

**Determination of flood hazard Zones Using Geographical Information Systems and Remote Sensing techniques: A case Study in part Yenagoa Metropolis**

**Abstract**

*Flood has been a serious hazard for the past decades in Nigeria at large. The incidence of 2012 and 2018 flood disaster in Yenagoa, Amassoma and other parts of the state have not been recovered till date and the government is not concerned about the well-being of the people. The major causes of the flood are attributed to increased rainfall and lack of drainages including dredging of rivers and disobeying of environmental law and infrastructure failure. Coastal Towns or communities are one of the most affected areas of flood and their farms and fishing implements were washed away by the floodwater in 2012 and 2018 in Bayelsa State. Flood management is needed for provision of time information so quick response can be done as soon as possible. Using SRTM data to produce digital elevation model and IDW Contour, the 3D model from ground data of Yenagoa metropolis using ArcGIS 10.4 to generate and analyze them. As a result of field survey, flood level calculation was made to classify flood hazard zones for migration, Agricultural Educational, and construction purpose such as land suitability. This was used in ascertaining the extent of the flooded area. The result reveals that an area of over 5.9888882km<sup>2</sup> and riverine and coastal area is flooded, affecting more than 15 coastal and riverine communities. The finding also concludes that remote sensing data like SRTM data and Geospatial techniques seem effective in mapping and identifying areas prone to flooding. Therefore Remote sensing and Geospatial database should be established for proper flood mapping and the government should constantly dredge the area from time to time.*

**Keyword:** Flood Hazard Zone, SRTM, Disaster, IDW, Remote Sensing, GIS

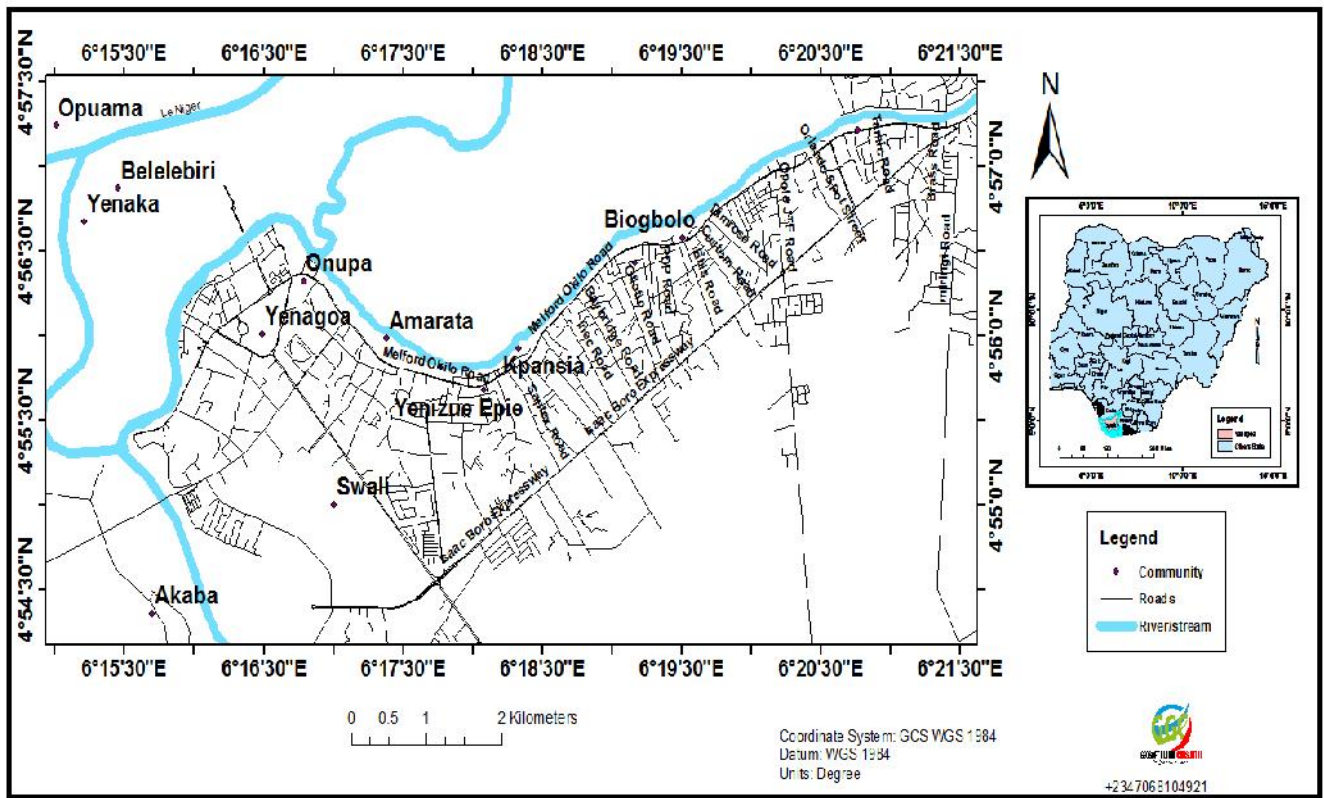
**Introduction**

Floods are a major problem affecting many States in Nigeria and other countries in the world such as Nigeria, Italy, Ghana, etc causing great loss of human life and economic loss. The impact of flooding has increased greatly because of the number of factors such as increased developmental activity on the floodplains and rising

