International Journal of Engineering Research and Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 21, Issue 11 (November 2025), PP 65-79

Assessing Soil Suitability for Floating Building Development in the Floodplains of Bayelsa State, Nigeria

*[1]Koinyan A. A., [2]Udom G. J. and [3]Nwankwoala H. O.
[1]*Institute of Natural Resources, Environment and Sustainable Development (INRES)*
University of Port Harcourt, Rivers State, Nigeria
[2]*Department of Geology, Faculty of Science*
University of Port Harcourt, Rivers State, Nigeria
[3]*Department of Geology, Faculty of Science*
Rivers State University, Rivers State, Nigeria
**Corresponding Author*

ABSTRACT
This study assesses the soil suitability of floating building development in Bayelsa State's floodplains through soil quality analysis and community feedback. Heavy metal concentrations exceeded WHO safety limits in several communities, with lead and cadmium posing significant health and structural risks due to industrial and agricultural pollution. Copper and zinc levels remained within safe ranges but showed signs of anthropogenic influence, warranting ongoing monitoring. Community preferences favored traditional floating-building designs, emphasizing cultural fit, sanitation, and flood-season livelihoods. Statistical analysis identified habitat protection and livelihood continuity as top priorities, while water quality and ecosystem concerns ranked lower. These findings highlight the need for resilient infrastructure that integrates indigenous practices, stilted foundations, and robust anchoring systems. Modular and sustainable materials should be introduced through education and pilot programs to build trust and acceptance. The study recommends aligning floating infrastructure with local conditions and values, supported by participatory planning and targeted investment to ensure long-term sustainability and community resilience.
Keywords: *Floating building, Floodplain, soil quality,socio-environmental benefits*

Date of Submission: 01-11-2025 Date of acceptance: 08-11-2025

I. INTRODUCTION

Floods are common natural disaster occurring in most parts of the world resulting in damages and loss of human life and livelihood sources, deterioration of environment and retardation to development (Wizor& Week, 2014).In the Niger Delta of Nigeria, floodplains experience regular flooding, which presents considerable environmental, social, and economic challenges (Echendu, 2020).

The increasing frequency and intensity of floods, exacerbated by climate change and human activities, has necessitated innovative approaches to environmental management. Bayelsa State, located in the Niger Delta region of Nigeria, is highly susceptible to flooding due to its low-lying topography and extensive network of rivers and creeks (Berezi et al., 2019). Flooding in this region has significant socio-economic and environmental impacts, necessitating effective floodplain management strategies (Nkwunonwo, 2016). Flooding is a recurrent problem in Bayelsa State, Nigeria, causing significant damage to infrastructure, displacement of communities, and loss of lives. 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.

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 and Gray, 2022). The most catastrophic flood (Figure 2), 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 reliance on traditional flood control measures has not only failed to prevent recurrent flood disasters but has also displaced communities and damaged vital ecosystems (Shah et al. 2020). As urban population's increase and climate change continues to alter weather patterns, there is an urgent need for re-evaluated strategies that prioritize sustainable and adaptive solutions. Flooding has severe environmental and socio-economic consequences that affects the effective movement and sustenance, Figure 3 describes a typical situation of survival mode. It leads to soil erosion, water contamination, and loss of biodiversity. The disruption of natural habitats can have long-term effects on the local ecosystem (Ajumobi et al., 2023).

In response, integrated floodplain management (IFM) has emerged as a multidisciplinary approach that combines ecological, social, and economic perspectives to enhance community resilience and mitigate flood risks (World Meteorological Organization, 2006). Among the innovative solutions proposed under IFM are floating buildings, which can adapt to rising water levels while minimizing infrastructure damage and accommodating urban expansion (Penning-Roswell, 2019). These structures present an opportunity to redefine living and working environments in flood-prone areas, ultimately contributing to sustainable development goals.

Figure 1: An Aerial view of a Flooded Community in Bayelsa State (Research and Flood Control, Min. of Environment, Bayelsa State, 2022)

Figure 2: A Flooded House in a Community (Research and Flood Control, Min. of Environment, Bayelsa State, 2022)

Figure 3: Means of Transportation during Flood in a community of Bayelsa State (Research and Flood Control, Min of Environment, Bayelsa State, 2022)

Floating buildings are defined as residential or commercial structures that are moored permanently, float on water with a floatation system, do not contain a watercraft built or intended for navigation, and have a premises service system (city gas, water/sewage, and electricity) that is connected to the land by permanent supply/return lines, or have self-supporting service facilities for themselves (Habibi, 2015).

The offshore industry also uses floating buildings, which are well-known and often take the shape of gigantic floating platforms (Amaechi et al. 2022). However, floating homes and facilities are only implemented on a very modest scale. In the last ten years, the concept of floating structures has not been revolutionary. There are locations in the globe where people have been living on the ocean for generations (Tri and Ikaputra, 2022)

In flood-prone areas, floating buildings structures made to adjust to rising water levels offer a resilient and sustainable substitute for conventional building methods (Wang and Tay, 2011).

In order to address issues with land shortages, the effects of climate change, and flooding, sustainable and resilient urban regions need creative and flexible urban developments. Floating structures provide the adaptability and versatility needed to effectively handle these demands and problems (Wang and Tay, 2011). These buildings can reduce the displacement of communities and minimize environmental degradation caused by conventional flood management methods.

