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Flood Disaster: Imperative of Planning and Mapping in Post-Disaster Adaptation and Mitigation in Rivers State, Nigeria

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Abstract: Flooding in Rivers State has significantly impacted over 22,000 residents, with approximately 9,600 people forced to flee their homes. Rivers State was identified by the National Emergency Management Agency (NEMA) as one of the most flood-hit states in Nigeria, with serious impacts in the year 2012 and 2022 amongst other years. These impacts also cuts across 8 Local Government Areas (LGAs) in Rivers State such as Ahoada West, Ahoada East, Khana, Ogba-Tai and Egbema-Ndoni, amongst others and displacing 71,700 people in Nigeria, and forcing residence to seek refuge with relatives in nearby Communities. This study highlights the importance and planning, surveying and mapping in post-disaster adaptation and mitigation of flood incidences in Nigeria. Mitigation approaches were highlighted using scientific techniques such as planning and mapping of flooded area prior to reconstruction and mapping of areas for relocation of flood victims to forestall imminent impacts and consequences of flood disaster in Rivers State of Nigeria.

Keywords: *Flood Disaster, Planning, Mapping, Flood Mitigation, Reconstruction.*

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I. BACKGROUND OF THE STUDY

The United Nations Defines Disaster as a serious disruption of the functioning of a community or society, which involve widespread human, material, economic or environmental impacts that exceed the ability of the affected community or society to cope using its own resources.

According to the International Federation of Red Cross, a disaster occurs when a hazard impacts on vulnerable people and the inability to reduce the potential negative consequences of risk results in disaster. Most disaster are often caused by nature and human origins.

Disaster management is how we deal with the human, material, economic or environmental impacts of said disaster, it is the process of how we "prepare for, respond to and learn from the effects of major failures (Bisong, Willabo and Wike, 2024).

The United Nations Office for Disaster Risk Reduction characterizes Natural Disasters in relation to their magnitude or intensity, speed of onset, duration and area of extent.

- Natural Disasters consists of the Following:

✓ Geophysical (Earthquakes, Landslides, Tsunamis and Volcanic Activity)
✓ Hydrological (Avalanches and Floods)
✓ Climatological (Extreme Temperatures, Drought and Wildfires)
✓ Meteorological (Cyclones and Storms/Wave Surges)
✓ Biological (Disease Epidemics and Insect/Animal Plagues)

International Federation of Red Cross & Red Crescent Societies views Man-Made Disaster as events that are caused by humans which occur in or close to human settlements often caused as a results of Environmental or Technological Emergencies (Kesyton and Stephe, 2025).

- This May include:

✓ Environmental Degradation
✓ Pollution (Air, Noise
✓ Accidents (Industrial, Technological and Transport usually involving the production, use or transport of hazardous materials)

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➢ *Phases of Disaster Management*