31 sea level In most cities of the world, the problems of floods are rapidly growing considering the enormity of this  
32 problem, the United Nations Environmental Program(UNEP) in 1991 pointed out that many countries  
33 considered uncontrolled stormwater to be their greatest problems as far as the preservation or urban  
34 infrastructure is concerned. Such as Bangkok, Calcutta, Dares Salam, Jakarta, Guayanguil, Manila, Lagos,  
35 many neighborhoods are flooded at least once a year, and inhabitants have with the water in their dwellings  
36 (UNDP, 1991;Usoro, 2004). The potential of Geospatial techniques in flood studies cannot be overemphasized.  
37 It allows for a proper integration of all physical, socio-economic and demographic data, as data management  
38 and map representation capabilities of GIS help in exploring new portions, hence, its integration with remote  
39 sensing, enhances the ability for forecasting/predicting of new scenarios and preparation of flood hazard maps  
40 (Thilagavathi, et al.2011). Besides its constraints like technological Knowledge requirements, hardware, and  
41 software requirements, GIS can be very useful in flood hazard study and mitigation. Geographic Information  
42 System (GIS) has been applied extensively to flood studies. GIS is a technological system that reflects all kinds  
43 of spatial data in the real world. It can input, output, store, search, display, analyze and be applied under certain  
44 support of software and hardware (Mayer et al .1998, Usoro, 2004). Gurin et al. (2004), carried out a  
45 community-based flood risk assessment of San Sebastian, Guatamcla, using three epochs of aerial photographs  
46 acquired in 1964, 1991 and 2000, questionnaire and integrated GIS techniques for the study.

## 48 **2.0 Study area and Geology**

49 The area selected for this study is situated in the central Niger delta sedimentary basin of Southern Nigeria  
50 (Figure1) in Bayelsa State, Nigeria. The area lies within Latitude 4o57'30"N - 4o54'30"N and Longitude  
51 6o15'30"E - 6o21'30"E. The area is within Yenagoa Metropolis, with a good road network links to different  
52 communities. The topography of the area is low with a maximum of 40m elevation. The May social economic  
53 activities of the locals are farming, fishing and local sand dredging from creeks and rivers. The study area which  
54 is the southwestern flank in Niger Delta, Niger Delta geology has been described by Short and Reyment (2018),  
55 and others. The Niger Delta Basin which is form by failed rift junction with the separation of South American  
56 plate with the African plate, which opens the South Atlantic. Rifting in the basin started late Jurassic and ended  
57 in the mid-Cretaceous. Several faults occur which are more of thrust faults. The delta covers a land area in  
58 excess of 105,000 km<sup>2</sup> (Reijers, 2011).



59  
60 **Figure 1 Map of Study area**

61  
62 **2.1 Aim**

63 The study focuses on determining Flood hazard Zone and predict area for migration using Geospatial  
64 techniques (remote sensing and GIS)

65 **2.2 Objectives**

- 66 1. Understanding the general topography of the area.
- 67 2. To detect the vulnerability of the study area
- 68 3. To produce a flood hazard zone map
- 69 4. To understand the economic impact of the study area
- 70 5. To determine the database for future flood disaster planning which includes risk mitigation of the area

71 **3.0 Material and Method**

72 The following materials and data were collected for Digital Elevation Dataset from Shuttle Radar  
73 Topographical Mission (SRTM) downloaded from USGS explorer, prior and the spatial locations of some  
74 flooded communities were also acquired by the use of Garmin72 GPS, an administrative map from where

75 political boundaries and roads were digitized. Fieldwork with GPS and notebook were also used for the  
76 acquisition of coordinates of the communities respectively.

77 **3.1 Geographical Relief of the Study Area:** The essential geographic relief attributes examined in this study  
78 were the digital terrain model

79 **3.2 Topography of the Study Area** Contour lines (Figure5) connects areas of equal elevation were generated  
80 at 2m intervals. The spot height tells the direction in which water flows through. From the map, the contour of  
81 the study area ranges from -5-28.

### 82 3.3 Data processing

83 Arc GIS 10.7 spatial analyst extension was used to generate the height information from SRTM DEM (Digital  
84 Elevation Model). The data were collected using handheld Global Positioning System (GPS) in degree, minute,  
85 second and imported into Microsoft Excel where the data was converted to degree decimal and transferred to  
86 Geographical Information System environment in Data Base Format before point map was generated alongside  
87 Contour, Inverse Distance weight using the 3D analysis tools in Arc map were created before using the algebra  
88 map calculator to subtract IDW from DEM and the result was classified using raster calculator to determine  
89 flood level Zone and reclassify and import it to arc scan environment for 3D view.

