International Journal of Multidisciplinary Approach Research and Science
E-ISSN 2987-226X P-ISSN 2988-0076
Volume 3 Issue 03, September 2025, Pp. 1101-1114
DOI: https://doi.org/10.59653/ijmars.v3i03.1971
Copyright by Author

Impact of Flood on Bayelsa State, Nigeria: Causes, Consequence, and Management Strategies

Jude Okeibunor Nwambuonwo[1], Ogheneovo Maureen Atie[2*], Mariam Reuben-Okoye[3]
Delta State School of Marine Technology, Burutu, Nigeria[1]
Delta State School of Marine Technology, Burutu, Nigeria[2]
Delta State School of Marine Technology, Burutu, Nigeria[3]
Corresponding Email: samuwhes@gmail.com*

Received: 26-07-2025 *Reviewed: 02-09-2025* *Accepted: 10-10-2025*

Abstract

One of the most common and destructive environmental hazards in Nigeria has been flooding that has resulted in massive destruction of infrastructure, agriculture and human settlements. The geomorphological characteristics and the closeness of the Atlantic Ocean makes Bayelsa State, which is in the low-lying Niger Delta region, highly susceptible to floods. This paper will discuss the 2022 flood disaster that occurred in Bayelsa State, its physical and socioeconomic effects, the primary causes of the disaster, and some of the current measures taken with regards to flood management. The study is an empirical research based on the structured questionnaires, interviews and field observations conducted in seven communities across Bayelsa and Delta States, but also supported by secondary information, which presents multidimensional impacts of the flood. The findings noted that the flood swept away farmlands, animals, and households, displaced thousands of people, disrupted both transport and education and increased poverty and food insecurity. Results also suggest that ineffective drainage, level ground and lack of government preparedness are some of the factors that contributed to the disaster. The paper ends by giving recommendations on the need to actively manage river basins, to develop proper urban planning and to establish a good collaboration between the institutions to ensure the development of resilience against the occurrence of future floods.

Keywords: Flooding, Bayelsa State, Niger Delta, Environmental Management, Disaster Risk Reduction

Introduction

In human societies all over the world, flooding is one of the most prevalent and devastating natural calamities. It happens when waters provisional cover dry lands that would have otherwise not been covered due to excess precipitations, overflow of rivers, or coastal overflows (Bradshaw, 2007). Flooding is one of the most common natural disasters that affect over 70 million individuals every year worldwide (Peduzzi et al., 2009). Floods are becoming

more frequent, which is associated with climate change and fast urbanization and environmental mismanagement (Komolafe et al., 2015).

Floods in Nigeria are frequent and intensive particularly in lowlands like the Niger Delta. In 2012, 2018, and 2022, the country experienced a series of disastrous floods, each with massive consequences of claimed lives and damaged properties (Umar & Gray, 2022). The most catastrophic flood, which took place in 2022, claimed the lives of 2.5 million individuals, over 82,000 houses were ruined, and over 332,000 hectares of agricultural land were submerged (Federal Ministry of Humanitarian Affairs, 2022).

The central Niger Delta basin area was one of the worst affected states including Bayelsa State. According to the state government, more than 300 communities had been submerged, and thousands of people displaced (Punch, 2022). This level of disaster indicated the ineffectiveness of current flood management systems in the area.

This paper thus examines the 2022 flood crisis in the Bayelsa State, its physical and socioeconomic effects, short-term and long-term causal factors, and institutional reactions. It also aims at suggesting sustainable mitigation policies grounded on empirical evidence and observations at the field.

The core objective of the research is to evaluate the effects of the 2022 flood on the people of the Bayelsa State in Nigeria, with the perspective of offering viable solutions to the management and control of floods. To achieve the particular goals, it is necessary to:

1. Determine effects of the 2022 flood on the affected communities physically.
2. Analyze how the 2022 flood affected the socioeconomic livelihoods and households.
3. Determine the short-term and long-term reasons of the 2022 flood in Bayelsa State.
4. Assess the available flood management and control strategies in the state.
5. Identify the degree of community susceptibility and readiness to subsequent flood incidences.

