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Geospatial Mapping and Assessment of Flood-prone Communities in the Core Niger Delta, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The study identified and assessed flood-prone communities in the core Niger Delta region of Nigeria using GIS (Geographic Information Science). Data for the study was obtained from both primary and secondary sources. The primary data was generated from the information obtained from the respondents through the administration of the questionnaire and the use of GPS to generate coordinates for the flood-prone communities in the core Niger Delta. The population of the study comprised of people in both rural and urban communities prone or ravaged by flood in the core Niger Delta states of Bayelsa, Delta, and Rivers. Random sampling technique (using blindfold) was used in the selection of 5 flood-prone communities from each of the 3 states. Random sampling technique was also used in the selection of 50 respondents from each of the 5 selected communities spread across each of the 3 selected states. This gave a sample of 250 per state totalling 750 in the 3 selected states. Furthermore, the geographic coordinates (i.e. Northings, Eastings, and Elevation) of the identified fifteen (15) flood-prone communities were taken at specific locations across the core Niger Delta. The result shows three (3) geo-referenced maps of flood-prone communities in the core Niger Delta. Further evidence from the study revealed that the respondents' major source of livelihood was farming occupation (34.7%) and fishing occupation (21.0%), while respondents with low socioeconomic status dominated (53.0%) in the study area

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which implies that in the event of a flood disaster, coping with the flood disaster becomes a challenge due to the low socioeconomic status of the residents. Finally, the findings of the study reveal that the yearly occurrence of flood in the core Niger Delta region has led to the devastation or destruction of a large expanse of land including cultivated farmlands, crop yield before the flood occurrence was average (48.2%) and high (35.1%) while crop yield after the flood was very low (50.8%) and low (33.2%). The study, therefore, recommended the development or building of resilience to reduce the devastation of flood menace across communities in the core Niger Delta area and construction of structural measures like dams, culverts, drainages, and ditches to accommodate and reduce the runoff or overflow of floodwaters which causes severe social, economic and infrastructural damages or impacts in the flood-prone communities.

Keywords: Core Niger Delta; flood-prone; geospatial; mapping; Nigeria; livelihood.

1. INTRODUCTION

Conceptually, flooding is the result of water overtopping its natural and manmade defences and overflowing places not typically submerged [1]. It is also a result of the sudden arrival of heavy storms, which overwhelms soil infiltration capacity and urban drainage systems. Flooding is a natural phenomenon and the people of the Niger Delta located in the South-South geopolitical region of Nigeria, have experienced it almost every year with varying degrees of severity. 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 [2]. Flooding is the overflowing of water either as a result of torrential rainfall, a broken Dam, a high rise in the volume of water in rivers, ocean or seas as a result of melting ice caps or prolong rainfall, thereby flooding its neighbouring environment and beyond. Floods can be very dangerous depending on the nature and level of water volume involved. Often when flowing water is termed “flood”, danger or disaster is implied. Indeed, floods have been associated with huge economic loses, disruption and loss of lives. Wisner et al. [3] submit that floods accounted for the largest share of economic loses and fatalities from all-natural hazards experienced in the late 1980s and throughout the 1990s.

The incidence of flooding in the Niger Delta occasioned by torrential rainfall or by the overflow of rivers is a perennial problem faced by the inhabitants of the coastal communities. The damages caused by floods is colossal, it includes the destruction of crops, farm produce and farmland, business premises and houses, thereby leading to disruption of commercial activities, people are rendered homeless and in some cases family members separated, access roads are blocked and movement restricted. In the worst cases, there could be an outbreak of cholera and death. These communities face untold hardship while battling with the impact of the flood. The flood has hampered sustainable development and also frustrated the millennial development goals of the government especially in the area of food security [4].

There are numerous kinds of flooding, and each one has a different impact as regards how it occurs, damage caused, and how it is projected. The core Niger Delta experiences a combination of pluvial and fluvial flooding. Fluvial flooding happens when too much rainfall over an extensive phase of time causes a river to surpass its capacity. It can also be caused by heavy snowmelt and ice jams. The harm from a river flood can be widespread as the overflow affects smaller rivers downstream, often causing dams and dykes to break and swamp nearby areas. Flash flooding is a typical example of fluvial flooding. It is characterized by an intense, high-velocity torrent of water that occurs in an existing river channel with little to no notice. Flash floods are usually very dangerous and destructive not only because of the water force but also due to the continuous gathering of debris that is often swept up in the flow. This type of fluvial flood is very common in the core Niger Delta [5].

The Niger-Delta region where this study is based is highly affected due to its geographic attributes. Its characteristic flat topography that is crisscrossed by a plethora of river distributaries coupled with its location at the Atlantic coast makes the region to be highly vulnerable to flooding, sea-level rise and saltwater intrusion. Before 1950, agriculture (farming and fishing) was the main source of livelihood and the exploitation of natural resources was sustainable. About 65% of the population of the region

depends on the natural environment for their livelihoods while the other 35% depends on remittance [6,7,8]. Today, the Niger Delta environment has changed. The global changes in climatic condition have exacerbated the condition of the physical environment. Today, coastal flooding, sea-level rise, saltwater intrusions are common features in most communities. This has resulted in the alteration of habitats, biodiversity loss and pollution of water bodies and land which are the most important livelihood assets of the people. In local communities, hundreds of thousands of people are affected, particularly the poorest and those who rely on traditional livelihoods such as fishing and crop farming [9].