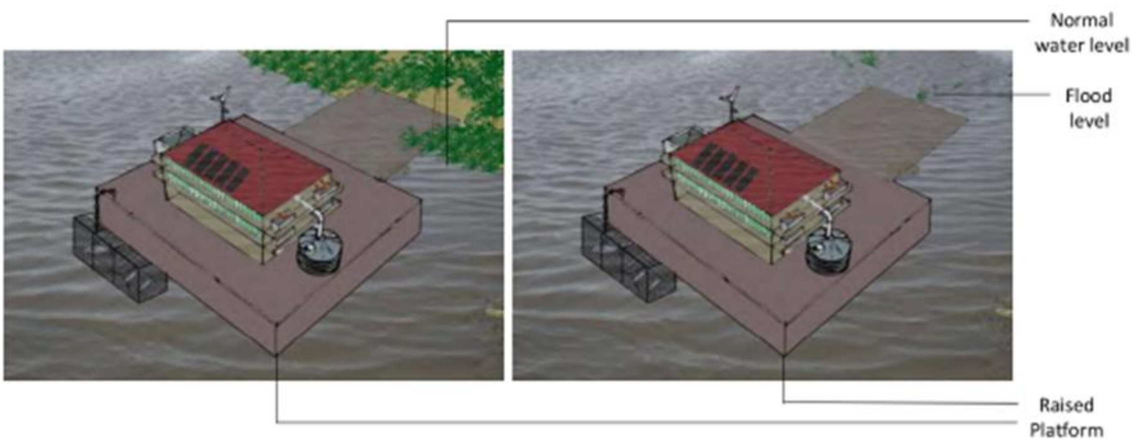

Figure4: The conceptual 3D floating house model before and during flood(Bhattacharjee & Mukherjee, 2017)

In order to address issues with land shortages, the effects of climate change, and flooding, sustainable and resilient urban regions need creative and flexible urban developments. Floating structures provide the adaptability and versatility needed to effectively handle these demands and problems (Wang & Tay, 2011). These buildings can reduce the displacement of communities and minimize environmental degradation caused by conventional flood management methods.

Floating architecture has emerged as a transformative response to the twin pressures of climate change and urban expansion, particularly in flood-prone and coastal regions. Originally inspired by 19th-century maritime living, the concept evolved into a structured discipline with the advent of seasteading and early speculative projects like Kiyonori Kikutake's Marine City, which introduced modular, mobile urbanism as a counter to land scarcity (Januszkiewicz et al., 2024)

Floating architecture has gained global attention as a viable solution for urban expansion, climate adaptation, and sustainable living in response to rising sea levels, land scarcity, and coastal urbanisation (Penning- Rowsell, 2019)

Floating architecture has evolved from niche innovation to mainstream climate adaptation strategy, with successful implementations in the Netherlands, Bangladesh, and parts of Southeast Asia. These structures offer resilience against flooding, land scarcity, and urban expansion pressures.

Examples of Floating Buildings:

Figure 5: Floating Pavilion, Amsterdam, The Netherlands (Blue21.nl, 2024)

The design duo deltasync/PublicDomain Architects created the 12-meter-tall, fully customisable multimedia dwelling and event space known as the Floating Pavilion. It was built by Dura Vermeer and is noteworthy for its climate-proof, inventive, sustainable, and flexible features in addition to the semicircular spheres that float on the water (deltasync, 2010).

Figure 6:Autark Homes, Maastricht, The Netherlands (Chang-ho Moon, 2015**)**

Autark Homes is a self-sufficient, passive floating home. The floating house is two stories tall, with a floor area of 109.4 square meters, an outside wall made of huge EPS that is 55 cm thick, isolated windows and doors, triple glass, and no cold bridges (Chang-ho Moon, 2015).

Benefits of Floating Buildings

The Environmental Implications expected are; Adaptation to Rising Sea Levels: Floating buildings can rise and fall with water levels, making them resilient to flooding and sea-level rise (Neumann et. al, 2015).

Efficient Land Use: By utilizing water surfaces, floating buildings reduce the need for land reclamation and deforestation, preserving natural habitats (Van long et al., 2020).

Sustainable Living: These structures can incorporate renewable energy sources, water purification systems, and waste management solutions, promoting sustainable living (Olthuis, 2010).

Some Cultural and Social Implications are: the integration of floating buildings into communities, especially in regions like Bayelsa State, has significant cultural and social implications:

Community Adaptation: Floating buildings can transform how communities interact with their environment. In flood-prone areas, these structures can provide a sense of security and stability, fostering a culture of resilience and adaptation (Neumann et al., 2015).

Social Cohesion: The communal nature of floating buildings can enhance social cohesion. Shared spaces and resources can promote stronger community bonds and collective responsibility (BBC, 2017).

Cultural Heritage: Floating buildings can be designed to reflect and preserve local cultural heritage. Incorporating traditional architectural styles and materials can help maintain cultural identity while embracing modern solution. (Lawanson et al., 2023).

Economic Opportunities: The construction and maintenance of floating buildings can create new economic opportunities, from job creation to tourism. This can lead to improved livelihoods and economic stability for local communities (Riise & Adeyemi, 2015).

This study conducts an environmental assessment of proposed floating buildings in Bayelsa's floodplains, focusing on key indicators such as soil quality and socio-environmental impacts. The objectives are to elucidate floating buildings and their role as an innovative, adaptive and resilient solution tailored to floodplains in Bayelsa State, to examine environmental challenges inherent in floodplains during flooding in Bayelsa State, to analyze how floating buildings contribute to the enhancement of environmental resilience of the floodplains of some communities in Bayelsa State, and to analyze the socio-economic, soil quality status and effects of proposing Floating Buildings on Floodplains in Bayelsa State

The goal is to evaluate the ecological viability of floating infrastructure and provide evidence-based recommendations for sustainable implementation. By bridging the gap between innovation and environmental stewardship, this research contributes to the broader discourse on climate adaptation Nigeria.

Previous environmental assessments of floodplain developments highlight concerns around water contamination, habitat disruption, and socio-economic displacement. In the Niger Delta context, Bayelsa's floodplains are ecologically rich but under-researched, particularly regarding the integration of floating infrastructure. Existing literature lacks localized data on soil anchorage capacity, hydrological dynamics, and community perceptions gaps this study aims to address.

Location of Study

The study is situated within Bayelsa State, located in the South-South geopolitical zone of Nigeria and centrally positioned in the Niger Delta region (Britannica Encyclopedia, 2021). In Figure 7, Bayelsa spans approximately 10,773 square kilometers (The Guardian News, 2022; Bayelsa: History and Culture, 2021), bordered by Rivers State to the east, Delta State to the north, and the Atlantic Ocean to the south (Olademeji, 2012) as shown in Fig 8. The assessment will focus on flood-prone areas within Yenagoa, Sagbama, and Ogbia Local Government Areas, where vulnerable Communities such as Polaku, Swali, Igeibiri, Aguobiri, Otuogori and Alagbafame (Onuebum), are situated which are frequently impacted by the overflow of the Nun River and Kolo Creek.