## 90 4. Result

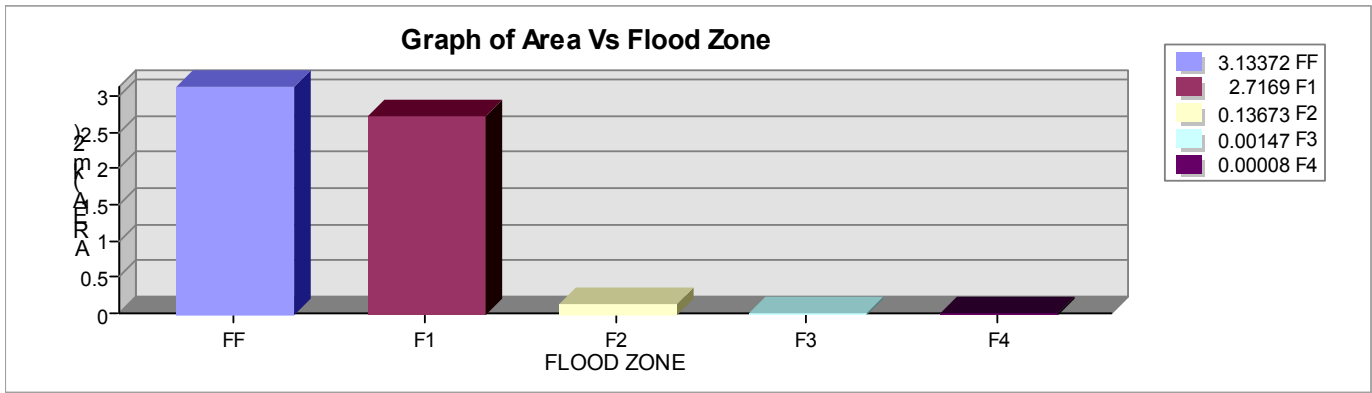
91 **Table 1: Statistical data from process Flood analysis Zone**

Flood Zone	COUNT	AREA (Km <sup>2</sup> )	MIN	MAX	RANGE	MEAN	STD	SUM	VARIETY	MAJORITY	MINORITY	MEDIAN
FF	40613	3.133719	1	1	0	1	0	40613	1	1	1	1
F1	35211	2.716898	2	2	0	2	0	70422	1	2	2	2
F2	1772	0.136728	3	3	0	3	0	5316	1	3	3	3
F3	19	0.001466	4	4	0	4	0	76	1	4	4	4
F4	1	7.72E-05	5	5	0	5	0	5	1	5	5	5

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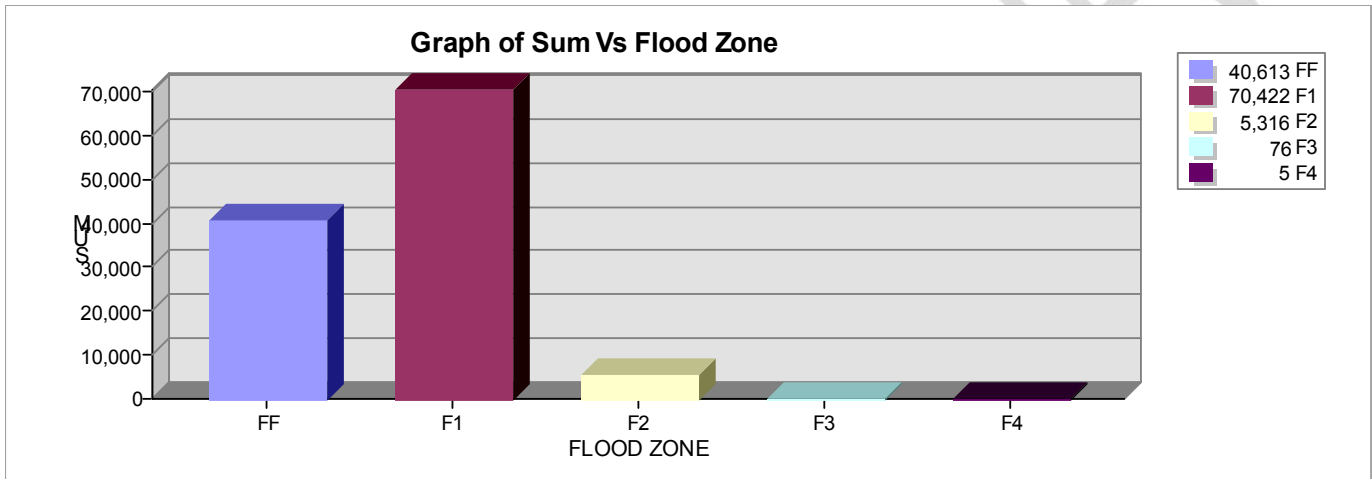
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96 **Figure 2: Showing Area against Flood Zone**