Literature Review

Concept of Flooding

One of the commonest and devastating natural hazards in the world is floods. It is referred to as the short-term flooding of normally dry terrain due to rains, river overflow, storms, or insufficient drainage (Petroski, 2006; Komolafe et al., 2015). UNISDR (2009) explains that floods are the excess of water on the surface of the land that is normally arid and leads to disruptions in environmental and human systems. Even though the natural hydrological cycle includes floods, the effects of floods have been heightened by the rapid urbanization process, deforestation, and climate change.

Smith and Ward (1998) categorized the floods in fluvial (riverine), pluvial (surface or urban), and coastal. All three types are common in Nigeria, and riverine and coastal floods are common in the Niger Delta because it is located at a low altitude and is near to the Atlantic Ocean (Ezenweani, 2017). Floods replenish groundwater and are known to support wetlands,

but their negative impacts that include loss of life, displacement and destruction of infrastructure are usually more than benefits that may arise (Apan et al., 2010).

Explaining floods, the Pressure and Release (PAR) model by Blaikie et al. (1994) says that it is a interaction of natural hazards and social vulnerability, which is determinable by poverty, bad governance, and poor institutions. Poor waste disposal, unplanned urbanization and blocked drainage systems in Nigeria increase exposure (Nkwunonwo, 2016; Aderogba, 2012). Flood risks are further worsened by climate variability and the increase in sea levels (Liu et al., 2018),

As a result, the flooding in Bayelsa and other places like this is a hydrological phenomenon and a human induced phenomenon showing the interaction between natural processes and socio-economic vulnerability. The mitigation process must then be based on effective environmental planning, institutional capacity and community awareness.

Flood Causes and effects

Due to both natural and man-made factors, flooding in Nigeria is affected. These natural reasons are high precipitation, tidal surges, and the low level of flood plains (Liu et al., 2018). The anthropogenic factors comprise subpar drainage systems, garbage disposal in waterways, deforestation, and uncontrolled development in flood drain areas (Nkwunonwo et al., 2016). In Niger Delta, natural flood channels have been blocked by sand filling, and land reclamation to accommodate housing projects with the effect of increasing the intensity of flood effects.

Both of these have immediate consequences, i.e. property destruction, losses to agriculture, and damages to infrastructure, and indirect ones, i.e. food insecurity, displacement, and outbreaks (Apan et al., 2010). Most of the water-borne diseases are caused by floodwater contamination, including cholera and typhoid (Qomariyatus et al., 2020). Though there are some instances where floods may benefit soils and groundwater, the adverse effects of socioeconomic impacts usually have the negative effects.

Flood Management and River Basin Concept

The concept of river basin forms the core of the modern water and environmental management. A river basin refers to the geographical area served by a river and its tributaries, and is a natural hydrological unit of the water and other resources (Teclaff, 1996; Barrow, 1998). It offers a comprehensive system that connects upstream and down-stream water systems with each other encouraging co-ordinated planning to eliminate conflicts and increase sustainable development.

This idea is the basis of the philosophy of Integrated River Basin Management (IRBM), which is aimed at controlling water, land, and environmental resources in a catchment area. Biswas (2004) argues that IRBM is a combination of structural and non-structural interventions to provide a balance between economic utilization and environmental security and prevention of disasters. Physical means of water management include levees, embankments, and reservoirs, whereas the non-structural ones comprise land-use control, reforestation, and

community education, which make people less vulnerable (Petroski, 2006; Komolafe et al., 2015).

In Nigeria, the federal government created River Basin Development Authorities (RBDAs) between 1976 and 1981, to usher in basin wide planning in irrigation, water supply, and flood control. Eleven authorities were established such as the Niger Delta River Basin Development Authority, which covers Bayelsa, and other neighboring states. Nevertheless, lack of proper funding, poor coordination, and political interference has limited most of them (Ezenweani, 2017; Biswas, 2004). As a result, the flood management has been in reactive mode where most of it is based on post-disaster relief instead of preventive planning.