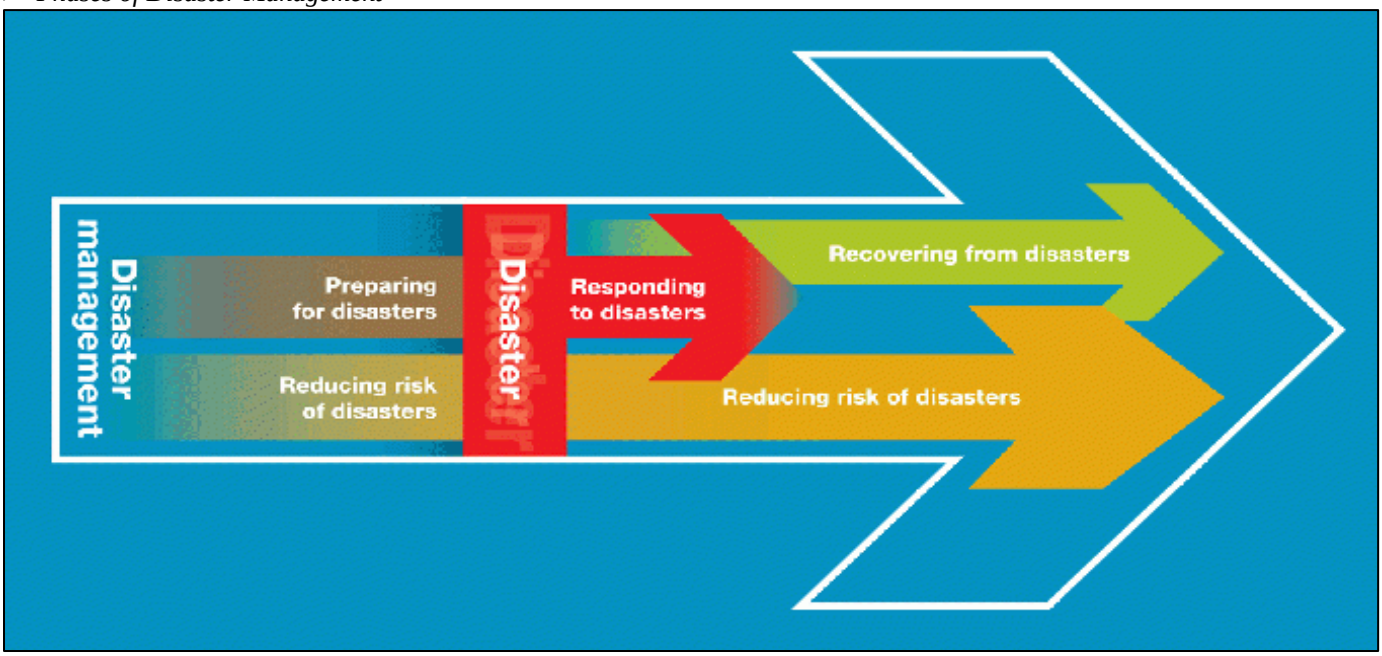

Fig 1 Phases of Disaster Management (International Federation of Red Cross & Red Crescent Societies)

➢ *Overview of Flood Disaster in Nigeria*

Flood occurs when an overflow of water submerges land that is usually dried, and is one of the most frequent forms of natural disaster (Bisong et al, 2024).

Official statistical chart from the Ministry of Humanitarian Affairs, the flood data obtained as at 24th October, 2022, revfealed that the death toll in Jigawa stood at 91, while it was 77 in Anambra. In Kogi 471,991 persons were affected, with no death record. The data also disclosed that 3,219,780 Nigerians were affected nationwide, while number of displaced persons stood at 1,427,370, with total number of recorded dead put at 612.

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Fig 2 Flood Disaster in Parts of Ogbaru, Akwa North Local Government Area, Anambra State (Kesyton and Stephen, 2025).

Fig 3 Parts of Lokoja, Kogi State (Kesyton and Stephe, 2025).

Nigeria has got her own share of flood disasters, which is evident in the recent widespread devastating flood disaster that hit the country cutting across major cities in about 31 states in the country from June to September 2012. The worst affected states are those that are at the borders of the Niger-Benue River and those around the Niger Delta area, they are, Adamawa, Taraba, Benue, Niger, Kogi, Anambra, Bayelsa, Delta, Edo, Rivers, Cross River and Akwa Ibom. This flood incident has been characterized as the most devastating since the last 40 years. The flood submerged houses, severed transportation routes throughout the affected areas (Najibi and Devineni, 2018).

- *Key Impacts of Flooding in Rivers State.*

Notable Humanitarian Crisis was witnessed in Rivers State in the Year 2012, 2022 and 2025 respectively, as a result of flood disaster, with roughly 171,700 people affected especially in specific LGAs such Ahoada West, Ahoada East, Khana, Ogba-Tai and Egbema-Ndoni, as residents were forced to seek refuge with relatives in nearby communities.

There were also cases of Economic and Agricultural Loss as Extensive damage was recorded on over 23,281 farmlands nationwide, with Rivers being a primary area of concern. In communities like Ahoada West, the rising Orashi River forced farmers to harvest crops prematurely to avoid total loss.

Infrastructure & Property Damage were also recorded with Floods resulting to the collapse and partial destruction of residential buildings, school workshops, and administrative offices. Significant waterlogging was reported in urban centers like Port Harcourt and Bonny Island, affecting roads and businesses. Plate 3 and 4 shows huge impacts of flood in Okogbe Communities, with a reconstructed building impacted the second time as a result of improper planning and mapping prior to construction.

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Fig 4 Flooded Area in Okogbe Community in Ahoada West LGA, Rivers Sate

Fig 5 Re-Constructed Building Impacted by Flood at Okogbe Community, Ahoada East LGA, Rivers State (Bisong, Willabo. and Wike, 2024).