Niger Delta is a region that is at high risk of natural disasters, such as floods. The frequency and intensity of such disasters appear to be increasing globally, widely believed to be driven by climate change. Besides, climate change is manifesting in increasing rainfall variability and changing seasonality both within rainfall seasons and between years. The start and end of the rainfall season have become less predictable and dry spells are of longer duration. Rain-fed agricultural production is under increasing pressure, with low and variable yields and losses. These are already showing, with negative effects already on chronic food insecurity and fragile livelihoods.

This is of concern, particularly in the flood-prone areas of the core Niger Delta region, where a large number of the population is rural and most of the coastal communities depend on agriculture for food security and livelihoods. To strengthen the populations' resilience, food security is becoming an integral feature of climate and disaster risk reduction response. In the past, disaster management focused primarily on logistical efforts to remove people from dangerous areas, provide food and shelter and help with post-event socio-economic recovery. The emergency preparation and response ap-proach became entrenched in policies, plans, strategies and programmes [10].

The yearly occurrence of flooding in the core Niger Delta has led to the devastation or destruction of a large expanse of land including cultivated farmlands like that witnessed in Kolaware Community in Patani Local Government Area of Delta State were the 2018 flooding incidents led to the loss of their major crops like yam, plantain, okra and cocoyam. Also, the extent of the flood that occurred in Akinima community in Ahoada West Local Government Area of Rivers State led to the destruction of crops like plantain, cassava and banana [11]. Interestingly, it is important to state categorically that flood hazard in the core Niger Delta is real. Wizor and Week [11] revealed that food security, livelihood and socio-economic characteristics of flood-prone areas of the core Niger Delta has been negatively impacted by flooding particularly with regards to the destruction of farmlands and other sources of livelihood leading to food insecurity, income reduction, and poor livelihood among the residents of the core Niger Delta States.

In 2008 and 2012, flooding devastated farmlands and food crops and displaced many local people from their communities in the core Niger Delta. Many farmers also lacked access to modern implements, fertilizers, and herbicides capable of helping to boost crop yields. In most communities, the farmers seem unaware of facilities or programs designed to boost agriculture offered by the State's Ministry of Agriculture and other government interventionist agencies. In Ikarama, Yenagoa Local Government Area (LGA), Bayelsa State, some farmers complained that they were not able to afford seedlings for planting farms and had to resort to begging to be given such seedlings. Some also lamented their inability to afford labourers to weed their farms before the planting season [12].

The local communities, which used to have rich varieties of fresh and saltwater fish, can now hardly catch nor afford to buy enough fish to meet their dietary needs. Many species of fish, such as catfish, are no longer seen, while the tilapia and mudfish populations have been seriously depleted. Oil pollution has affected artisanal fishermen more significantly than fish farmers (aquaculturists), because oil companies do not pay compensation for their pollution of rivers and damage caused to fishing nets and traps. An edible beetle that is gathered from the raffia palm is also gradually becoming extinct as a result of the destruction of the swamps and rain forest due to oil-related activities. In Bayelsa State, this insect is called Bayelsa suya (palm weevil larvae) and it serves as a supplementary source of protein for many people, given the scarcity or depletion of fish. Previous studies have also shown that sea-level rise and repeated ocean surges will not worsen the problems of the coastal erosion that are already a menace in the Niger Delta and also increase the problems of

flooding, the intrusion of seawater into freshwater bodies and ecosystems, thereby destroying stabilizing systems as the mangroves and agriculture, fisheries and general livelihoods upon which the general populace depend on for sustenance [12,13].

The focus of this present study is geospatial mapping and assessment of flood-prone communities in the core Niger Delta, Nigeria.

1.1 Research Objectives

In order to achieve the aim of this study, the research objectives are to:

1. Identify and map the flood-prone communities in the core Niger Delta.
2. Determine the socio-economic characteristics of residents of flood-prone communities in the study area.
3. Investigate the extent of crop yield before and after flood occurrence in the study area.

1.2 Study Area

The Niger Delta has the similitude of a prism formed by the accumulation of sedimentary deposits transported by rivers Niger and Benue. Within the flood plains, the river splits into six major tidal channels and innumerable smaller outlets. The region experiences very high annual rainfall ranging between 3000 to 4500 m with double maxima characteristics of July and September peaks. Although the Niger Delta can be roughly categorized into four ecological sub-zones (coastal barrier Islands, mangrove, freshwater swamp forest and the lowland rainforest), the mangrove is the largest and dominant eco-subzone. In terms of socio-economic development, the region could be