Bayelsa's estuarine and riverine environment, shaped by distributaries of the Niger-Benue system, presents unique challenges for infrastructure development (Berezi et al., 2019). The region experiences high annual precipitation averaging 4000 mm, with a humid tropical climate and a bimodal seasonal pattern rainy season from March to October and dry season from November to March (UNEP, 2021). In Figure8, these climatic conditions contribute to frequent flooding and make the area a critical zone for groundwater recharge. The study will account for seasonal variations in hydrology and their implications for floating building performance.

Polaku and Swali Communities in Yenagoa Local Government Area, Otuogori and Onuegbu (Alagbafame) communities in Ogbia Local Government Area, and Aguobiri and Igeibiri communities in Southern-Ijaw Local Government Area all located within the flood-prone areas of Bayelsa State, Nigeria (Figures 9 – 14). The study concluded that a significant portion of Bayelsa State is susceptible to flooding and recommended regular flood assessments and preparedness measures for vulnerable communities. These areas experience seasonal flooding, making them suitable for studying the environmental implications of floating buildings.

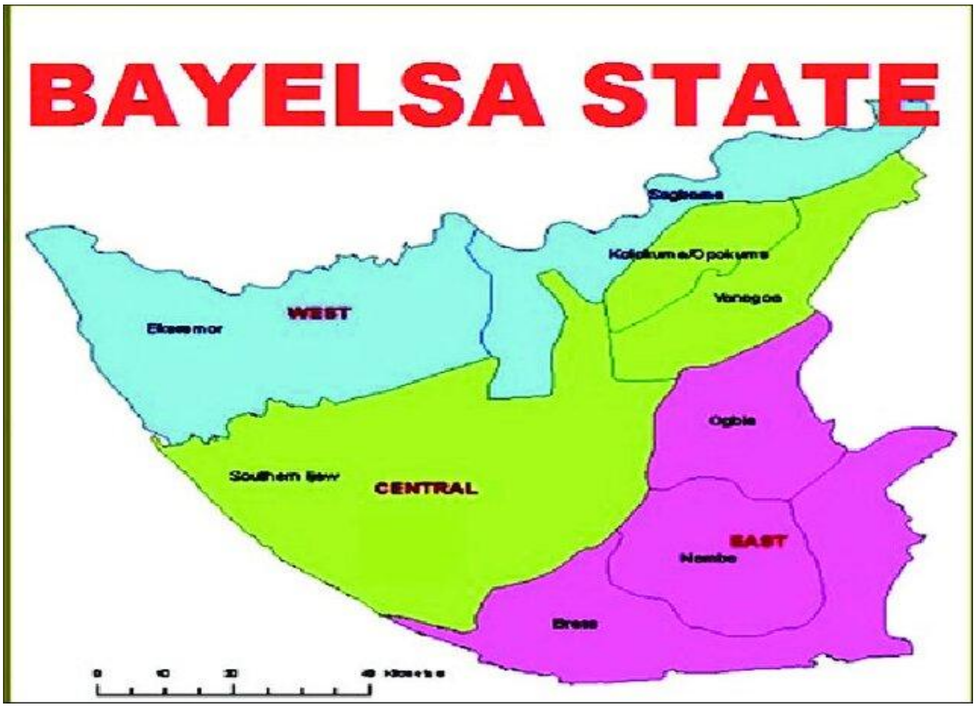

Figure 7: Map of Bayelsa State(GIS Dept, Min of Lands and Survey. Bayelsa State, 2023).

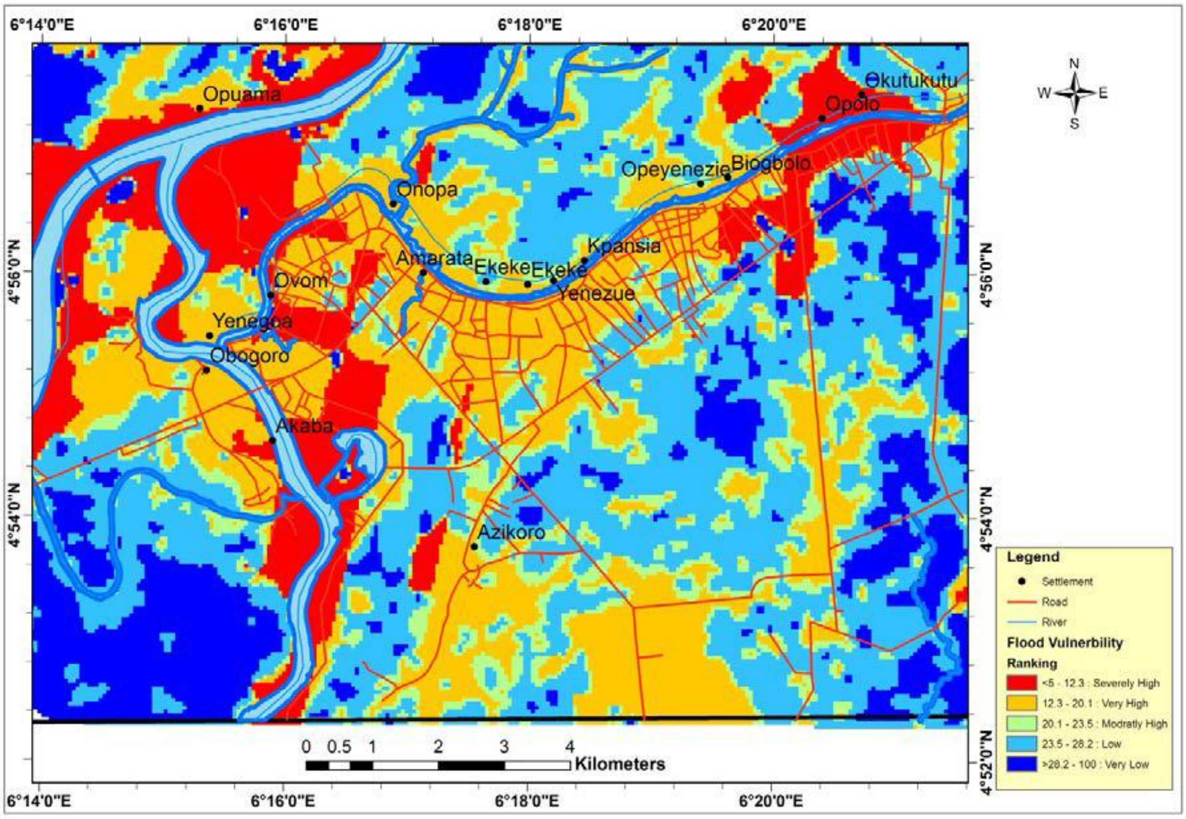

Figure 8: Flood Vulnerability Ranking for Yenagoa and its Environs (Source: GIS Dept, Min of Lands and Survey. Bayelsa State, 2023).