The Bayelsa State situation is a case illustrating the drawbacks of broken river basin management. The degradation of the basin in terms of its ability to absorb floodwaters has been caused by poor maintenance of natural drainage channels, deforestation, and uncontrolled urban growth. Watson et al. (2022) also observe that climate change heightens the variability of rainfall creating a greater flood risk in low-lying regions like the Niger Delta.

Scientific hydrological analysis, ecosystem conservation, and community involvement should be incorporated in the river basin management in Bayelsa in order to reduce the number of future disasters. The enhancement of the institutional structures, better drainage system and land-use regulations within the basin are the key measures to achieve sustainability of flood resilience.

Study Area

Location

Bayelsa State is located in the South-South geopolitical region with a core of the Niger Delta region, Nigeria. Its boundaries are Delta State on the west, Rivers state on the east, and Atlantic ocean on the south. The state lies in the latitudes of about 4 o 30 N and 5 o 30 N, with longitudes of about 5 o 00 E and 6 o 45 E with a geographical area of approximately 10,773 square kilometers.

Climate

The climate in the state is tropical equatorial with high rainfall (as high as 3,500 mm a year), moisture levels of more than 80 percent, and a temperature of between 25C and 31C. The wet season has over 300 days which causes the place to be very vulnerable to floods.

Relief and Vegetation

Bayelsa State is mostly a low land region with flat topography, tidal flats and coastal beaches. Mangrove forests and freshwater swamps predominate the vegetation with patches of the lowland rainforests found inland. Biodiversity in these ecological conditions predisposes this region to seasonal flooding.

Geology and Soils

The geology of Bayelsa is mainly alluvial Necramentary sediments of the Quaternary age, which is made up of deposition of river Niger sediments. These soils consist mostly of

poor drained clay loams and acid Sulphate soils that absorb water and lower infiltration making floods more probable..

Figure 1: Bayelsa State, Nigeria, Map
Source: MapCarter, 2023

Research Method

This research paper assumed a descriptive research design that was used in gathering information about the causes, effects, and management of the 2022 flood in Bayelsa State.

Data Collection

Structured questionnaires, interviews and field observations were used to provide primary data. Three6 respondents were picked representing seven communities: Umeh, Famgbe, Kaiama, Ekeremor Camp, Ogobiri (Bayelsa), and Patani, Okogbe (Delta). Respondents were categorized into residents, local leaders and flood victims.

In search of secondary data, journals, government reports and academic reports about flood management in Nigeria were used.

Data Analysis

Descriptive statistics (frequencies and percentages) were used to analyze quantitative data whereas thematic interpretation of qualitative data in interviews was used. The findings have been categorized under physical, socioeconomic and institutional impact.

Results

The obtained data were interpreted and displayed using descriptive statistics. There were 36 questionnaires that were conducted in seven communities with supplemented field observations and interviews.

Socio-Demographic Characteristics

The population is equally divided between the genders and all the age categories within the study area.

Sex of Respondents

Table 1. Sex of Respondents

Sex	Frequency	Percentage (%)
Male	20	55.6
Female	16	44.4
Total	**36**	**100**

Source: Fieldwork, 2023

As noted in Table 1, most of the respondents (55.6) were male, and the females were 44.4%. This indicates that both sexes were equally engaged in the process of responding to the survey, which implies that there was an equal representation of the flood victims.

Age of Respondents

Table 2. Age Distribution

Age (Years)	Frequency	Percentage (%)
18–25	8	22.2
26–40	13	36.1
41–56	10	27.8
Above 56	5	13.9
Total	**36**	**100**

Source: Fieldwork, 2023

Table 2 shows that the statistics show that the age category 2640 years constitute majorities (36.1 percent), a group that is economically active. This means that the people of the affected areas were hit at the prime of their productive age thus increasing socioeconomic effects.