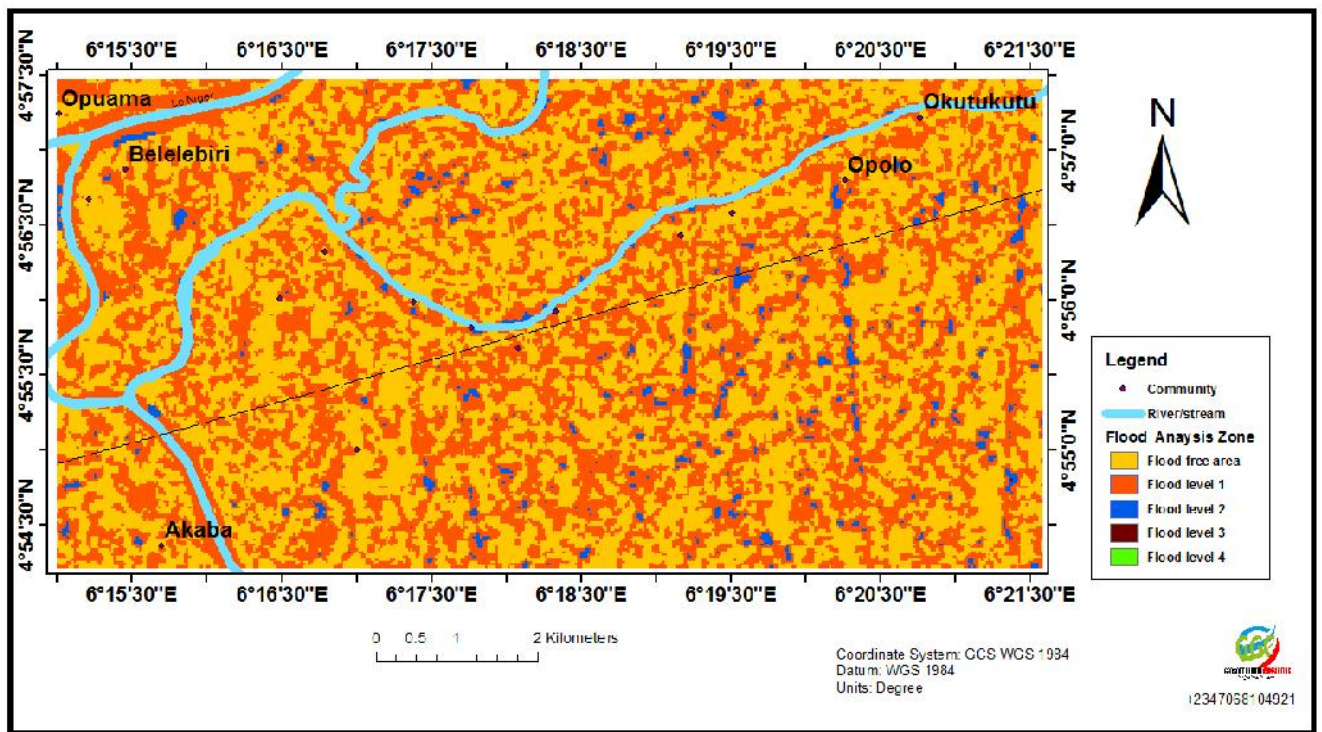
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98 **Figure 3: Showing Sum against Flood Zone**

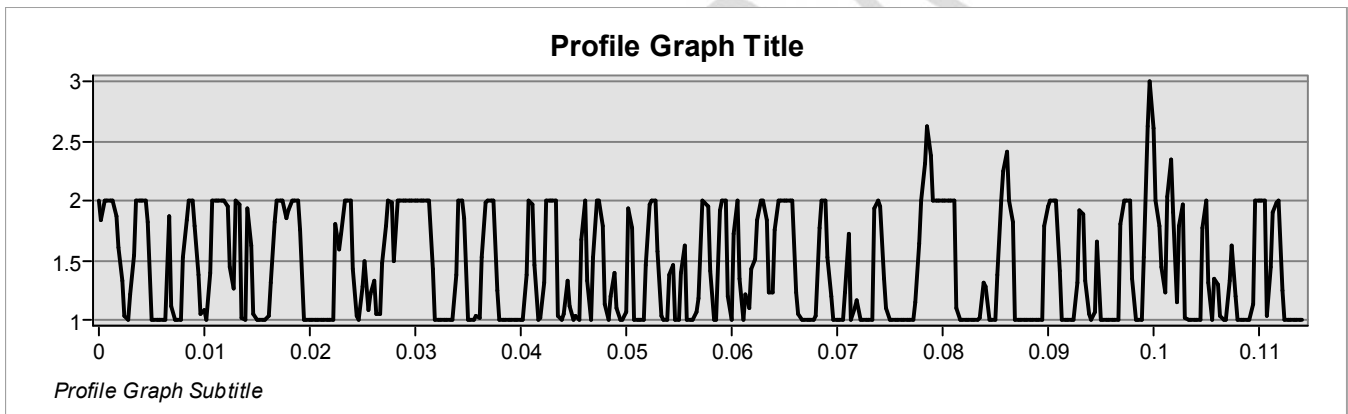
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**Figure 4: Cross Section map**

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The cross-section map makes us know the elevation at the line of the cross section A-B at each point.