Figure 9: Satellite Imagery of Polaku Community

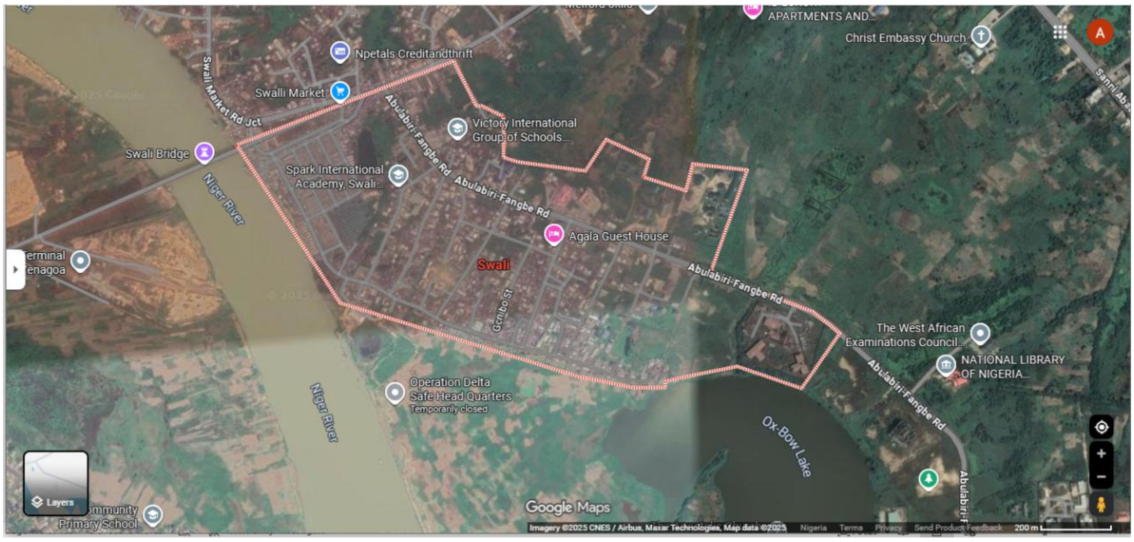

Figure 10: Satellite Imagery of Swali Community

Figure 11: Satellite Imagery of Otuogori Community

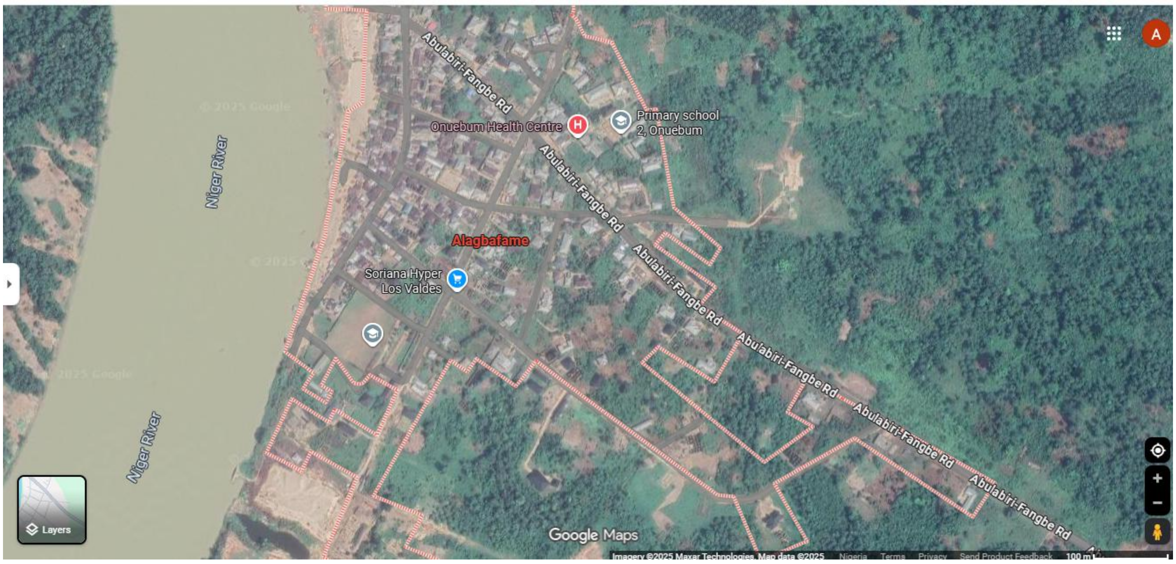

Figure12: Satellite Imagery of Alagbafame (Onuebum) Community

Figure 13: Satellite Imagery of Aguobiri Community

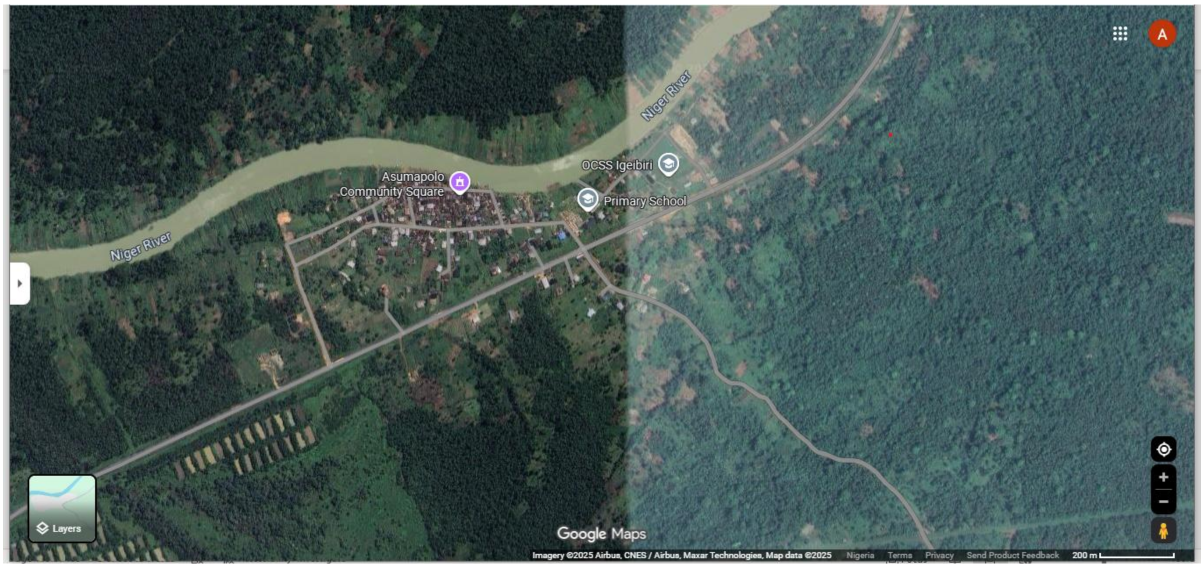

Figure 14: Satellite Imagery of Igeibiri Community

II. MATERIAL AND METHODS

This study employed a multidisciplinary Environmental Assessment pattern to evaluate the potential soil quality effects of floating building development in Bayelsa's floodplains. The methodology integrated field data collection, laboratory analysis, and stakeholder engagement.

Materials

The study will employ the use of materials such as:

- Physical Equipment: Devices like laboratory instruments (sample bottles) , hand held GPS and cameras.
- Data Collection Tools: Questionnaires, surveys, and data collection software for recording responses.
- Samples or Specimens: Materials like soil and water used in testing or observation.
- Technological Resources: Computers, software for statistical analysis and GIS tools.
- Instructional Materials: Guidelines, manuals, or protocols that provide standard procedures.

Methods

Soil Sample: Soil samples were also collected using the grab method, which involves manually scooping surface soil from the top 0–15 cm layer. This depth is ideal for assessing contamination, nutrient levels, and sediment characteristics influenced by flooding.

Procedure: Samples were taken from shoreline areas adjacent to the riverbanks in each community. Sterilized plastic containers were used to store the soil, ensuring no external contaminants altered the sample composition. Each sample was labeled with precise location coordinates, date, and time of collection.
Storage: Soil samples were kept in cool, dry conditions and refrigerated at 4°C to prevent microbial growth and chemical alteration. This temperature control is critical for preserving volatile compounds and ensuring accurate laboratory analysis.

Laboratory Analysis
All collected samples were later transported to certified reference laboratories for comprehensive analysis. Parameters tested included:
Soil: heavy metals (Pb lead, Zn Zinc, Cd Cadmium)