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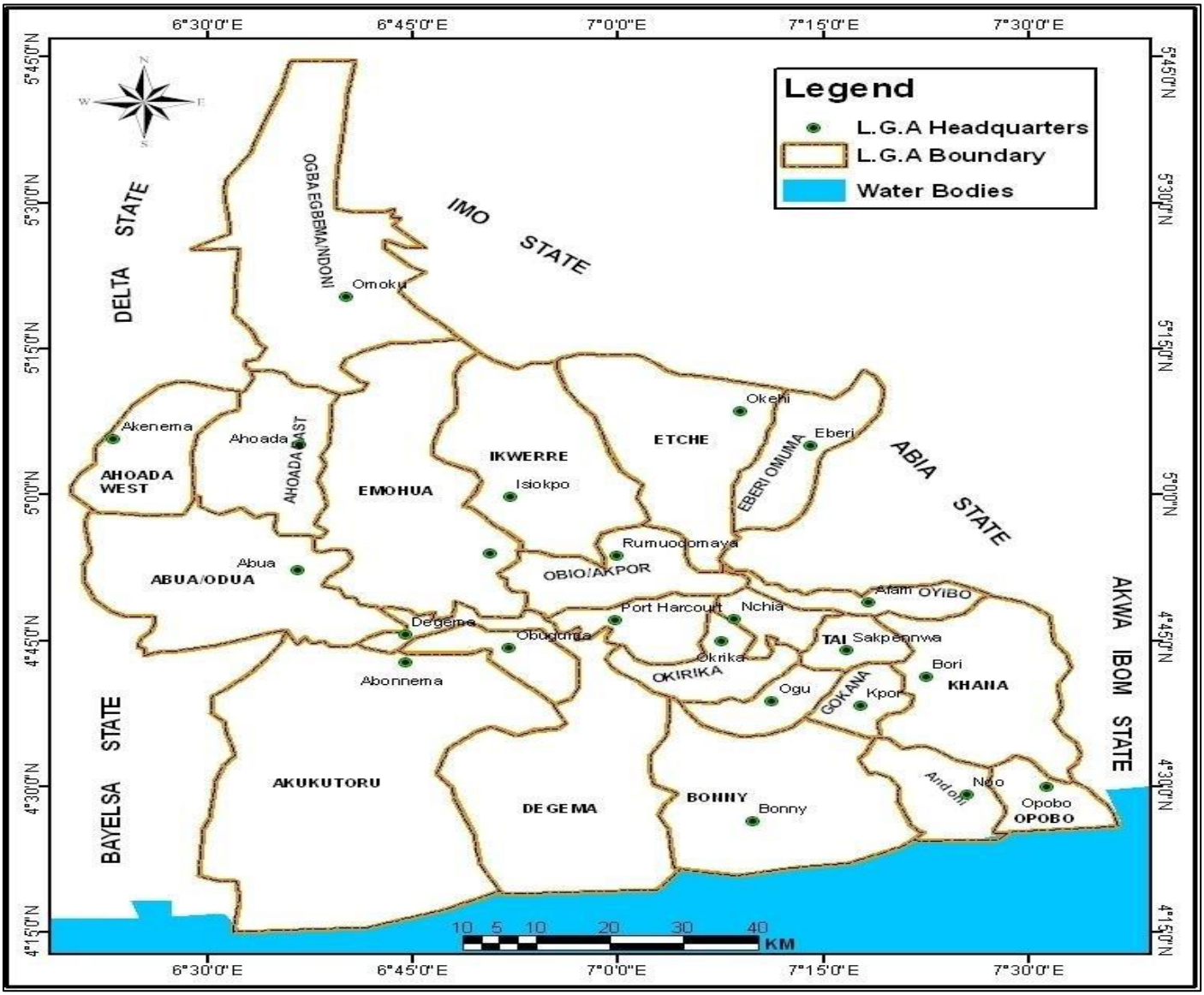

Fig 6 Map of Rivers State of Nigeria (Ndubueze-Ogaraku, et al, 2017).

Rivers State is presently one of the States in the South-South Geo-political zone and Niger Delta Region. The State was created in 1967 when it split from the then Eastern Region. The State Capital, Port Harcourt is known for its metropolitan and cosmopolitan nature and the commercial center of the Nigerian Oil Industry (Owei and Obinna, 2011).