Marital Status

Table 3. Marital Status of Respondents

Single	11	30.6
Married	20	55.6
Divorced	2	5.5
Widowed	3	8.3
Total	**36**	**100**

Source: Fieldwork, 2023

As indicated in Table 3, over half (55.6) of the respondents were married meaning that they had more people in their homes, which made them addition family dependency, which exacerbates vulnerability in times of disasters.

Educational Status

Table 4. Educational Status

Education Level	Frequency	Percentage (%)
No formal education	2	5.5
Primary	5	13.9
Secondary	24	66.7
Tertiary	5	13.9
Total	**36**	**100**

Source: Fieldwork, 2023

Table 4 shows that most of them (66.7%) have attained secondary education with moderate levels of literacy. This means that there would be the possibility of the awareness of floods but there will be little of capacity to embrace scientific adaptation.

5.1.5 Occupation

Table 5. Occupational Distribution

Occupation	Frequency	Percentage (%)
Farmer	11	30.6
Business	21	58.3
Civil Servant	1	2.8
Others	3	8.3
Total	**36**	**100**

Source: Fieldwork, 2023

Table 5 indicates that most of them (58.3) were traders or business owners, and 30.6% were farmers. The reliance of these groups on physical assets, farmlands, shops and goods is also very susceptible to floods which is why this type of economic impact is very dramatic.

Household Size

Table 6. Household Size

Household Members	Frequency	Percentage (%)
1–3	15	41.7
4–6	11	30.5
7 and above	10	27.8
Total	**36**	**100**

Source: Fieldwork, 2023

Table 6 showed that Household sizes were mostly 1-6 persons (72.2%) which is common in extended family systems in the Niger Delta. The bigger the family the harder it is to evacuate and feed them in case of a disaster.

Physical Impact of the 2022 Flood

Table 7. Physical Impact of the 2022 Flood

Statement	SA (%)	A (%)	D (%)	SD (%)
Crops, livestock, and habitats were submerged	94.4	5.6	0	0
Areas close to rivers experienced worst impacts	22.2	8.3	38.9	30.6
Riverbanks were eroded	55.6	41.6	2.8	0
Drinking water sources were affected	86.1	13.9	0	0
Soil fertility declined	50.0	11.1	30.6	8.3
Forests and vegetation were affected	63.9	33.3	2.8	0

Source: Fieldwork, 2023

As it can be seen in Table 7, all respondents reported serious destruction of agriculture and environment. The biggest ones were water pollution (100%) and erosion (97.2%). The percentages of the major physical impacts are distributed as in figure 2 (below).