The grab sampling method, combined with sterilized containers and controlled refrigeration, provided a reliable and standardized approach for collecting environmental data across six floodplain communities. This methodology ensures that the samples remain uncontaminated and chemically stable, allowing for accurate assessment of water and soil quality in support of floating building proposals and broader flood resilience planning.

Questionnaire Administration Method and Analysis
To ensure statistically robust and unbiased insights from each floodplain community of roughly 15,000 to 10,000 residents per community, the survey process unfolds in four integrated phases: determining sample size, constructing a sampling frame, selecting respondents through random-selection techniques, and administering the questionnaire in the field.
First, the sample size is calculated to balance precision with feasibility. Starting with a 95 percent confidence level ($z = 1.96$) and a ±5 percent margin of error, Cochran's formula $n_0 = (z^2 \cdot p \cdot (1-p)) / d^2$, assuming maximum variability ($p = 0.5$) yields an initial estimate of 384 respondents. Applying the finite-population correction for N = 15,000 reduces that to about 375. To account for the clustering of households and potential non-response, we multiply by a design effect of 1.3 (to reach ~488) and then inflate by 10 percent to cover expected non-responses, settling on a target of approximately 550 completed interviews per community.
Soil Sampling: Samples were collected from six floodplain sites across Yenagoa, Sagbama, and Ogbia LGAs. Parameters such as Heavy Metals:Pb lead, Zn Zinc, Cd Cadmiumwere analyzed.
Analytical Tools
GIS Mapping: Identified flood-prone zones and overlaid proposed building sites.
Statistical Analysis: ANOVA and regression models detected significant environmental variations.
Limitations
Sampling was restricted to the rainy season, limiting temporal variability.
Terrain and security challenges hindered access to some communities.

III. RESULTS

The results of the heavy metal assessment across six floodplain communities in Bayelsa State reveal critical deviations from international safety standards, highlighting serious environmental and public health risks that must be addressed in the planning and design of floating buildings (Table 1). While copper and zinc concentrations remained within acceptable limits, elevated levels of lead and cadmium in several communities pose significant threats to water safety, material integrity, and resident well-being.