Rivers State of Nigeria lies approximately between geographical coordinates of longitude 6^0 55' 0" and latitude 4^0 35' 0" to longitude 7^0 55' 0" and latitude 5^0 10' 0" and bounded to the North by Abia, Imo, Delta and Anambara States, East by Akwa-Ibom State, West by Bayelsa State and South by the Gulf of Guinea respectively as shown in figure 2.

Findings from 2006 National Population Census, conducted by the National Population Commission of Nigeria revealed that Rivers State has a population and population density of 5,198,716; 469 respectively. It has a lowland area and fairly flat terrain with an average elevation below 30m above sea level. Significant changes in the land use/ land cover in the area include changes in water bodies, built-up areas, and depletion of the mangrove vegetation along rivers and creeks shorelines, vegetation, and wetlands (Eze and Lawson, 2023). The State is rich with land and natural resources, such as land, soil, vegetation, water, coal, petroleum, gas, animals, wildlife, air, wind and atmosphere, clay, sand, gravel. The land mass is about 11.077km^2 and approachable through land, water and air and the area belongs to the south-south regions of Nigeria (Onugha, 2019).

Rivers State has is well known for its capital city called Port Harcourt City, the city has continued to witness rapid development and industrialization with patches of villages now municipals especially in Port Harcourt City and Obio / Akpor Local Government Areas. These may have led to the present-day Port Harcourt City and Obio/Akpor Local Government Areas now called Port Harcourt Urban and all land in the Local Government Areas declared as urban land (Kingsley et al, 2011; Owei and Obinna, 2011).

II. POST-DISASTER ADAPTATION AND MITIGATION STRATEGY

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Post-disaster adaptation and mitigation means taking action towards adjustments and changes made in the ecological, social and economic systems after a disaster to improve resilience and reduce future vulnerability to similar disaster.

Vulnerability of communities may persist for some time after a disaster incidence. Disaster recovery goes beyond provision of immediate relief to assist those who have suffered the full impact of a disaster, but required programs such as planning, surveying, mapping and reconstruction to enhanced recovery and mitigation.

➢ *Post-Disaster Adaptation and Mitigation Programs*

National Institute of Health (NIH) recommended the following programs:

- Heath Care and Rehabilitation
- Rebuilding damaged infrastructure (Homes, Schools, Hospitals and Roads)
- Development activities (building human resources for health and psychology
- Development policies and practices to forestall or mitigate the occurrences of similar incidence of disaster in the future.
- Sustainability Programs

➢ *Planning Processes Prior to Reconstruction of Flood impacted Areas*

- Feasibility Study and Site Selections
- Layout / Subdivision Surveys
- Statutory / Customary Property Rights
- Construction cost and estimation
- Conceptual Building Plan Design
- Schematic Design
- Storm Drainage Design
- Final Design
- Plan Submission and Permitting
- Construction and Reconstruction
- Canalization and Channelization
- Setting out of Plan Data
- Monitoring of Structure Displacement
- Post Construction Services (Baseline data for structure deformation and monitoring

➢ *Site Analysis*

The purpose of site analysis is to provide the designer with a full understanding of the potential or allowable use of a landed property. The processes includes a review of current planning and regulatory controls is performed. Comprehensive plan, Zoning ordinance, Subdivision regulations and previous land development proposals affiliated with site are taking into considerations.

➢ *Feasibility Study, Environmental Policies and Regulations.*

Federal and State laws on environment as it concerns Fish and wildlife, coastal zones management, endangered species, safe drinking water, noise pollution and controls and marine protection laws. Contextual and physical assessment of sites should be adhered to.

Other considerations during planning and site reconnaissance surveys for reconstruction are Environmental site feasibility and assessments, preliminary wetland assessments, threatened and endangered species habitat, cultural resources assessments, regulatory database review, contamination investigation, natural hazard and risk assessment.

➢ *Site Suitability and Assessment*

The following site (environmental) characteristics must be considered during site suitability and assessment prior to the commencement of reconstruction activities. These includes: topography, slope and soil, property geometry / configuration, existing vegetation, hydrology, drainage, flood plain, visual characteristics, climate, site orientation and exposure, utility location and existing easements, adjacent land use, access to site, comprehensive land development plan and zoning restrictions.

➢ *Design Elements and Philosophy*

The purpose of reconstruction is to ensure that the environment is not flood the second time. Design must be in accordance to published guidelines within the jurisdiction on standard of land development design depending on land use approved for the site. Attribute data, dimensional data, geological data, Environmental Impacts Assessment (EIA), underground utility data and historical are very essential in design processes.