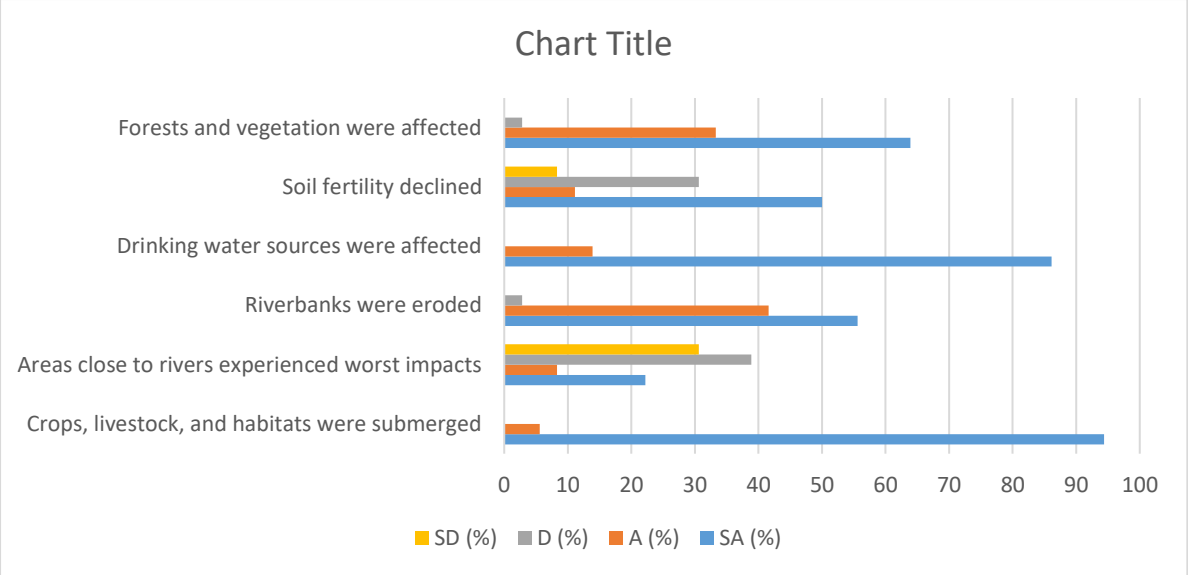

Figure 2. Bar Chart Showing Major Physical Impacts of Flooding

Figure 2 chat indicates that crops/livestock loss is 100, erosion 97, water contamination 100, soil fertility reduction 61 and vegetation loss 92. Therefore, the figure depicts the key physical effects of the 2022 flood in Bayelsa State. The majority of respondents were categorically in agreement with the fact that the flooding had submerged crops, livestock and habitats, eroded riverbanks, burnt forests and plants and had also polluted drinking water sources. The moderate group was of the view that there was a decline in soil fertility but the least amount of victims was associated with the riverine areas. On the whole, the chart indicates that the flood had tremendous environmental impact with a severe impact on land, water and vegetation in the state.

Socioeconomic Impact of the 2022 Flood

Table 8. Socioeconomic Impacts

Impact Variable	SA (%)	A (%)	D (%)	SD (%)
Affected by flood	100	0	0	0
Transportation disrupted	100	0	0	0
Prices of commodities increased	100	0	0	0
Buildings collapsed	72.2	19.4	8.3	0
Livelihood destroyed	80.6	19.4	0	0
Hunger and starvation	100	0	0	0
People rendered homeless	100	0	0	0
Exposed to diseases and animals	80.6	19.4	0	0
Food insecurity	77.8	22.2	0	0
Health care access disrupted	63.9	22.2	13.9	0
Lives and properties lost	72.2	16.7	11.1	0
Schools closed	100	0	0	0

Source: Fieldwork, 2023

Table indicated that every respondent had losses. Flooding stopped people, demolished companies and caused food shortage. School and hospital closure were other factors that worsened social distress.