Table 1: Soil Quality Analysis on heavy metals across six Communities

S/N	Community	Copper Cu (mg/l)	Zinc Zn (mg/l)	Lead Pb (mg/l)	Cadmium Cd (mg/l)
1	Polaku	0.125	0.349	0.028	<0.001
2	Swali	0.076	0.28	<0.001	<0.001
3	Otuogori	0.173	0.864	0.077	<0.001
4	Alagbafame(Onuebum)	0.079	0.418	0.122	<0.001
5	Aguobiri	0.054	0.559	<0.001	0.077
6	Igeibiri	0.2	0.524	0.074	0.028

Soil Quality Assessment Results

Lead concentrations exceeded the WHO permissible limit of 0.01 mg/L in Alagbafame (0.122 mg/L), Otuogori (0.077 mg/L), and Igeibiri (0.074 mg/L). These values suggest contamination from industrial runoff, lead-based infrastructure, or improper waste disposal. Lead is highly toxic, particularly to children, and its presence in these communities necessitates urgent intervention through water purification systems and community health screenings. Cadmium levels also breached the safe threshold of 0.003 mg/L in Aguobiri (0.077 mg/L) and Igeibiri (0.028 mg/L), indicating possible agricultural pollution from phosphate fertilizers or

battery waste. Cadmium is a known carcinogen and can cause long-term kidney damage, making its detection a serious concern for both environmental and human health (Table 1).
Copper levels ranged from 0.054 mg/L in Aguobiri to 0.200 mg/L in Igeibiri, all well below the WHO guideline of 2.0 mg/L. Although not immediately hazardous, elevated concentrations in Igeibiri and Otuogori may reflect anthropogenic influences such as corroded plumbing or industrial discharge. Zinc, an essential trace element, was also within safe limits across all communities, with the highest concentration recorded in Otuogori (0.864 mg/L). While not toxic at current levels, periodic monitoring is recommended to ensure long-term safety, especially in areas with rising industrial activity (Table 1).

Socio-Environmental Survey
Community feedback was mixed. While many residents welcomed flood-resilient housing, concerns emerged around cultural compatibility, and waste management. Public health risks, especially waterborne diseases, could rise without adequate sanitation planning. Education, participatory design, and inclusive governance are critical to successful adoption.

In Table 2,preferences strongly favor Traditional/Local floating-building designs over Modern/International ones. This pronounced community bias suggests that resilience innovations should integrate indigenous construction practices and cultural aesthetics to maximize acceptance. Aligning interventions with local knowledge systems will likely improve uptake and sustainability in Bayelsa's floodplain communities
The results in Table 3imply that flood-resilience initiatives in Bayelsa's floodplains should foreground stilted foundation designs and robust anchoring systems to align with community preferences. Incorporating sustainable materials remains valuable but should play a supportive role, while fully buoyant foundations may require additional community education to boost acceptance.

Table 2: Respondents familiarity with Floating Buildings across six Communities

S/N	Community (Respondents)	(Modern/ International Context)	(Traditional/ local Context)
1	**Polaku (380)**	**60**	**320**
2	**Swali (450)**	**90**	**260**
3	**Otuogori (350)**	**75**	**275**
4	**Alagbafame (Onuebum) (390)**	**90**	**300**
5	**Aguobiri (400)**	**50**	**350**
6	**Igiebiri (410)**	**30**	**380**
	Six Communities (2,380)	**395**	**1,985**

Table 3: Respondents' perspectives on features of Floating Buildings

S/N	Community (Respondents)	A	B	C	D	E
1	**Polaku (380)**	**20**	**100**	**-**	**80**	**180**
2	**Swali (450)**	**30**	**120**	**-**	**100**	**200**
3	**Otuogori (350)**	**50**	**100**	**-**	**50**	**150**
4	**Alagbafame(Onuebum) (390)**	**40**	**120**	**-**	**50**	**180**
5	**Aguobiri (400)**	**20**	**130**	**-**	**90**	**180**
6	**Igiebiri (410)**	**10**	**120**	**-**	**100**	**160**
	Six Communities (2,380)					

A Buoyant-foundations that rise with floodwaters
B Anchoring or guide systems (e.g., piles, rails)
C Modular or movable components
D Sustainable materials (plastic drums or recycled pontoons)
E Stilts Foundations that are built above flood waters

Table 4: Respondents' reaction to types of materials for floating building construction

S/N	Community (Respondents)	A	B	C	D	E
1	Polaku (380)	115	190	10	65	-
2	Swali (450)	100	190	65	95	-
3	Otuogori (350)	95	200	15	40	-
4	Alagbafame (Onuebum) (390)	105	220	20	45	-
5	Aguobiri (400)	100	230	10	60	-
6	Igiebiri (410)	120	215	15	60	-
	Six Communities (2,380)	635	1,215	130	365	

A Treated Bamboo (Body) and Bamboo floats (buoyancy)
B Ply Wood and Plank (body) and plastic drums or barrels and planks (buoyancy)
C Pre-fabricated materials or Fibre-reinforced polymers (body) and concrete barges (buoyancy)
D Recycled Plastic (Body) or PVC materials and Plastic drums or barrels (buoyancy)

E Aluminium or Steel (body) and Polyethylene floats or steel pontoons (buoyancy)

These findings in Table 4 imply that flood-resilience interventions in Bayelsa's floodplains should prioritize anchoring/guide systems and buoyant foundations, which communities value most. Sustainable materials can play a supportive role, while purely modular solutions may require targeted education or demonstration to improve acceptance.

In practical terms, Table 5 Shows that planners and designers of flood-resilient infrastructure in Bayelsa should prioritize interventions that maximize flood resilience and bolster livelihoods during flood seasons, as these deliver the greatest perceived community value. While ecosystem preservation and improved water quality remain important, they may need targeted awareness and engagement strategies to elevate their salience. Aligning resource allocation and program design with this hierarchy will ensure that limited funds and efforts address the benefits most vital to local stakeholders

Table 5: Respondents' perspective to Environmental benefits of Floating Buildings

S/N	Community (respondents)	A	B	C	D	E
1	Polaku (380)	150	40	100	80	60
2	Swali (450)	120	30	180	60	60
3	Otuogori (350)	130	20	120	40	40
4	Alagbafame (Onuebum) (390)	150	50	100	50	40
5	Aguobiri (400)	180	40	120	20	40
6	Igiebiri (410)	130	40	130	60	50
	Respondents (2,380)	860	220	750	310	290

A Flood resilience homes to minimize displacements
B Reduced Land degradation
C Improved access to flood-season livelihoods
D Preservation of water quality by improving sanitation
E Preservation Ecosystem

Table 6: Respondents perspective on measures of contribution of floating buildings on floodplains