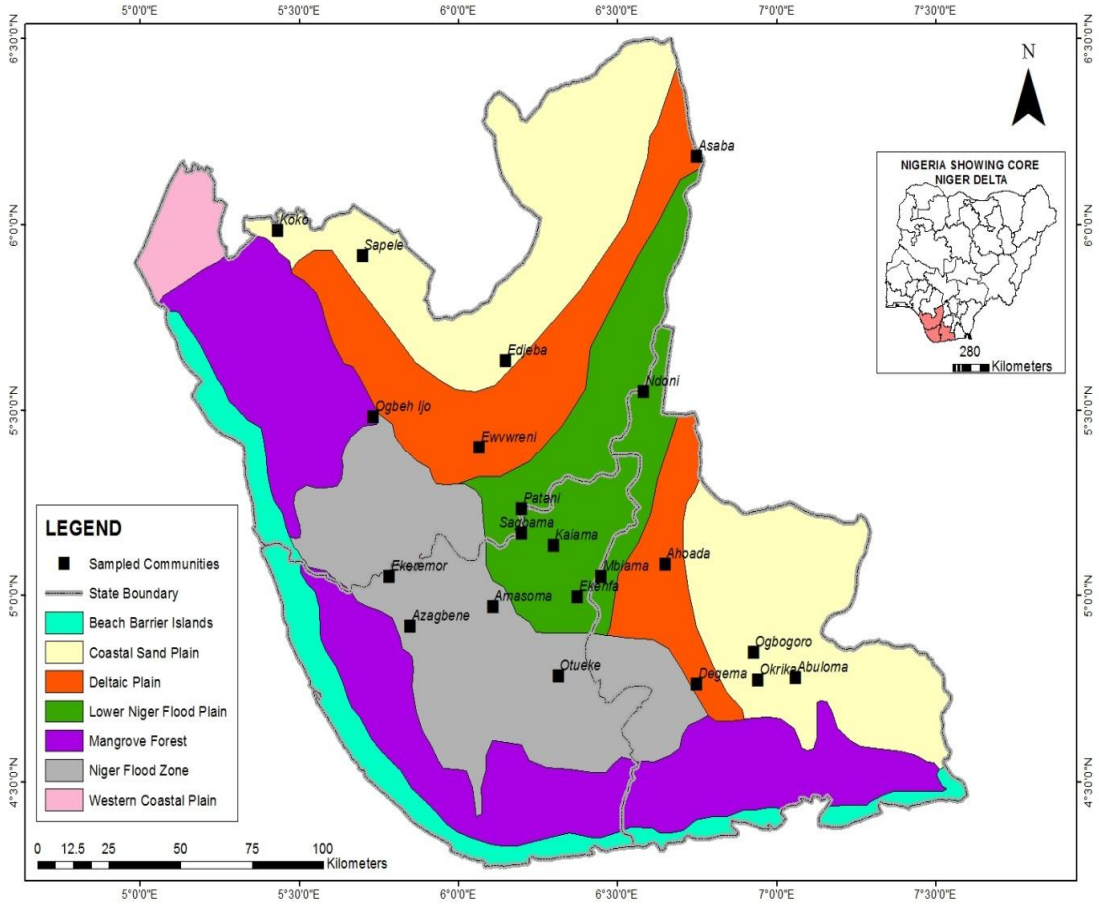

Fig. 1. Core Niger Delta
Source: GIS Laboratory, University of Port Harcourt

described as being a "rich region with poor people". It is blessed with abundant Crude Oil and Natural Gas, which is the mainstay of Nigeria's economy. Apart from crude oil and natural gas, the mangroves offer a lot of biological resources on which the rural livelihood depend [14]. The people of the Niger Delta get their source of livelihood from the natural resource around the coastal and swampy area; this is why flooding is a serious disaster for the people in the Niger Delta region.

Geographically, the Niger Delta is described as a unique ecological zone by its size and geophysical configuration [15]. It is one of the world's largest wetlands covering an area of approximately 70,000 km^2, located in the south-south geopolitical region of Nigeria. It lies between latitude 4º and 6º north of the equator and longitude 5º and 7º East of Greenwich. Along the coast, the Niger Delta stretches from the Benin River in the West to Bonny River in East, while inland, it begins a few miles below Aboh at a point where river Niger bifurcates into river Nun and Forcados into the Atlantic West at the South, stretching over 160 miles [16].

The Niger Delta is plagued with the problem of perennial flooding and shoreline erosion which has accounted for severe loss of lives & properties in the region owing to its physiographic configurations. The Niger Delta with a population of over 10 million people is one of the industrial and commercial hubs of Nigeria. It is the home of Nigeria's Oil and Gas Industries and a commercial nexus in Nigeria because of its coastal location. It is witnessing rapid economic growth and little or no development [14].

The Core Niger Delta comprises of Bayelsa, Delta and Rivers States (Fig. 1).

2. MATERIALS AND METHODS

This section discusses the techniques, steps and methods adopted in carrying out the research. A reconnaissance survey and physical field observation of the study area was carried out in order to familiarize the researchers with the study area and the subject of enquiry. This assisted the researchers immensely in planning the acquisition of the various coordinates and administration of the research instrument.

The study was a comparative study that adopted the descriptive survey research design and data was obtained or collected through both primary and secondary sources. The primary data was collected or generated from the information obtained from the respondents through the administration of the questionnaire and the use of GPS to generate coordinates for the flood-prone communities in the core Niger Delta.

The secondary information includes:

i. Topographical map of the study area.
ii. Landsat imagery of the study area at 5 m resolution.
iii. Digital administrative maps from GIS sections of the States involved in this study.
iv. Journals, Books, LGA Documents, etc.

The populations of the study area comprised of people in both rural and urban communities prone or ravaged by flood in the core Niger Delta states namely: Bayelsa, Delta, and Rivers. A sample of 750 respondents (otherwise residents) were selected 50 each from 5 communities each in the selected states (i.e. Bayelsa, Delta, and Rivers). Firstly, the random sampling technique (using blindfold) was used in the selection of 5 flood-prone communities from each of the 3 States. This led to consecutively picking 5 numbers from each of the three states to arrive at flood prone-communities in the three states making up the core Niger Delta.

In the second phase, the random sampling technique was used in the selection of 50 respondents from each of the 5 selected communities spread across each of the 3 selected states. This gave a sample of 250 per state totalling 750 in the 3 selected states.

Similarly, the entirety of these 15 communities in the 3 states constituted the sampling frame for the study. Furthermore, the coordinate (i.e. Northings, Eastings, and Elevation) were taken at specific locations (otherwise sampling points) across all the 15 communities using certain landmarks like market, stream, river, bridge, school, canal, road/drainage and farmlands.

The instruments for data collection for this study was the Flood Disaster Scale (FDS).

The FDS was a 22 item self-structured instrument patterned after a four-point rating scale of "Strongly Agree" (SA, 4 Points), "Agree" (A, 3 Points), "Disagree" (D, 2 Points), and "Strongly Disagree" (SD, 1 Point). The FDS instrument also comprised of two sections.