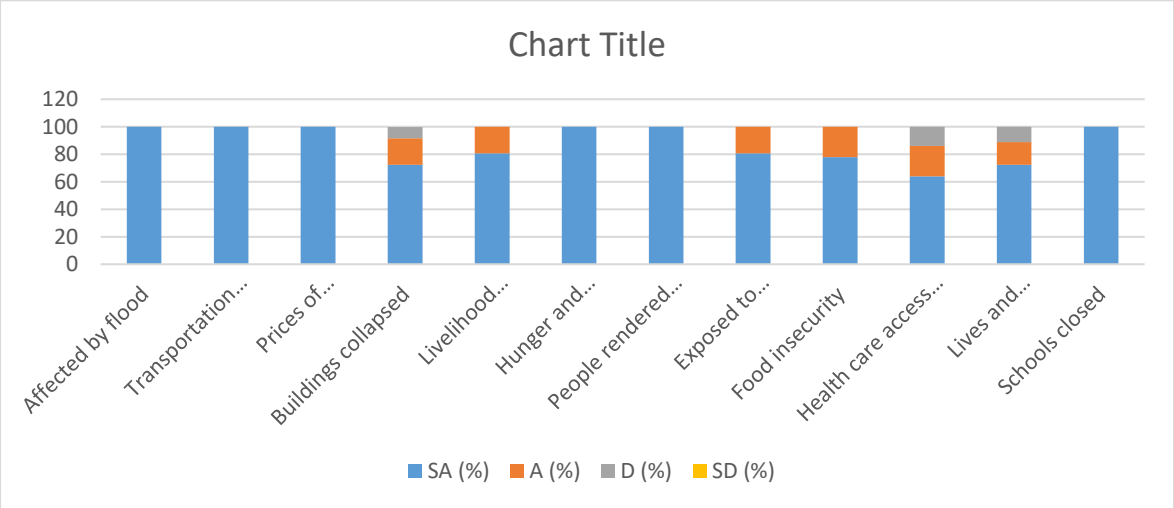

Figure 3. Pie Chart of Socioeconomic Impacts

Figure 3 shows percent weight of the significant impacts, of Homelessness 100, Price rise 100, Food insecurity 78, Loss of livelihood 81, and Infrastructure collapse 72. The chart indicates that the 2022 flood in Bayelsa State had serious socioeconomic impacts. Almost all of the respondents were emphatic that they had been impacted; they had been disrupted by transport, food prices had increased, livelihoods were destroyed, people were hungry which resulted in people being homeless and schools were forced to close. The moderate answers were presented only to the issue of the access to health care and the loss of property, yet, in general, the flood resulted in a great misery and disruption of the main services as well as deterioration of the conditions under which people lived throughout the state.

Flood Management and Control Measures

Table 9. Multidimensional Management of Floods

Statement	SA (%)	A (%)	D (%)	SD (%)
Preventive measures before flood	0	0	22.2	77.8
Received relief funds	11.1	25.0	11.1	52.8
NGOs provided assistance	8.2	27.8	44.4	19.4
Areas rehabilitated after flood	5.6	5.6	25.0	63.8
Measures to prevent future floods	0	0	0	100
Communal mitigation measures	8.3	11.1	22.2	58.3
Individual mitigation efforts	11.1	27.8	30.6	30.6
IDP camps set up	55.6	0	0	44.4

Source: Fieldwork, 2023

Table 9 revealed that Flood management was appalling. 100 percent of the respondents reported that they had not taken any measures before the flood and 63.8 percent of them reported that the areas that were affected were never rehabilitated. The mitigation lacks sustainability, which points to systemic institutional flaws.

Causes of Flooding

Table 10. Causes of the 2022 Flood

Cause	SA (%)	A (%)	D (%)	SD (%)	UD (%)
Excessive rains	5.6	16.7	36.1	25.0	16.7
Poor infiltration	11.1	2.8	33.3	33.3	19.4
Shallow water table	5.6	5.6	27.8	25.0	36.1
Poor drainage	19.4	25.0	19.4	25.0	11.1
Flat terrain	13.9	25.0	27.8	25.0	8.3
Too many creeks and rivers	16.7	16.7	27.8	16.7	22.2
Poor management of supplying streams	58.3	13.9	8.3	8.3	11.1

Source: Fieldwork, 2023

Table 10 shows that the main cause was ineffective management of streams supply (72.2%), next was that of flat terrain and inadequate drainage systems. The presence of only natural factors such as rainfall could not be used to explain the extent of the disaster as human mismanagement contributed a lot to the severity of the floods.

Vulnerability Assessment

Table 11. Vulnerability Levels

Group	SA (%)	A (%)	D (%)	SD (%)
Urban areas more exposed	0	0	58.3	41.7
Rural areas more exposed	0	0	61.1	38.9
Children more vulnerable	58.3	33.4	8.3	0
Men more vulnerable	52.6	33.3	8.3	5.8
Women more vulnerable	63.9	25.0	11.1	0

Source: Fieldwork, 2023

The data presented in Table 11 indicated that children (91.7%), and women (88.9%) were the most vulnerable groups. Their role of dependency and care did not allow them to be as resilient and available to relief resources.