S/N	Community (Respondents)	A	B	C	D	E
1	Polaku (380)	64	66	98	96	54
2	Swali (450)	80	92	63	127	88
3	Otuogori (350)	40	60	100	110	40
4	Alagbafame (Onuebum) (390)	50	60	100	120	60
5	Aguobiri (400)	62	64	120	100	54
6	Igiebiri (410)	58	70	120	112	50
	Six Communities (2,380)	354	412	601	665	346

A Mitigating soil erosion
B Maintaining clean water quality
C Preserving fish and wetland habitats
D Sustaining farm and market access
E Ecosystem preservation

This analysis compared five environmental-benefit measures in Bayelsa's floodplain communities using one-way ANOVA and post-hoc tests. Flood-season livelihoods (D) and habitat protection (C) emerge as top priorities, while water quality/sanitation, soil erosion control, and broader ecosystem preservation occupy a secondary tier. These insights should guide resilience planning toward interventions that strengthen market access and wetland conservation, while deploying targeted outreach to elevate the perceived value of water and erosion management (Table 6)

Table 7: Respondents' perspective to Floating Building Concept as a Resilient Innovation

N0	Community (Respondents)	A	B	C	D	E
1	**Polaku (380)**	**-**	**-**	**110**	**270**	**-**
2	**Swali (450)**	**-**	**-**	**150**	**300**	**-**
3	**Otuogori (350)**	**-**	**-**	**120**	**230**	**-**
4	**Alagbafame (Onuebum) (390)**	**-**	**-**	**180**	**210**	**-**
5	**Aguobiri (400)**	**-**	**-**	**120**	**280**	**-**
6	**Igeibiri (410)**	**-**	**-**	**140**	**270**	**-**
	Six Communities (2,380)	**-**	**-**	**820**	**1,570**	**-**

A Strongly disagree
B Disagree
C Neutral

D Agree
E Strongly agree

The findings in Table 7 demonstrate robust community backing for floating-building initiatives. Planners and policymakers should leverage this clear mandate by prioritizing funding, pilot programs, and stakeholder engagement around floating-infrastructure solutions, confident that local sentiment aligns with such resilience investments.

IV. DISCUSSION AND CONCLUSION

Soil Quality Analysis (Table 1)

The presence of toxic heavy metals particularly lead and cadmium reinforces the need for adaptive design strategies in floating building proposals. These contaminants not only compromise water quality but also threaten the health of residents and the durability of construction materials. Floating structures must incorporate advanced filtration systems, corrosion-resistant components, and elevated platforms to mitigate exposure and ensure safe habitation (Chang-ho Moon, 2012).

The heavy metal analysis underscores the importance of integrating environmental safety into the design and deployment of floating buildings in Bayelsa's floodplains. By prioritizing health safeguards and pollution control, planners can ensure that floating infrastructure serves as a resilient and sustainable solution for vulnerable communities.

Cultural Preferences in Floating Building Design (Table 2)

Respondents overwhelmingly favored traditional floating designs, such as stilt houses and canoe-inspired forms, over modern international prototypes. This strong cultural bias suggests that successful implementation of floating buildings must integrate indigenous construction practices, local materials, and familiar aesthetics (Hendarti, 2022). Community ownership and long-term sustainability are more likely when designs resonate with cultural identity.

Preferred Features and Materials (Table 3 and Table 4)

Stilted foundations and robust anchoring systems emerged as the most valued structural features. While sustainable materials were appreciated, they were seen as secondary to stability and durability. Fully buoyant foundations and modular systems may require targeted education and demonstration projects to improve community understanding and acceptance.

The analysis of respondents' feedback on material preferences for floating building construction in Bayelsa's floodplain communities reveals a clear prioritization of anchoring systems and buoyant foundations. These structural components are perceived as critical to ensuring safety, stability, and adaptability during flood events, reflecting the community's practical concerns about resilience and reliability. While sustainable materials such as bamboo, raffia, and recycled composites are acknowledged for their environmental benefits, they are viewed as complementary rather than central to the design (Tri and Ikaputra, 2020). Their acceptance hinges on their ability to support the core structural functions without compromising durability. In contrast, purely modular construction systems received more cautious responses. This suggests that unfamiliarity with modular technologies may limit community confidence. To improve uptake, planners and designers should consider targeted education campaigns, hands-on demonstrations, and pilot projects that showcase the performance and benefits of modular solutions in real floodplain conditions.

Environmental Benefits and Perceived Value (Table 5)

Flood resilience and livelihood protection were identified as the most important environmental benefits of floating buildings. Ecosystem preservation and water quality improvements, though acknowledged, were not top priorities. This suggests that planners should initially focus on interventions that deliver immediate, tangible benefits, while gradually building awareness around broader ecological gains.

Contribution to Environmental Resilience (Table 6)

Flood-season livelihoods and habitat protection ranked highest among environmental benefit measures (Habibi, 2015). Water quality, erosion control, and ecosystem preservation formed a secondary tier. These findings should guide resource allocation toward market access, wetland conservation, and targeted outreach to elevate the perceived importance of water and soil management.

Community Support for Floating Infrastructure (Table 7)

There is strong community support for floating buildings as a resilience innovation. This endorsement provides a clear mandate for planners and policymakers to prioritize funding, pilot programs, and stakeholder engagement around floating infrastructure solutions.

Conclusions

This study has provided a comprehensive environmental assessment for floating building development across six floodplain communities in Bayelsa State, revealing a complex intersection of social, cultural, and ecological factors that must guide the development of climate-resilient infrastructure. The findings underscore the urgent need for adaptive housing solutions that respond not only to environmental vulnerabilities but also to the lived realities and preferences of local populations.

Floating buildings offer a viable solution to recurrent flooding in Bayelsa's floodplains, but their success relies on more than technical innovation. Cultural preferences strongly shaped community acceptance, with traditional designs like stilt houses and canoe-inspired structures favored over modern prototypes (Hendarti , 2023). This underscores the need to integrate vernacular techniques and local materials to enhance social acceptance and sustainability. Safety was prioritized through stilted foundations and robust anchoring, while sustainable materials were viewed as secondary to structural integrity. Modular and buoyant systems drew cautious interest, indicating the need for education and pilot projects to build trust.