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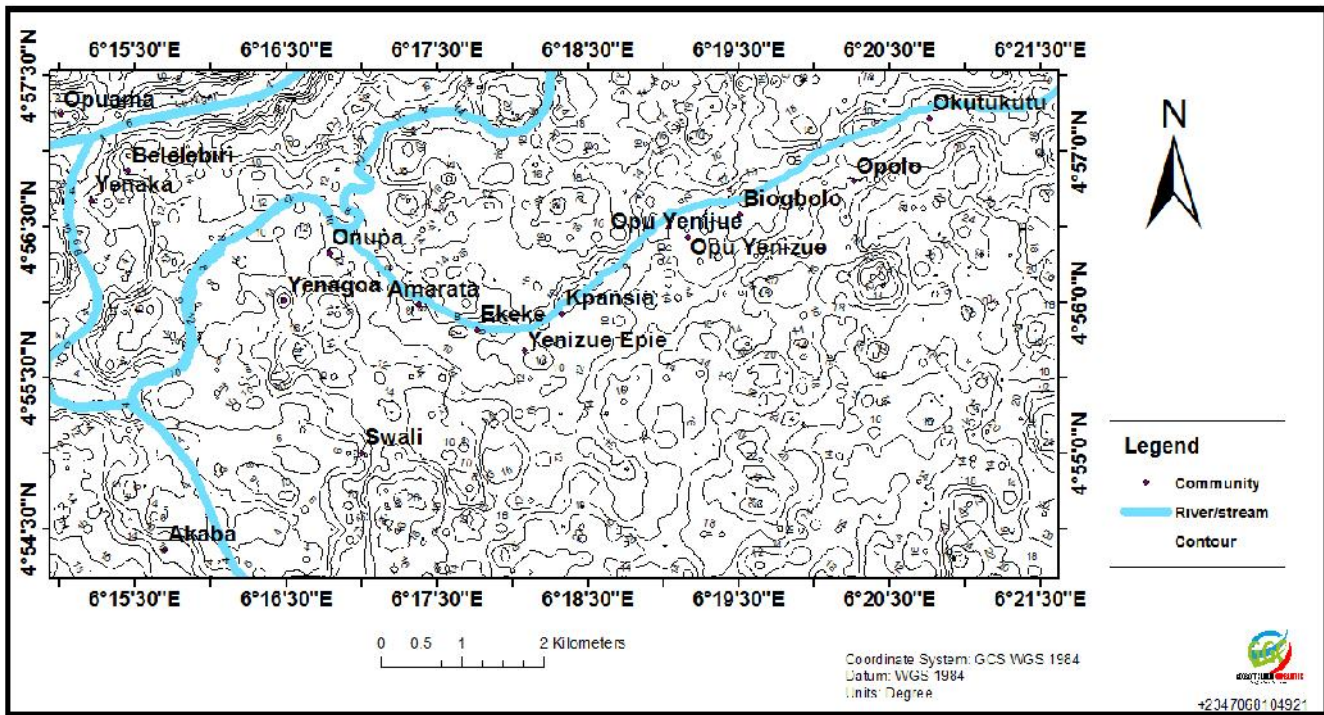