Section A consisted of the demographic data or information on the respondents' socio-economic characteristics while Section B consists of items on approaches to flood disaster management (via planning and right attitude). The flooded area map of these communities across Bayelsa, Delta, and Rivers States (study area) were also be identified and overlaid with its topographic features.

The face and content validity of the FDS instrument was determined by experts (colleagues) from the Department of Geography and Environmental Management, University of Port Harcourt, Nigeria.

However, the reliability or internal consistency of the FDS instrument was determined using the Cronbach Alpha (ra) method to ascertain whether or not the instrument measures what it purports or intends to measure. In doing this, the FDS instrument was administered to a sample of fifty (50) respondents. Then 50 copies of the serially and correspondingly marked or numbered FDS instrument was distributed to these residents and upon completion, the FDS instrument was retrieved, sorted, coded and analyzed using the Cronbach Alpha (ra) method to obtain a reliability coefficient 0.719 for the FDS instrument. This reliability coefficient necessitated the use of the FDS instrument for the actual administration.

A face-to-face direct delivery technique was applied as the method of data collection to all the 750 respondents. Furthermore, the researchers also adopted the face-to-face method of administration in administering the serially numbered FDS instrument to the respondents. Out of the 750 copies of the FDS instrument administered to the respondents, 632 (representing 84.3% return rate) were valid copies retrieved and subsequently used for analysis.

Data obtained were sorted, collated and coded to present the data generated for the study. Simple percentage and frequency analysis were used to present the socio-economic and other variables while digitized maps were used to show the flood-prone communities in each of the three states in the core Niger Delta.

3. RESULTS AND DISCUSSION

This section shows findings, relevant discussion and comparison of findings. The results/findings were presented under various theme namely, geospatial mapping of flood-prone communities in the core Niger Delta, socio-economic characteristic of the residents of flood-prone communities of the core Niger Delta and the extent of crop yield before and after flood occurrence in the flood-prone communities of the core Niger Delta.

3.1 Geospatial Mapping of Flood-prone Communities in the Core Niger Delta

Table 1 shows that the respondents in Bayelsa State dominated with 234 respondents representing 37.0% of the sample. This was followed by Rivers State with 203 respondents representing 32.1% of the sample, while the least was Delta State with 195 respondents representing 30.9% of the sample.

Table 2 shows that the respondents from Anyama-Ijaw Community (Bayelsa State) dominated (9.8%). This was followed by respondents from Obogoro Community (7.3%) in Bayelsa State, respondents from Otuokpoti Community (Bayelsa State) accounted for 6.8% of the sample and respondents from Agudama Ekpetiama Community (Bayelsa State), Patani Community (Delta State) and Ogbogolo Community (Rivers State) each accounted for 6.6% of the sample. The least were respondents from Bomadi Community (5.7%) in Delta state.

Table 3 shows that Ahoada West LGA (Rivers State) was the highest flood-ravaged LGA with 32.1% of the sample, this was followed by Yenagoa LGA (16.5%) in Bayelsa State, Kolga (13.8%) in Bayelsa State and Bomadi LGA (13.0%) in Delta State, Patani LGA (10.6%) in Delta State while the least flood-ravaged LGA was Ogbia LGA in Bayelsa State with 6.8% of the sample.

Table 1. Distribution of the respondents by state of residence

State	N	%	Remark
Bayelsa State	234	37.0	Dominant
Delta State	195	30.9	
Rivers State	203	32.1	
Total	632	100.0	

Table 2. Distribution of the flood prone or ravaged communities

Flood prone community	State	N	%	Remark
Anyama-Ijaw Community	Bayelsa	62	9.8	Dominant
Otuokpoti Community		43	6.8	
Agudama Ekpetiama		42	6.6	
Tombia		41	6.5	
Obogoro		46	7.3	
Bomadi	Delta	36	5.7	
Odorubu		39	6.2	
Koloware		37	5.9	
Kpakiama		41	6.5	
Patani		42	6.6	
Akinima	Rivers	41	6.5	
Ekpeye		40	6.3	
Mbiama		39	6.2	
Ogbogolo		42	6.6	
Egbema		41	6.5	
Total		632	100.0	

Table 3. Distribution of the flood prone or ravaged Local Government Area (LGA)

Flood prone LGA	N	%	Remark
Souther-Ijaw	46	7.3	Dominant
Ogbia	43	6.8	
Yenagoa	104	16.5	
Kolga	87	13.8	
Bomadi	82	13.0	
Patani	67	10.6	
Ahoada West	203	32.1	
Total	632	100.0	

Table 4. GPS Coordinates of identified flood-prone communities in the Study Area

Communities	Northings	Eastings	State
Egbema	4.933001	6.548720	Rivers
Mbiama	5.050785	6.451162	
Ogbogoro	4.844961	6.934192	
Akinima	5.132540	6.485852	
Ekpeye	5.198753	6.583332	
Obogoro	4.382545	5.969196	Bayelsa
Agudama	4.648332	6.217649	
Anyama	4.768514	6.233827	
Otuokpoti	4.850561	6.267340	
Tombia	4.998477	6.266184	
Bomadi	5.166505	5.933222	Delta
Kpakiama	5.167550	5.950285	
Odobor	5.116014	6.066938	
Koloware	5.215952	6.165831	
Patani	5.234059	6.199608	

Table 4 shows the GPS coordinates (Northings and Eastings) of the identified flood-prone communities in the study area. Fifteen (15) flood-prone communities were identified across the study area (Five 5 for each state).