Environmentally, floating buildings mitigatesoil contamination, enhance public health, and support socio-economic resilience. The presence of toxic heavy metals like lead and cadmium in floodplain communities highlights the urgency of elevated, non-grounded housing systems (Nkwunonwo, 2016).To ensure inclusive adoption, financial accessibility, clear regulations, and community engagement are essential. Addressing affordability, improving policy awareness, and tailoring outreach to local contexts can foster long-term impact. This study identifies key environmental concerns soil degradation, and habitat disruptionwhile highlighting opportunities for ecological enhancement and socio-economic upliftment. Future efforts should focus on long-term monitoring, pilot implementation, and cross-sector collaboration to establish floating buildings as a resilient infrastructure model for flood-prone regions.

Recommendations

Community-Centered Design and Cultural Integration

- Prioritize traditional design elements such as stilted foundations, canoe-inspired hulls, and locally woven materials to enhance cultural resonance and community acceptance.
- Incorporate vernacular construction techniques and symbolic motifs to foster ownership and long-term sustainability.
- Address skepticism toward modular and buoyant systems through education campaigns, pilot demonstrations, and hands-on workshops to build familiarity and trust.

Functional and Adaptive Infrastructure

- Focus initial interventions on tangible benefits such as flood adaptability, property protection, and livelihood continuity, while gradually introducing broader ecological advantages.
- Design floating buildings to accommodate essential services including safe drinking water and agricultural support, which communities ranked above secondary infrastructure.
- Embed features such as elevated decks, slatted walls, and amphibious adaptability to improve moisture control, ventilation, and indoor health.

Soil Quality Management

- Elevate floating structures above contaminated water sources and incorporate advanced filtration systems to mitigate exposure to toxic heavy metals such as lead and cadmium.
- Promote public health awareness campaigns to educate residents on the risks of heavy metal exposure.

Strategic Positioning for Climate Adaptation

- Recognize floating buildings as proactive tools for climate resilience, capable of reframing flood risk as an opportunity for innovation.
- Align infrastructure development with broader goals of socio-economic stability and environmental stewardship to empower vulnerable floodplain communities.

REFERENCES

[1]. Ajumobi, V. E., et al (2023). Impacts of the 2022 flooding on the residents of Yenagoa, Bayelsa State, Nigeria. *Global Journal of Environmental Management and Public Safety (GJEMPS)*, 11(1), 1–6.

[2]. BBC. (2017). The Future of Floating Cities – and the Realities. Retrieved from BBC

[3]. Berezi O. K., et al (2019). Flood Vulnerability Assessment of Communities in the Flood Prone Areas of Bayelsa State, Nigeria. International Journal of Geology and Earth Science. ISSN 2395-647X www.ijges.com Vol. 5.

[4]. Chang-ho Moon (2014) Applications of Sustainable Factors in Floating Architecture ISBN: 978-84-697-1815-5 Kunsan National University, Kunsan, Korea.

[5]. Echendu, A. J. (2020). The impact of flooding on Nigeria's Sustainable Development Goals (SDGs). *Ecosystem Health and Sustainability, 6*, Article 1791735.

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

[7]. Habibi S. (2015) Floating Building Opportunities for Future Sustainable Development and Energy Efficiency Gains. J Archit Eng Tech 4: 142. doi:10.4172/2168-9717.1000142

[8]. GIS Department, Ministry of Lands and Survey, Bayelsa State. (2023). *Flood vulnerability ranking for Yenagoa and its environs* [Map]. Bayelsa State Government.

[9]. GIS Department, Ministry of Lands and Survey, Bayelsa State. (2023). *Map of Bayelsa State* [Map]. Bayelsa State Government.

[10]. Kiedrzyńska, E., et al (2015). Sustainable floodplain management for flood prevention and water quality improvement. *Natural Hazards, 76*(2), 955–977.

[11]. Komolafe, A. A. et al. (2015). A review of flood risk analysis in Nigeria. *Journal of Geography and Regional Planning, 8*(8), 193–204.

[12]. Lawanson, O. I. et al. (2023). The impact of flooding on poor communities in Lagos State, Nigeria: The case of the Makoko urban settlement. *Journal of Flood Risk Management, 16*(1), e12838. https://doi.org/10.1111/jfr3.12838

[13]. Neumann, B. et. al (2015). Future coastal population growth and exposure to sea-level rise and coastal flooding a global assessment. *PLOS ONE, 10*(3), e0118571.

[14]. 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.

[15]. Olthuis, K. and Keuning, D. (2010) Float! : Building on Water to Combat Urban Congestion and Climate Change. 2010, Amsterdam: Frame

[16]. Penning-Rowsell, E. C.,et. al (2013). Socioeconomic scenarios and flood damage assessment methodologies for the Taihu Basin, China. *Journal of Flood Risk Management, 6*(1), 23–32.

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

[18]. Research and Flood Control Department, Ministry of Environment, Bayelsa State. (2022). *Aerial and ground photographs of flood-affected communities in Bayelsa State* [Photographs]. Bayelsa State Government.

[19]. Riise, J., and Adeyemi, K. (2015). Case study: Makoko Floating School. *Current Opinion in Environmental Sustainability, 13*, 58–60

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

[21]. Tri Endangsih and Ikaputra (2020) Floating Houses Technology as Alternative Living on The Water. IOP Conf. Ser.: Mater. Sci. Eng. 797 01 2020

[22]. Umar, N., and 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.

[23]. Van Long, et al. (2020). Flood-resilient urban design based on the indigenous landscape in the city of Can Tho, Vietnam. *Urban Ecosystems, 23*(3), 675–687. https://doi.org/10.1007/s11252-020-00942-3

[24]. Wang, C. M., and Tay, Z. Y. (2011). Very large floating structures: Applications, research and development. *Procedia Engineering, 14*, 62–72. https://doi.org/10.1016/j.proeng.2011.07.007

[25]. Wizor, C. H. and Week, D. A .(2014), "Impact of the 2012 Nigeria Flood on Emergent Cities of Nigeria: The Case of Yenagoa, Bayelsa State, Nigeria", Journal of Civil and Environmental Research, 6(5), 31-34.