➢ *Subdivision Ordinances and Building Codes*

The components of subdivision ordinances and building codes are requires for comprehensive planning prior to construction. these includes street design, including right-of-way, side work and trail design, street and traffic control signage, parking standards and geometrics, storm water management system, water distribution systems, including trunk lines, mains and lateral, sewage collection, including trunk lines, mains lateral / pumping stations, on-site and small off-site sewage treatment design, utility systems and easement, erosion and sediment control design, sanitary lanes, lot and open space grading requirements, installation of survey monuments and markers, protection of environmental and historic features, land scape and buffer requirements and pavement design, geometric design and intersection design.

III. IMPERATIVE OF SURVEYING AND MAPPING IN POST-DISASTER ADAPTATION AND MITIGATION

Surveying and Mapping are traditionally concerned with the science and art of obtaining information about the

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relative position of points and spatial objects on, above, or below the surface of the earth or the sea; representing them in a usable format, charts, and maps This art of mapping is done by the Geomatics Specialist (the Surveyor) who is concerned in knowing what (Object/s) is where (space) and when (time) using a field-based or an object-based concept of reality or real world" (Eze and Pepple, 2022).

Fig 7 and 8 Unistrong GPS Position and Drone Mapping Scene (Pepple et al, 2024).

Some of the emerging digital mapping instrumentations and systems used for the geospatial data acquisition as shown in plate 5 and 6, includes but are not limited to the following; Global Navigation Satellite Systems, Geospatial Information System. Unmanned Aerial Vehicle (Drone Technology), Total / Smart Stations, Robotics Equipment, Inertial Surveying System, Digital Levels, Laser-Based Surveying Instruments, Light Detection and Ranging (LiDAR) and high-resolution satellite imageries.

➢ *Control Surveys for Reconstruction Activities*

The following stages are very fundamental during control surveys for reconstruction activities. These involves the Identify the history of existing controls on site, control extension, establishment or re-establishment. Control surveys technique such as conventional Global Navigation Satellite Systems (GNSS), Continuously Operating Reference Systems (CORS), and Aerial Mapping Controls (AMC). Others are control densification project, control survey specification and accuracy standards, coordinate systems / transformation parameters, National datum adjustment lineage: critical knowledge for today's Surveyors and Error analysis and probability theories (Sidney and Lisa, 2016).

➢ *Boundary Surveys for Reconstruction of Structures impacted by Flood*

Boundary surveys is carried out to determine the size and shape of space for adequate planning, design, reconstruction and management of structure impacted as a result of flood disaster. The following activities are required for boundary surveys;

- Planning for property surveying: office reconnaissance
- Secondary data sources: Base Maps, Layout, land records
- Field reconnaissance: control search, station selections, site status, take photographs of site status, check for adjoining properties, recce diagrams, attribute information
- Application of information to the boundary survey
- Preparing for field works: pre-analysis (order of survey)
- Monumentation and numeration (state base specifications must be adhered to)
- Field work: traverse survey, locating features and improvements, easements, grave sites, evidence of possession
- Office work: field data reductions, computations and adjustments
- Plan productions in a suitable scale and paper size

➢ *Topographic Survey for Flood Impacted Areas*

Topographic survey of flood impacted areas is essential to understand the terrain characteristics and configurations which are critical in the planning, design and construction and reconstruction activities. Planning for topographic surveys includes consideration of site physical features, required scale and accuracy, appropriate contour intervals for intended project, instrument selections and costing.

Field methods for topographic mapping includes traversing, trilateration, triangulation, Global Positioning System (GPS), and photogrammetry. Advantages and disadvantages of each method are put into consideration depending on the nature of the field.

further activities of topographic surveys includes, control identification / extension / establishment for taking off of field data acquisition, field data processing, data reductions, computations, adjustments and editing and topographic plan production with a suitable scale.

➢ *Aerial Surveys of Flooded Areas and Environs*

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Aerial mapping using unmanned aerial vehicle such as drone or aircraft is imperative to determine the characteristics of features on mapped area.

High resolution imageries can also deployed to extract terrain characteristics of mapped areas. As shown in Figure 3, Production of a Digital Terrain Model (DTM) that represents the bare earth, a Digital Surface Model (DSM) that captures the surface including objects like trees and buildings and a Canopy Height Model (CHM) which is derived by subtracting the DTM from the DSM, representing the height of objects above the ground is also fundamental in planning for reconstruction damaged structures after flood incidence (Perko et al, 2011).