Figs. 2 – 4 are geo-referenced maps of flood-prone communities in three states (Rivers, Bayelsa and Delta) of the core Niger Delta Region of Nigeria.

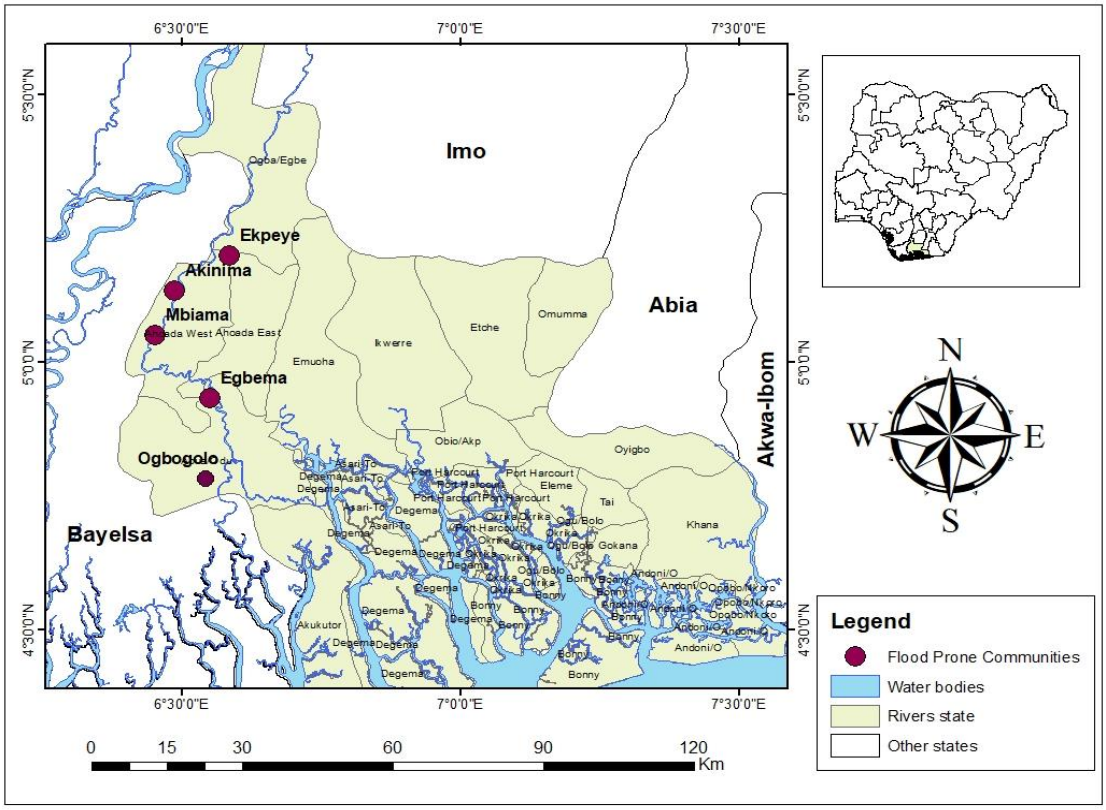

Fig. 2. Flood-prone communities in rivers state

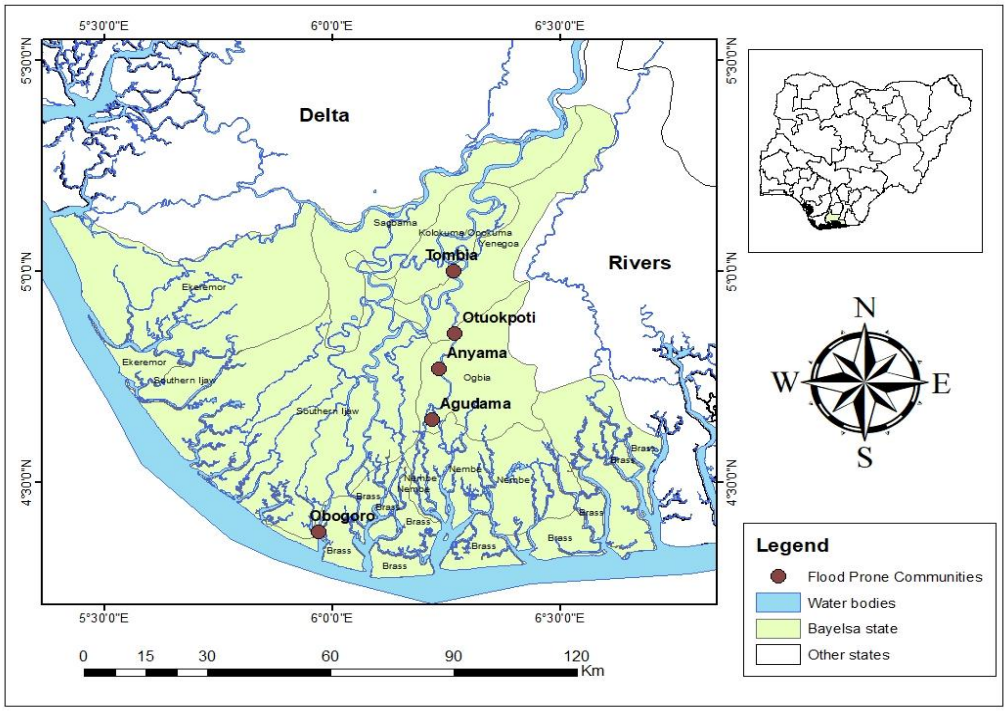

Fig. 3. Flood-prone communities in Bayelsa State

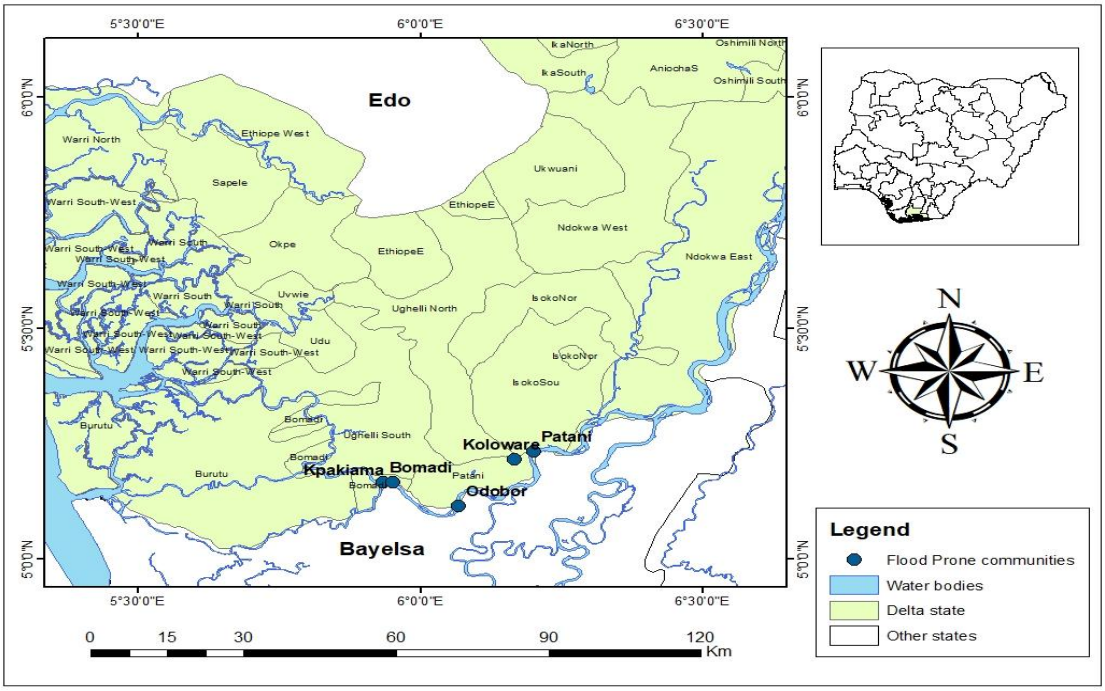

Fig. 4. Flood-prone communities in Delta State

Table 5. Gender distribution of the respondents

Gender	N	%	Remark
Male	442	69.9	**Dominant**
Female	190	30.1	
Total	632	100.0	

Table 6. Age distribution of the respondents

Age	N	%	Remark
16-30 years	191	30.2	Dominant
31-40 years	219	34.7	
41-50 years	122	19.3	
51-60 years	61	9.7	
61 years and Above	39	6.2	
Total	632	100.0	

Table 7. Educational qualification distribution of the respondents

Educational qualification	N	%	Remark
First School Leaving Certificate (FSLC)	32	5.1	Dominant
WAEC/SSCE	98	15.5	
NCE	74	11.7	
OND/HND	83	13.1	
Bachelor Degree	278	44.0	
Master Degree	51	8.1	
Doctorate Degree	16	2.5	
Total	632	100.0	

3.2 Socio-economic Characteristics of Residents of Flood-prone Communities in the Core Niger Delta

Tables 5 – 11 show findings on the socio-economic conditions of the residents of these flood-prone communities in the core Niger Delta region of Nigeria.

Table 5 shows that the male respondents dominated by 442 respondents (69.9%) of the sample while the female respondents were 190 respondents (30.1%) of the sample.