Figure 5: Contour of the Area

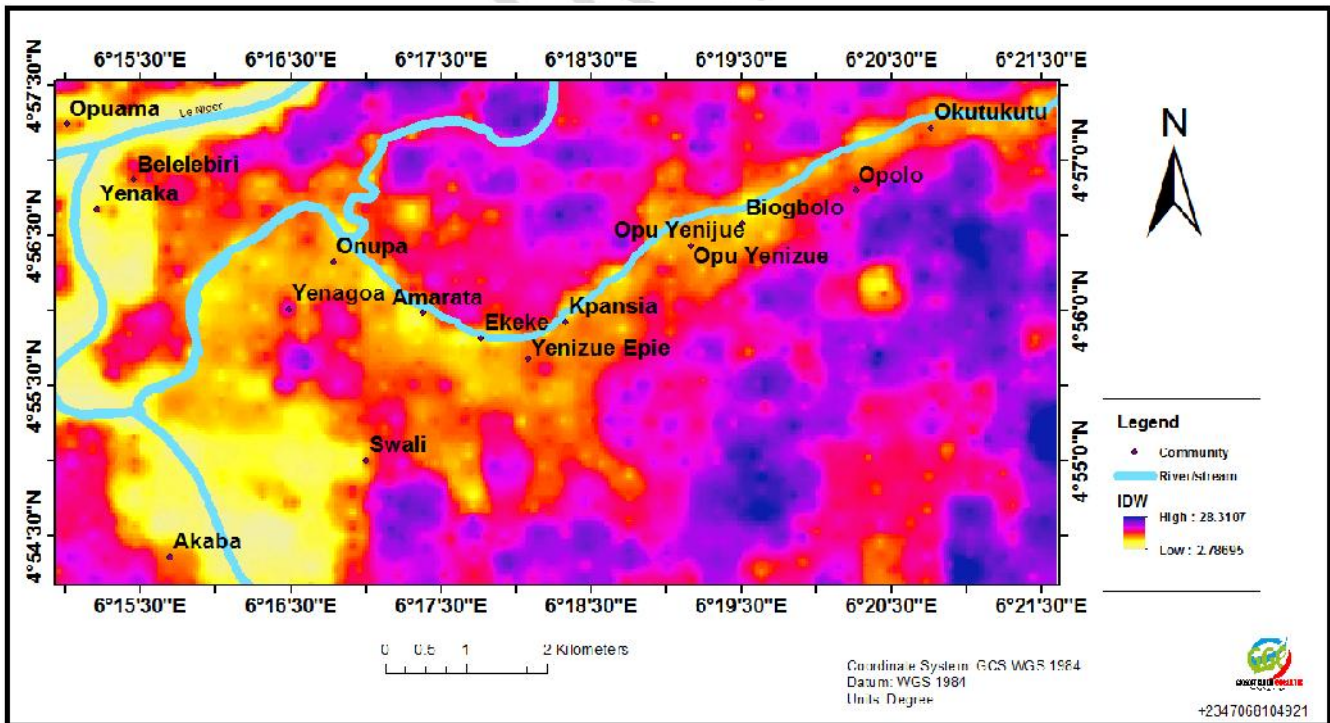
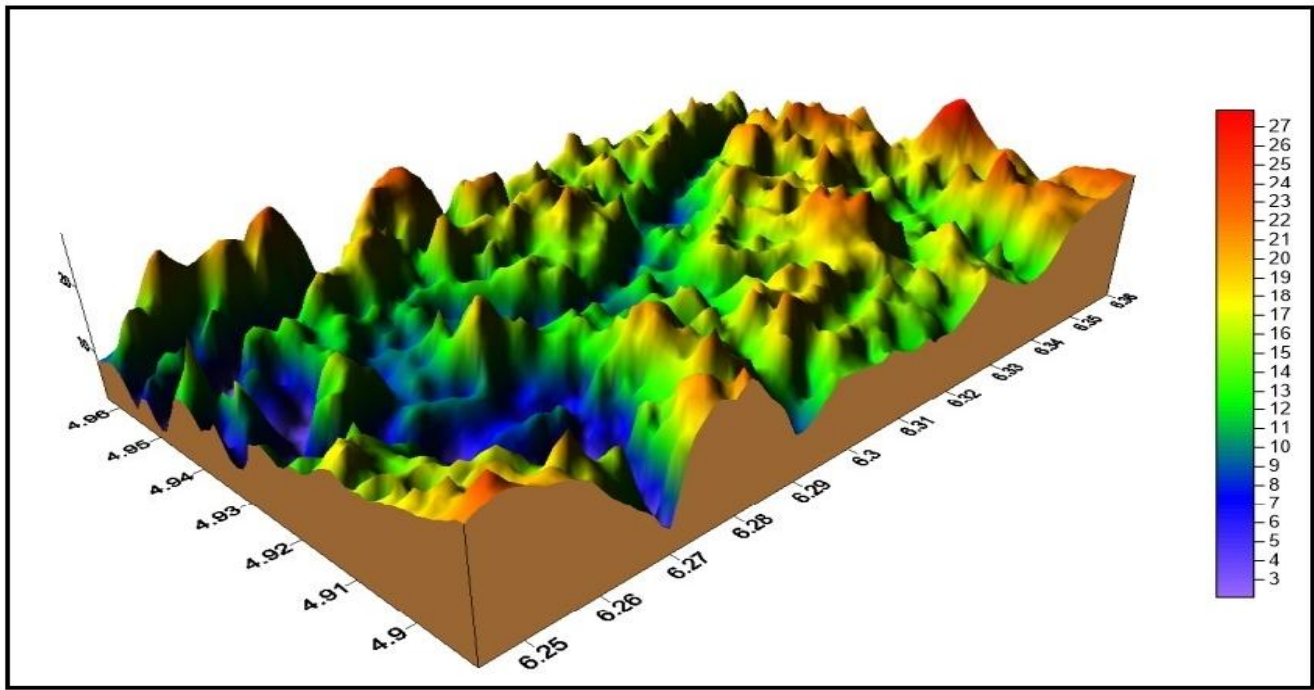
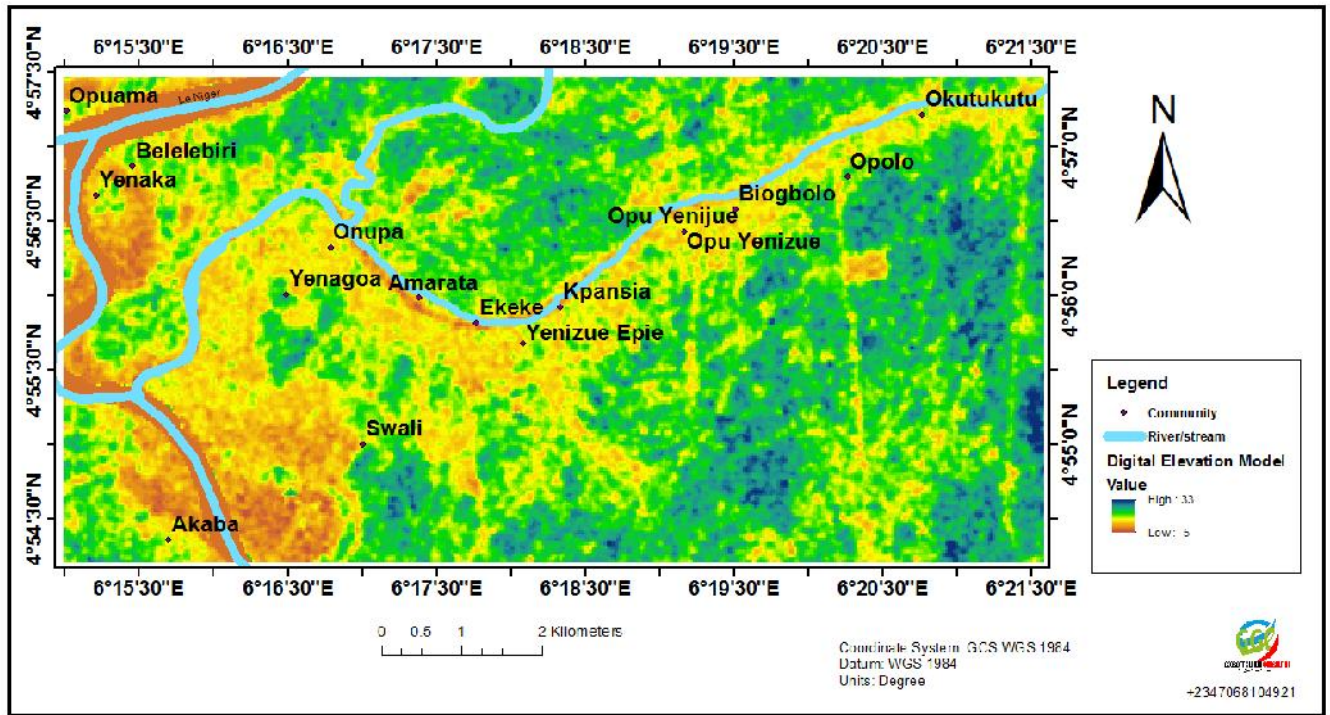