Figure 10 shows a Digital Elevation Model (DEM), an essential product of ground-based or space-based mapping. The DEM depicts terrain configuration which are essential in the planning, design and construction of engineering projects.

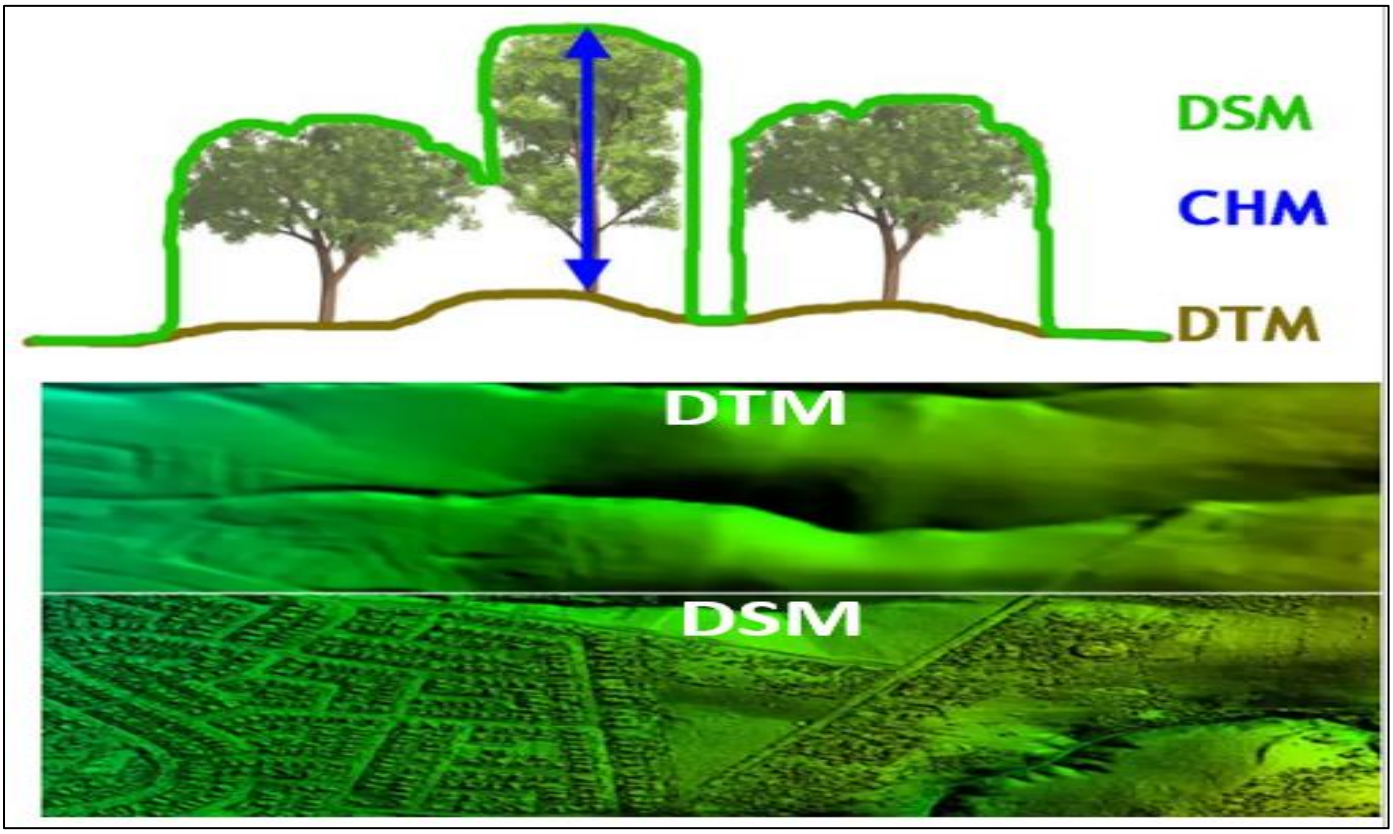

Fig 9 The Nexus between DSM, DTM and CHM (Zhang and Montgomery, 1994).