Table 6 shows that the respondents within the age bracket of 31-40 years dominated with 34.7% of the sample, this was closely followed by respondents within the age bracket of 16-30 years with 30.2% of the sample, while the least age bracket was 61 years and above with 6.2% of the sample.

Table 7 shows that the respondents with Bachelor Degree educational qualification dominated with 44.0% of the sample, this was followed by respondents with WAEC/SSCE (15.5%), respondents who had OND/HND educational qualification (13.1%), while the least educational qualification of the respondents was Doctorate Degree with 2.5% of the sample.

Table 8 shows that the respondents with self-source of income dominated with 39.9% of the sample, this was followed by the respondents supported by family members (19.0%), respondents with community support/empowerment (17.4%), respondents supported by their spouse (15.7%) of the sample, while the least means of support/source of income was community member (8.1%).

Table 9 shows that the respondents engaged in a farming occupation dominated with 34.7% of the sample, this was followed by the respondents involved in fishing occupation (21.0%), respondents involved in gin production as an occupation (16.6%), respondents engaged in boat carving was next (15.3%), respondents engaged in the hunting occupation (6.6%), while the least occupation of the respondents was lumbering/timber cutting (5.7%).

Table 10 shows that the respondents with low socioeconomic status dominated with 53.0% of the sample, this was followed by the respondents with average socioeconomic status (43.5%), while the respondents with high socioeconomic status were the least (3.5%).