Discussion of Findings

The results of this paper give a definite indication that the 2022 flood in Bayelsa State was due to both natural and anthropogenic factors, which support the multifaceted dynamics of the environment and human behavior in flood-affected areas. The topography of the state was low, and its rainfall was high per year and many river channels were flowing on the natural side which contributed to the severity of the flood. But the anthropogenic factors that were cited as important exacerbating factors included poor management of drainage, haphazard dumping of waste and unmitigated land reclamation projects. This substantiates the opinion of Nkwunonwo (2016), who characterized the flooding in Nigeria as the human-environmental crisis instead of the natural phenomenon.

The research also determined that there was a wide loss in agriculture and infrastructures. Huge areas of agricultural lands had been flooded, animals had died and essential infrastructure such as roads, schools and hospitals destroyed or made inaccessible. These results are consistent with those by Abubakar et al., (2020) as they observed that the frequency of floods in the riverine communities in Nigeria have continued to wash away the productive foundation of the rural economies and undermine the local resilience. The destruction also caused social and economic links resulting in long food shortage and inflationary pressures within the state.

Concerning the institutional response, the study found out that the government interventions were mainly reactive and short-term. Relief was delayed, ineffective and disorganized and pre-flood planning or preventive systems were not evident. The respondents said that the majority of government agencies got active after the disaster had taken place, which indicates the greater problem of poor disaster governance realized (Douglas et al., 2008). The lack of early warning systems and low participation of the communities also weakened the effectiveness of response.

In addition, the statistics demonstrated the high rate of vulnerability of women, children, and low-income families. These populations were the most affected by displacement, food insecurity and health risks. They did not have access to the resources and power to make decisions in the emergency due to their social economic and gender-based disadvantages. This result agrees with Apan et al. (2010) who recorded that geography is not the sole source of flood vulnerability in the developing regions, but also social inequality and poverty.

On the whole, the findings highlight the fact that there is a pressing need to develop a powerful solution to the flood management problem that involves environmental planning, institutional capacity building and education of communities. The floating sustainable flood governance in Bayelsa should therefore transcend temporary relief responses to entail structural

response like better drainage systems, implementation of land use laws and the active involvement of the local people in disaster preparedness.

Conclusion

The 2022 Bayelsa State flood proved the long time susceptibility of the Niger Delta to hydrologic disasters. The paper has determined the role of natural and anthropogenic causes in the extent of the flood. The topography was low, there was inadequate drainage infrastructure and readiness to tackle this disaster aggravated the physical socioeconomic consequences of the disaster. The government reaction was not much proactive as there was little relief and poor rehabilitation systems.

The reason is that sustainable flood management in Bayelsa will involve a transition of short-term emergency management to long-term preventive management based on integrated river basin management, enhanced infrastructure as well as community involvement.

Recommendations

The research also came up with the following recommendations:

1. Comprehensive Flood Mitigation Plan: The state government of Bayelsa State needs to develop and introduce a state-wide Flood Mitigation and Response Master Plan in accordance with the National Flood Policy of Nigeria.
2. Drainage and Infrastructure: Improve the drains and take care of the ones that are already in place which would avoid stagnation of water.
3. River Basin Management: Enhance the Niger Delta River Basin Development Authority to do coordinated flood management and watershed management.
4. Community Education: Hold frequent sensitization education to the people on waste disposal and flood preparedness.
5. Urban Planning Implementation: Control the construction within the flood plains and implement the zoning rules.
6. Research and Early Warning Systems: Invest in Hydrological and Meteorological monitoring systems in order to improve early warning systems.

References

Abubakar, B., Umar, H., Barde, M. M., & Adamu, S. (2020). Socio-economic impact of flooding on the riverine communities of River Benue in Adamawa State, Nigeria. *FUTY Journal of the Environment, 14*(2). https://doi.org/10.4314/fje.v14i2.11

Aderogba, K. A. (2012). Qualitative studies of recent floods and sustainable growth and development of cities and towns in Nigeria. *International Journal of Academic Research in Economics and Management Sciences, 1*(3), 1-25.

Apan, A., Keogh, D., King, D., Thomas, M., Mushtaq, S., & Baddiley, P. (2010*). The 2008 floods in Queensland: A case study of vulnerability, resilience and adaptive capacity (Report No 16/10).* National Climate Change Adaptation Research Facility.

