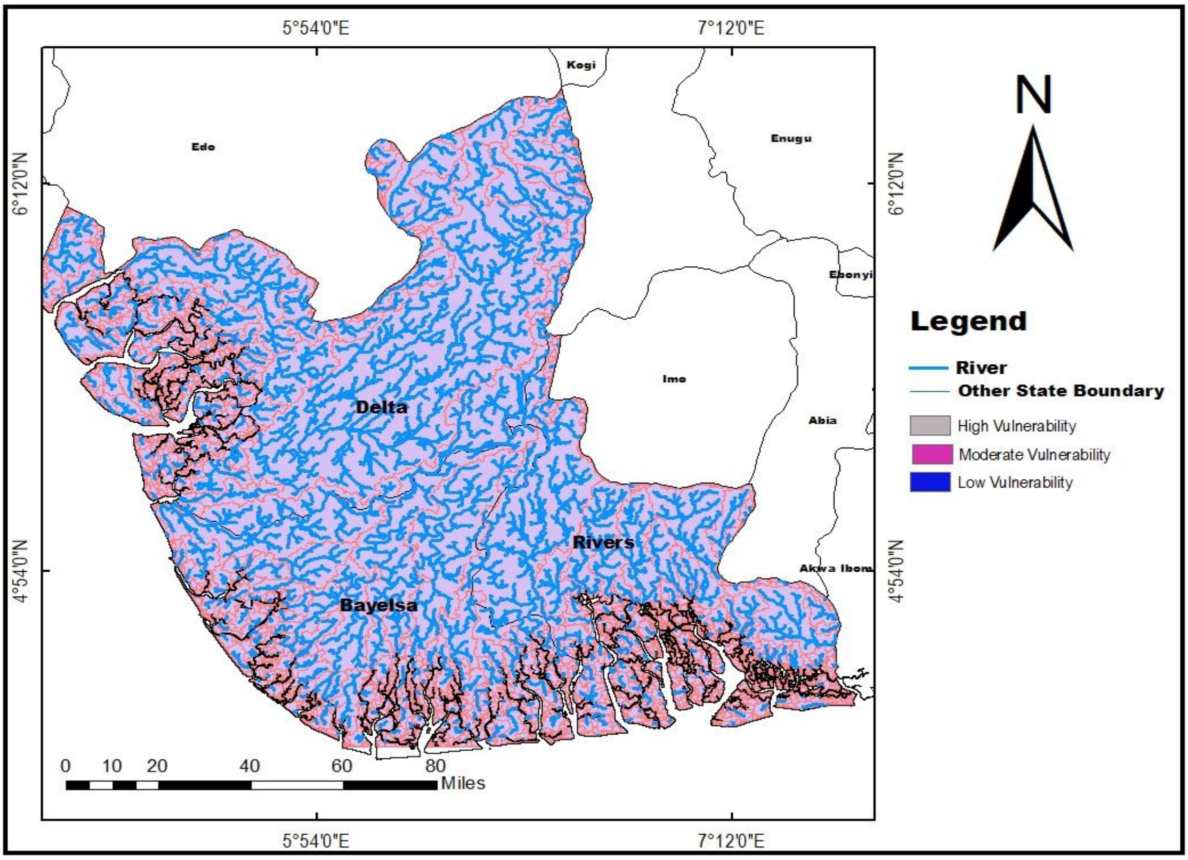


Figure 3.8 Drainage Vulnerability Map

Hypothesis Testing

Hypothesis 1: Elevation of study states does not have any significant relationship with vulnerability to flood hazard.

Table 3.10 Correlation coefficient between Elevation of study states and vulnerability to flood hazard in the study area.

Correlations

		Elevation	Vulnerability Level
Elevation	Pearson Correlation	1	.592**
	Sig. (2-tailed)		.000
	N	400	400
Vulnerability Level	Pearson Correlation	.592**	1
	Sig. (2-tailed)	.000	
	N	400	400

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3.10 show that the Pearson product correlation of Elevation of study states and Vulnerability to flood hazard was found to be moderately positive and statistically significant (r=.592, < .001). Hence, null hypothesis (H1) was retained. This indicates that study areas elevation plays a very significant role in their vulnerability to flood hazards.