Table 8. Respondents' means of support/source of income

Means of support	N	%	Remark
Self	252	39.9	Dominant
Spouse	99	15.7	
Family Member	120	19.0	
Community Member	51	8.1	
Community Support/Empowerment	110	17.4	
Total	632	100.0	

Table 9. Distribution of the respondents based on occupation

Occupation	N	%	Remark
Farming	219	34.7	Dominant
Fishing	133	21.0	
Hunting	42	6.6	
Lumbering/Timber Cutting	36	5.7	
Boat Carving	97	15.3	
Gin Production	105	16.6	
Total	632	100.0	

Table 10. Distribution of the respondents based on socioeconomic status

Socioeconomic status	N	%	Remark
High	22	3.5	Dominant
Average	275	43.5	
Low	335	53.0	
Total	632	100.0	

Table 11. Distribution of the respondents based on religion

Religion	N	%	Remark
Christianity	414	65.5	Dominant
Islam	31	4.9	
Traditional Religion	139	22.0	
Pagan	48	7.6	
Total	632	100.0	

Table 12. Distribution of the flood occurrence

Flood occurrence	N	%	Remark
Twice a year	67	10.6	Dominant
Yearly	435	68.8	
Once in Two years	98	15.5	
3-5 years	22	3.5	
6 years and Above	10	1.6	
Total	632	100.0	

Table 13. Distribution of the crops grown

Crop grown	N	%	Remark
Cassava	72	11.4	Dominant
Corn/maize	71	11.2	
Yam	71	11.2	
Cocoyam	71	11.2	
Okra	71	11.2	
Plantain	72	11.4	
Banana	70	11.1	
Vegetable	61	9.7	
Sugar Cane	73	11.6	
Total	632	100.0	

Table 11 shows that respondents who belong to the Christianity religion dominated in the sampled core Niger Delta communities with 65.5% of the sample, this was followed by the respondents who belong to the traditional religion (22.0%), Pagans (7.6%), while the least religious of the respondents was Islam (4.9%).

3.3 Flood Occurrence and Crop Yield in the Flood-prone Communities

Tables 12-16 show results on flood occurrence and crop yield in the study area.

Table 12 shows that the yearly occurrence of flood in the core the Niger Delta States dominated with 68.8% of the sample, this was followed by once in two years occurrence of the flood with 15.5% of the sample, while 6 years and above occurrence of the flood was the least response with 1.6% of the sample.

Table 13 shows that sugar cane was the dominant crop grown in flood-prone communities of the core Niger delta as attested by 11.6% of the sample, this was followed by cassava and plantain (each with 11.4% of the sample as the next dominant crops that are grown in flood-ravaged areas of the core Niger Delta region, this was followed by crops like corn, yam, cocoyam, and okra (each attested by 11.2% of the sample), banana was the next crop grown in the core Niger Delta (11.1%), while the least grown crop in the core Niger Delta was vegetable (9.7%).

48.2% of respondents in Table 14 affirmed that crop yield before the flood occurrence was average. This was followed by 35.1% of the respondents who attested that crop yield before the flood occurrence was high while the least category of respondents are those who believe that crop yield before the flood was very low (0.6%).

Table 14. Distribution of the extent of crop yield before flood

Extent of yield before flood	N	%	Remark
High	222	35.1	Dominant
Average	304	48.2	
Low	102	16.1	
Very Low	4	0.6	
Total	632	100.0	

Table 15. Distribution of the extent of crop yield after flood

Extent of yield after flood	N	%	Remark
High	12	1.9	Dominant
Average	89	14.1	
Low	321	50.8	
Very Low	210	33.2	
Total	632	100.0	

Table 16. Distribution of the size of farmlands destroyed by flood

Size of farmlands destroyed by flood	N	%	Remark
Small Area	49	7.8	Dominant
Large Area	228	36.1	
Entire Community Farmland	232	36.7	
Farmlands Close to the River	123	19.5	
Total	632	100.0	

Table 15 shows that there was low crop yield after the flood as attested by 50.8% of the sample. This was followed by respondents who reported very low crop yield after the flood (33.2%), average crop yield after the flood was next (14.1%), while the least are 1.9% of respondents who affirmed that crop yield after the flood was high.

Table 16 shows that the entire community farmland was destroyed by flood (as attested by 36.7% of the sample). This was followed by large area of farmlands destroyed by flood (as attested by 36.1% of the sample). The next category destroyed by the flood are farmlands close to the river (as attested by 19.5% of the sample), while the least category destroyed by the flood was a small area of farmland as attested by 7.8% of the sample.

4. RESEARCH IMPLICATIONS AND CONCLUSION

This study has revealed the nature of flood in the core Niger Delta region of Nigeria. In contemporary times, adequate knowledge of flood-prone areas particularly in the Niger Delta is of paramount importance and expected to help in the efficient planning of the region and mitigation of adverse flood impacts. This study thus becomes vital for urban and regional development planners in the area of conducting field investigations to analyze factors affecting land use, assessment of the feasibility studies, identification of needed changes and recommendations geared towards flood mitigation, food security and overall physical and economic development of the region. The findings of this study have revealed the importance of geospatial techniques in urban and regional flood studies. Thus, with the systematic geospatial mapping of urban and regional flood-prone communities in the region, policymakers, land speculators, prospective residents, architects, builders and the general public can at a glance see the various flood-prone communities in the core Niger Delta region and take appropriate decisions.

This finding conforms with the studies of Blong [17] and Barroca [18] which affirms that flood vulnerability mapping offers a hundred per cent security against floods. Flood disaster management just as other disaster risk management is very vital since it helps in ensuring preparedness, prevention and mitigation of flood disasters. Good knowledge of flood-prone areas in the region will lead to a

robust regional development planning and preservation of real properties and lives, ordering and regulation of land use efficiently and ethically.

The result of the study as shown in Table 7 reveals that the majority of residents of the core Niger Delta region has Bachelors Degree educational qualification (44.0%). This implies that they have adequate knowledge about the relationship between flood occurrence and food security in the region. However, the respondents' means of support and source of income as revealed in Table 8 shows that the respondents with self-source of income dominated with 39.9% of the sample. This was followed by the respondents supported by family members (19.0%), respondents who rely on community support/empowerment by politicians and other stakeholders (17.4%). The implications of these findings are enormous. For instance, during the yearly flood occurrence in the core Niger Delta which washes away farmlands, destroy houses and other infrastructures, support from the government and other major stakeholders which usually comes in the form of relief materials often arrive late leading to hunger, malnutrition and loss of lives sometimes.