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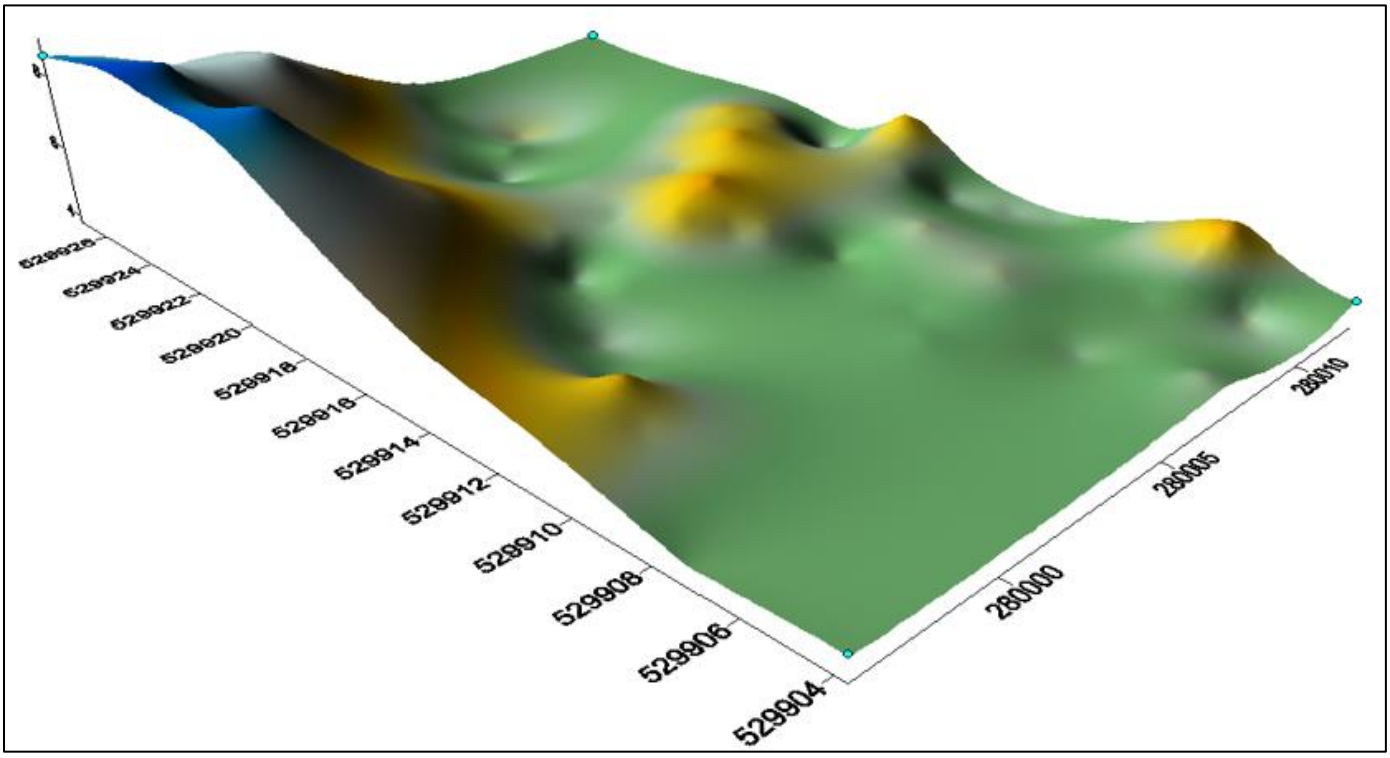

Fig 10 Digital Elevation Model (Hart and Eze, 2024).

IV. CONCLUSION

Several countries across the globe are faced with Natural and Man-made Disaster such as flooding, building collapse, structure deformation, land subsidence and erosion, among others, the case is not different from Nigeria. These environmental threats can only be mitigated and eradicated by incorporating the services of the Urban and Regional Planners, Surveyors (Geomaticians) amongst others, so that necessary activities such as planning, surveying and mapping are provided for post-disaster adaptation and mitigation.

RECOMMENDATIONS

Planning, surveying and mapping are the bedrock of every meaningful and sustainable development. The paper therefore recommends the following;

- Development of a spatial framework that will highlights geospatial solutions to post-disaster adaptation and mitigation in Rivers State and Nigeria at large
- Built environment professionals such as the Surveyors (Geomaticians), Planners, Civil Enginneers and Environmentalist should constitute parts of the National Disaster Committee to provide expert knowledge and mitigation measures.
- Preventive measures such as canalization and channelization and continuous mapping of flood prone areas are imperative to forestall imminent flood disaster and its consequences.

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