Barrow, C. J. (1998). River basin development planning and management: A critical review. *World Development, 26*(1), 171-186. https://doi.org/10.1016/S0305-750X(97)10017-1

Biswas, A. K. (2004). Integrated water resources management: A reassessment. *Water International, 29*(2), 248-256. https://doi.org/10.1080/02508060408691775

Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At Risk: Natural Hazards, People's Vulnerability and Disasters.* Routledge.

Bradshaw, C. J. A., Sodhi, N. S., Peh, K. S. H., & Brook, B. W. (2007). Global evidence that deforestation amplifies flood risk in the developing world. *Global Change Biology 13*(11), 2379–2395. https://doi.org/10.1111/j.1365-2486.2007.01446.x

Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., McLean, L., & Campbell, J. (2008). Unjust waters: Climate change, flooding and the urban poor in Africa. *Environment and Urbanization, 20*(1), 187–205. https://doi.org/10.1177/0956247808089156

Ezenweani, R. S. (2017). A comprehensive collation of river basins in Nigeria: Benefits and river basin development planning and management. *International Journal of Scientific & Engineering Research, 8*(11), 1587-1595.

Federal Ministry of Humanitarian Affairs. (2022). *2022 Flood Situation Report.* Abuja: Government of Nigeria.

Komolafe, A. A., Adegboyega, S. A., & Akinluyi, F. O. (2015). A review of flood risk analysis in Nigeria. *Journal of Geography and Regional Planning, 8*(8), 193-204

Liu, J., Zhang, Q., Singh, V. P., Song, C., Zhang, Y., Sun, P., & Gu, X. (2018). Hydrological effects of climate variability and vegetation dynamics on annual fluvial water balance in global large river basins. *Hydrology and Earth System Sciences, 22,* 4047-4060

Nkwunonwo, U. C. (2016). A review of flooding and flood risk reduction in Nigeria. *Global Journal of Human-Social Science: B (Geography, Geo-Sciences, Environmental Science & Disaster Management), 16*(B2), 23-42.

Nkwunonwo, U. C., Whitworth, M., & Baily, B. (2016). Review article: A review and critical analysis of the efforts towards urban flood risk management in the Lagos region of Nigeria. *Natural Hazards and Earth System Sciences, 16,* 349-369.

Peduzzi, P., Dao, H., Herold, C., & Mouton, F. (2009). Assessing global exposure and vulnerability towards natural hazards: The Disaster Risk Index. *Natural Hazards and Earth System Sciences, 9*(4), 1149–1159. https://doi.org/10.5194/nhess-9-1149-2009

Petroski, H. (2006). Levees and other raised ground. *American Scientist, 94*(1), 7-11.

Punch Newspaper. (2022, October 15). *Over 300 Bayelsa communities submerged by flood. Punch Nigeria.*

Qomariyatus, S., Wahyudi, K. C., & Sri, W. (2020). The analysis of the causes of flood disasters and their impacts in the perspective of environmental law. *IOP Conference Series: Earth and Environmental Science, 437*(1), 012056.

Smith, K., & Ward, R. (1998). Floods: Physical processes and human impacts. John Wiley & Sons.

Teclaff, L. A. (1996). Evolution of the river basin concept in national and international water law. *Natural Resources Journal, 36*(2), 359-391.

Umar, N., & Gray, A. (2022). Flooding in Nigeria: a review of its occurrence and impacts and approaches to modelling flood data. *International Journal of Environmental Studies, 80*(3), 540-561. https://doi.org/10.1080/00207233.2022.2081471

United Nations Office for Disaster Risk Reduction [UNISDR] (2009). *2009 UNISDR terminology on disaster risk reduction.* UNDRR.

Watson, A., Vystavna, Y., Kralisch, S., et al. (2022). Towards the development of an isotope-enabled rainfall-runoff model: improving the ability to capture hydrological and anthropogenic change. *Hydrological Processes, 37*(2), Article e14819.