In line with this UNISDR [19] emphasized the construction of roads, dams, flood levies or ocean wave barriers to tackling the eminent washing away of farmlands and the attendant food scarcity/shortage, starvation, and poor harvest. This finding is also in conformity with earlier findings by Bello and Ogedengbe [20] who stated that the direct impacts of flooding include: health-related problems, injuries, loss of farmlands, farm produce, income, malnutrition from consuming poorly harvested foods, structural and household properties and the outbreak of epidemics which threatens the health of individuals, families and survivors to the flood menace.

Further evidence from the study as shown in Table 9 revealed that the respondents' major source of livelihood was farming occupation (34.7%). This was followed by fishing occupation (21.0%), gin production (16.6%), boat carving (15.3%), hunting (6.6%) and lumbering/timber cutting (5.7%). Interestingly, the annual flood occurrence in the core Niger Delta negatively affects the livelihood of the residents of the region. This finding of the study found that the common flood impacts include disruption of movement (14.5%), damage to roads (13.9%), loss of valuable properties (13.7%), loss or washing away of farmlands (13.1%) and environmental degradation/pollution (11.5%) which depicts the severity of the flood event which has affected virtually the income and livelihood of the proportions of households or families.

This finding is also consistent with the findings of Adelekan [21]; Jha et al. [22] which stated that the direct effects of flood hazard may include but are not limited to loss of lives, washing away of stored crops, and other income yielding products (like gin, timber, etc.), personal injuries, damage to buildings, the disintegration of their means of support and sustenance, displacement of people from their homes, loss of valuable properties, and disruption of the livelihood and socio-economic life of individuals and groups leading to fighting for the survival of the fittest, wherein children and the elderly being at higher risk of getting relief, support, care and provisions drowned than younger adults [23].

The result in Table 10 revealed that the respondents with low socioeconomic status dominated with 53.0% of the sample. This was followed by the respondents with average socioeconomic status (43.5%), while the respondents with high socioeconomic status were the least (3.5%). This implies that in the event of a flood disaster, coping with the flood disaster becomes a challenge due to the low socioeconomic status of the residents. Also connected to this is the influence of the flood occurrence on their food security and livelihood. This finding differs with the finding of Samuel et al. [24] which affirmed that communities have varying degrees of risk exposure and ravaging effects to flooding based on the prevailing socio-economic circumstances (via low, average or high) which eventually influences the inhabitants of these communities to access, acquire and perceive not only risk but also the resultant disaster events and possibly their impacts.

The result in Table 12 shows that the yearly occurrence of flood in the core Niger Delta States dominated with 68.8% of the sample. This was followed by once in two years occurrence of the flood with 15.5% of the sample, while 6 years and above occurrence of the flood was the least response with 1.6% of the sample. This yearly flooding occurrence in the core Niger Delta States ravaged the entire large area of community farmland including farmlands close to the river. This finding is in agreement with

Samuel et al. [24] who emphasized that riverine communities or areas are frequently susceptible or wide-open to flood-inducing natural and human activities with great and devastating impacts or effects such as poor watershed management and dam failure in varying magnitude. Similarly, Onwuka et al. [25] emphasized that the occurrence and intensity of flooding incident are dependent on the individuals, households and community's level of resilience and preparedness galvanizes the eventual mitigation, recovery, remediation and resistance against the losses, destructions, and dangers from the risk, hazards or disaster like a flood.

Evidence from the study revealed that the yearly occurrence of flooding has led to the devastation or destruction of a large expanse of land including cultivated farmlands like that witnessed in Kolaware Community in Patani LGA of Delta State were the 2018 flooding incidents led to the loss of their major crops like yam, plantain, okra and cocoyam. The extent of the flood that occurred in Akinima community in Ahoada West LGA of Rivers State also led to the destruction of crops like plantain, cassava, banana, etc.

48.2% of respondents in Table 14 affirmed that crop yield before the flood occurrence was average. This was followed by 35.1% of the respondents who attested that crop yield before the flood occurrence was high. Interestingly, further evidence from the study as revealed in Table 15 shows that there was low crop yield after the flood as attested by 50.8% of the sample. This was followed by respondents who reported very low crop yield after the flood (33.2%) and average crop yield after the flood was next (14.1%).

This finding agrees with the study of Adelekan [21] on the vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria, which revealed that: a shortage of potable water, poor harvest, scarcity of food, low-quality nutrition, increased incidence of water-borne diseases, and disruptions of the social and economic life of the people were indirect impacts of flooding. This menace leaves flood victims or survivors severely traumatized, and many of them experiencing symptoms of posttraumatic stress disorder (PTSD), depression and anxiety [22,26].

In conclusion, it is the firm belief of the authors that developing or building resilience becomes the main issue that would reduce the devastation of flood menace across communities in the core Niger Delta area. Structural measures like dams, culverts, drainages, and ditches should be constructed to accommodate and reduce the runoff or overflow of floodwaters which causes severe social, economic and infrastructural damages or impacts in the flood-prone communities. Finally, the Federal and State Governments of the core Niger Delta urgently needs to invest in the provision of automatic flood-warning alert or alarm that will trigger itself when the water level at certain landmarks (like River Nun, Orashi River, etc.) reaches a threshold or critical level. This will help the activation of all the response system or strategy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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