3.11 The types and level of capacities in the study area

Table 3.11 level of capacities in the study area

	Items	Total per State					
		Bayelsa=127		Delta=163		Rivers=109	
		$\bar{X}$	Std	$\bar{X}$	Std	$\bar{X}$	Std
1	People are knowledgeable of flood community preparedness measures,	2.46	0.49	2.56	0.51	2.76	0.55
2	People have the needed physical ability of skill to withstand any flood emergency	3.37	0.67	3.33	0.67	3.41	0.68
3	Knows how to assess emergency close health facility.	3.39	0.68	3.37	0.67	3.53	0.71
4	Behavior of households towards flood hazard management is encouraging.	3.36	0.67	3.34	0.67	3.45	0.69
5	Community population understands what it means by (coping mechanisms, local knowledge, and community grouping, how to use tools and equipment to proactively reduce flood events impacts).	2.36	0.47	2.72	0.54	2.51	0.50
6	Government resources – government agencies/offices and assets are present in the affected communities.	3.28	0.66	3.33	0.67	3.26	0.65
7	Non – governmental resources- airline, transport companies, chamber of commerce groups, welfare organizations, disaster organizations, red cross/red crescent, general public (volunteers and blood donors) are present in the affected communities.	2.54	0.51	2.76	0.55	2.70	0.54
8	International resources – donors/partner agencies are present in the affected communities.	2.44	0.49	2.67	0.53	2.72	0.54
	Grand Mean ($\bar{X}$) & Std	**2.90**	**0.58**	**3.01**	**0.60**	**3.04**	**0.61**

Source: Researcher's Fieldwork, 2021

Table 3.11 shows the types and level of capacities in the study area to flood hazard among respondents across the sampled States in Niger Delta.

From the result in table 3.11 it indicates that the respondents from the three sampled States agreed with items 2, 3, 4 and 6 while items 1, 5, 7 and 8 attracted disagreement from the respondents across the studied States which is an indication that capacity level of Delta and Rivers were high with aggregate mean scores of 3.01 and 3.04 greater than the criterion mean of 3.0 while that of Bayelsa counterpart was low with the criterion mean of 2.90 below the criterion mean of 3.0.

3.12 Discussions of Findings

This study was aimed at assessing the vulnerability and capacity of flood hazard in selected States in the Niger Delta. Its objectives were to examine the followings: classify flood vulnerable areas with respect to land use/land cover in the study area, and identify elements at risk and examine the variation of social, economic, human, attitudinal, political, natural and physical categories of vulnerability of communities in the study area. After the analysis land use observed and the spatial coverage result showed that mangrove had the highest spatial extent of (11970.00 km^2), followed by swamp forest/thick forest having 8626.08. The analysis also revealed that water bodies recorded 1068.27km^2 while the built-up area recorded 6301.91 km^2 and farmland/light forest having 7203.37 km^2. The analysis further showed that the spatial coverage of the area for moderate flood vulnerability covered 45.01% while high flood vulnerability was 55.97 %. The Relief or Topography of the Study Area, the result shows that the high vulnerability zone based on relief was between 43.73m and 192.22m while the moderate vulnerability was between 192.22m and 266.47m. The low vulnerability zone was between 266.47m and 340.72m. The analysis also revealed that the high, moderate and low vulnerability covered 33540.74 km^2 (94.52%), 1040.68 km^2 (2.93%) and 905.57 km^2 (2.55%) respectively. The river network and their levels of vulnerability results show that the buffer of 500m from the river s (i.e., high flood vulnerability level based on the nearness to active channel) covered a spatial extent of 6250.15 km^2, the buffer of 1000m covered 5438.65 km^2 while the buffer of 1500m covered a spatial extent of 4503.73 km^2. Thus, the high vulnerability area covered 38.60%, moderate 33.59% and low covered 27.81%. The null hypotheses were tested at a 0.05 level of significance, using Pearson Product Moment Correlation (PPMC), the results of hypothesis show a moderately positive and statistically significant (r=.592, < .001). The finding of the study also reveals that the low-lying nature of the area and proximity to the river bank makes it vulnerable to seasonal flood. The findings also show that people have not recovered from the effects of past floods but are becoming resilient to the flood hazard arising from some applicable coping capacities like relocation from the flood plain, reconstruction of houses with reinforced materials against the bricks and mud/thatch houses, raising of houses above annual flood levels, erection of temporary houses along river banks, creation of water channels for easy evacuation of floods, frequent dredging of drainage outlets, construction of dykes using sand bags and fumigation of stagnant flood water against mosquito parasites. While social, economic, human, attitudinal, political, natural and physical categories are elements vulnerable to the flood hazard in the study area.

IV. CONCLUSION

This research study assessing land use/land cover and flood hazard vulnerability in the core Niger Delta states, Nigeria. Drawing conclusion from the research shows that flood events over the years has adverse impacted on the socio-economic status and livelihoods of the people of Niger-Delta and the States as sampled. Flooding affects more people on an annual basis than any other form of natural disaster in the study area. Its frequency and intensity are on the increase every year. In terms of livelihood, the study discovered that the flood incident has seriously devastated the economy of the rural community especially farming which is the major source of livelihood of the people. Farmlands were submerged and agricultural produce were destroyed. Therefore there is in need for repair and construction of new drainages and construction of flood diversion channels which involves the construction of artificial channels along main river channels to evacuate excess water during floods, Governmental and Non-Governmental organizations to assist in enlightenment campaign and dissemination of early warning to the local communities. The contributions to knowledge express that the research has established the level of vulnerability of the people and its environs to flood hazards.

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