Figure 6: Inverse Distance Weight from DTM



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114 **Figure 7: 3D Model**



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116 **Figure 8: Digital Elevation Model**

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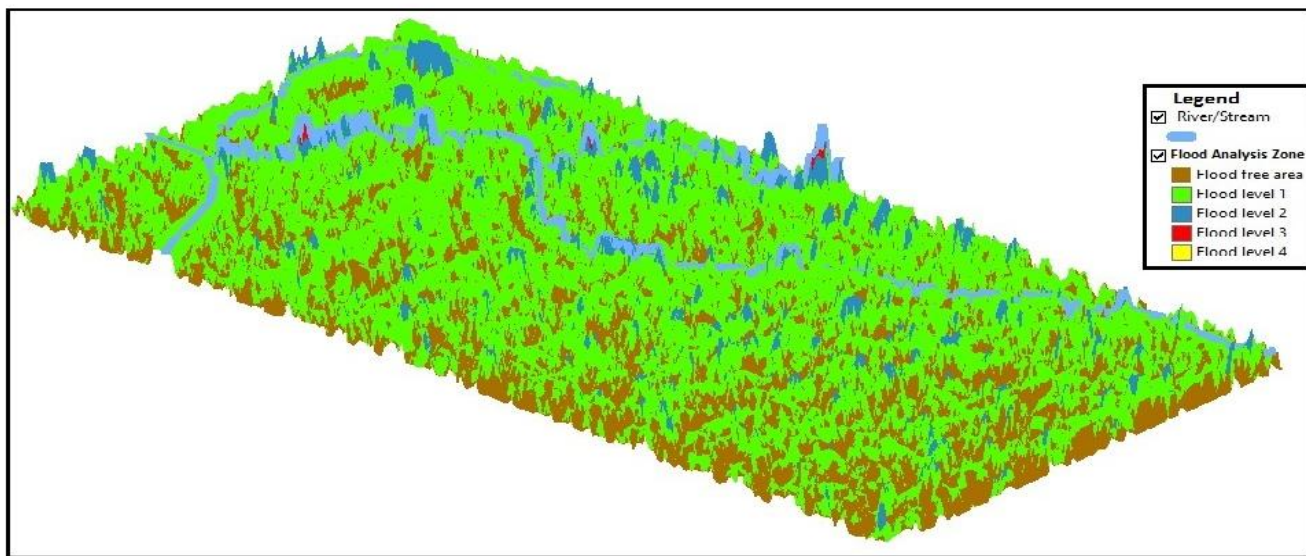
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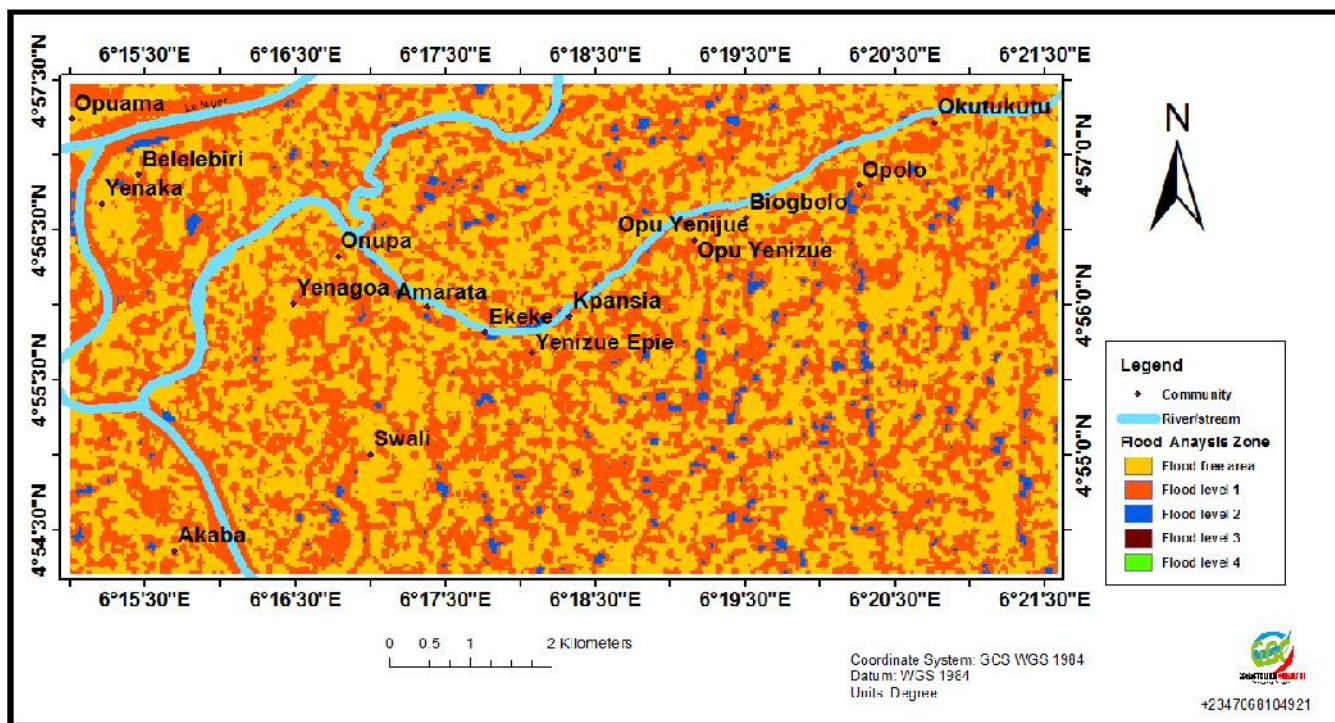
## 120 Discussion

121 The noble approach uses to discover the major sources of flooding in the area are explained such as  
122 digital elevation model (DEM) generated from the SRTM Data 30m is shown in Figure 8. The Figure  
123 shows that elevation in most parts of the area, is generally less than 33m above sea level and digital  
124 elevation model has a minimum value of -5m is highly flooded hazard zone and the maximum value of  
125 33m which are flood free but generally the area are prone to flooding. The low elevation of the area,  
126 coupled with its proximity to le River including Epie creek may have further communities in the  
127 flooding. Many of the communities in the of the within the study area fishing communities. The general  
128 contour (figure 5) tells us how that area is including the general trend on water flow direction. The IDW  
129 (figure 6) makes us get more information like the low and high area i.e low area has a minimum of  
130 2.78695 with light yellow color which indicates flood hazard area, middle with red color and dark blue  
131 which is the maximum with a value of 28.3207 is the flood free area. The 3D model (figure 7) makes one  
132 see the proper view on how the area is which from the legend we can see that area with blue color  
133 indicate flood risk area before green, yellow, red



134

135 **Figure 9: 3D View of Flood Analysis map**



**Figure 10: Flood Analysis Map**

The flood analysis Zone covers a land area of 5.9888882km<sup>2</sup> which are classified into five zones i.e flood free zone which cover 3.133719km<sup>2</sup> in the area, flood level 1 with 2.716898km<sup>2</sup>, flood level 2 cover 0.136728km<sup>2</sup> area, flood level 3 0.001466km<sup>2</sup> and flood level 4 7.72E-05km<sup>2</sup>. The flood free zone is suitable for settlement for flood relief centers like some part of Opuama, Yenagoa, Belelebiri communities and flood level 1 to 4 are prone from the elevation within the area are generally low.

**Conclusion**

Flood analysis mapping is a component for mapping flood-prone areas using the noble approach of remote sensing and Geospatial techniques to determine area that area flood free zone and area that flood risk zone. It creates easily read, rapidly accessible charts and maps that can facilitate administrators and planners to identify areas at risk and prioritize their mitigation and response efforts. The aim is to Analysis Flood zone using remote sensing and GIS. The use of GIS-based overlay analysis tool to determine spatial flood hazard levels in the. The area reveals that due to low relief, closeness to rivers, and lack of proper urban planning, most are proving to be highly vulnerable to flood hazard.

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