AJLP & GS
African Journal on Land Policy and Geospatial Sciences

e-ISSN : 2657-2664, Vol.4, Issue 4, September, 2021

https://revues.imist.ma/index.php/AJLP-GS/index

https://doi.org/10.48346/IMIST.PRSM/ajlp-gs.v4i4.19819 ***Category of the manuscript : Articles***

Received in: 29 February 2020 **Revised in:** 20 August 2021 ***Accepted in***: 20 August 2021

Assessment of Flood Risks in Ifo Local Government Area of Ogun State

Monsur Babalola Adewara[1], Anthony Olatunbosun Abiri[2]

[1]Department of Surveying and Geoinformatics, Federal Polytechnic, Ilaro, thawben@gmail.com, Nigeria.

[2]Department of Surveying and Geoinformatics, Obafemi Awolowo University, Ile-Ife, tony2bosun@gmail.com, Nigeria.

ABSTRACT

The most frequent natural hazards and the most costly in terms of property damage in study area is Flood. The purpose of this work is to use Geographic Information Systems Hydrological tools to model and map flood event in Ifo Local Government Area of Ogun state, Nigeria using Shuttle Radar Topographic Mission data and land use maps as input data layers. In this study, flood inundation depth is calculated with Geographic Information System in order to understand the temporal, spatial scale and transition. Flood inundation map and 3D views of the hydrological modelling results are provided for a better understanding of the severity of flooding in the location. It is recommended that the processed data from this study be used as input for future research and the development of flood warning systems for the area. It will also be a base study for future study when rainfall data will be available.

Keywords:

Flood, GIS, Inundation, Flood model, Flood risk, SRTM

1. INTRODUCTION

Flooding is a serious and growing challenge. It has been of great concern to the people of Ifo Local Government Area of Ogun State as it has claimed so many lives and properties. Over time some causes of flooding in most urban areas have been due to increase in population, blockage of channels as a result of bad waste disposal as well as human activities at flood plains (Olayinka and Irivbogbe, 2017). Against the backdrop of demographic growth, urbanization trends and climate change, the causes of floods are shifting and their impacts are accelerating (Jha *et al*, 2012). "Flood risk" can bear different definitions as it refers to natural disasters, depending on their adverse impacts on humans, lives, and the economy (Mahsa *et al*, 2012). However, flood risk can be discussed in terms of two elements: hazard and vulnerability (Dang *et al*, 2010).

Several attempts have been made to tackle flood issues in different parts of the world, but there seemed not to be a specific headway yet especially in Nigeria. These attempts have been approached from the academic points of view, literature reviews and from environmental perspectives. One approach in this regard is the 'SurgeWatch' v2.0 database that systematically documents and assesses the consequences of historical flood events, where a variety of 'soft' data such as journal papers, newspapers, weather reports, and social media are integrated. SurgeWatchv2.0 identifies 329 flooding events from 1915 to 2016, a more than five fold increase compared to the 59 events in SurgeWatchv1.0. Moreover, each flood event is now ranked using a multi-level categorization based on inundation, transport disruption, costs, and fatalities: from 1 (Nuisance) to 6 (Disaster). For the 53 most severe events ranked Category 3 and above, an accompanying event description based upon the Source-Pathway-Receptor-Consequence framework was produced. (Ivan, *et al.*, 2017).

In another development in which data-based flood modeling methods was used. Its purpose is to gain a deeper understanding of complex, poorly-defined environmental systems. The Data-Based Mechanistic methodology is employed in the data-based modeling procedure for structure identification and parameter estimation of a data-based model (DBM, in transfer function forms).

In a similar approach to the data based mechanistic, theory based flood modeling, a Recursive Prediction Error algorithm is modified and engaged in estimating time-varying parameters and detecting structural change for the theory-based model (TBM, in ordinary differential forms). Two concepts from linear processes in control system engineering, time constant and steady-state gain, are then examined in a synthesis of the two types of model in the parameter space spanned by these two lumped parameters.

The above methods are tied to the data availability, objectives of the flood vulnerability study as well as the desired results to be obtained. In this present study, the need to carry out a flood risk mapping using Digital Elevation Model (DEM) raster based calculations will reveal the areas that are highly prone to flooding.

1.1 Theory of Flood Model

Flood models are designed to simulate the surface runoff response of river basins to precipitation by representing the basins as an interconnected system of hydrologic and hydraulic components (HEC-1, 1998). A flood model is a computer program that simulates watershed precipitation-runoff process; precipitation runoff, channel routing, reservoir routing, diversion and hydrograph combinations that are used to estimate hydrographs at various locations. The model capabilities include automatic parameter estimation and flood damage analysis.

1.2 Study Area

This work investigates areas at risk to flood in Ifo Local Government Area of Ogun state, Nigeria (Figure 1). The Local Government covers an area of about 521 square kilometers and lies within the geographical coordinates of 18° 15' to 19° 55' N latitudes and 83° 20' to 84° 20' E longitudes with an estimated population of 164,486 and total number of house hold of 41,997 according to 2006 National Population Census figure. The temperature variation in the plains of the basin is between 10^{o}C to 430C.

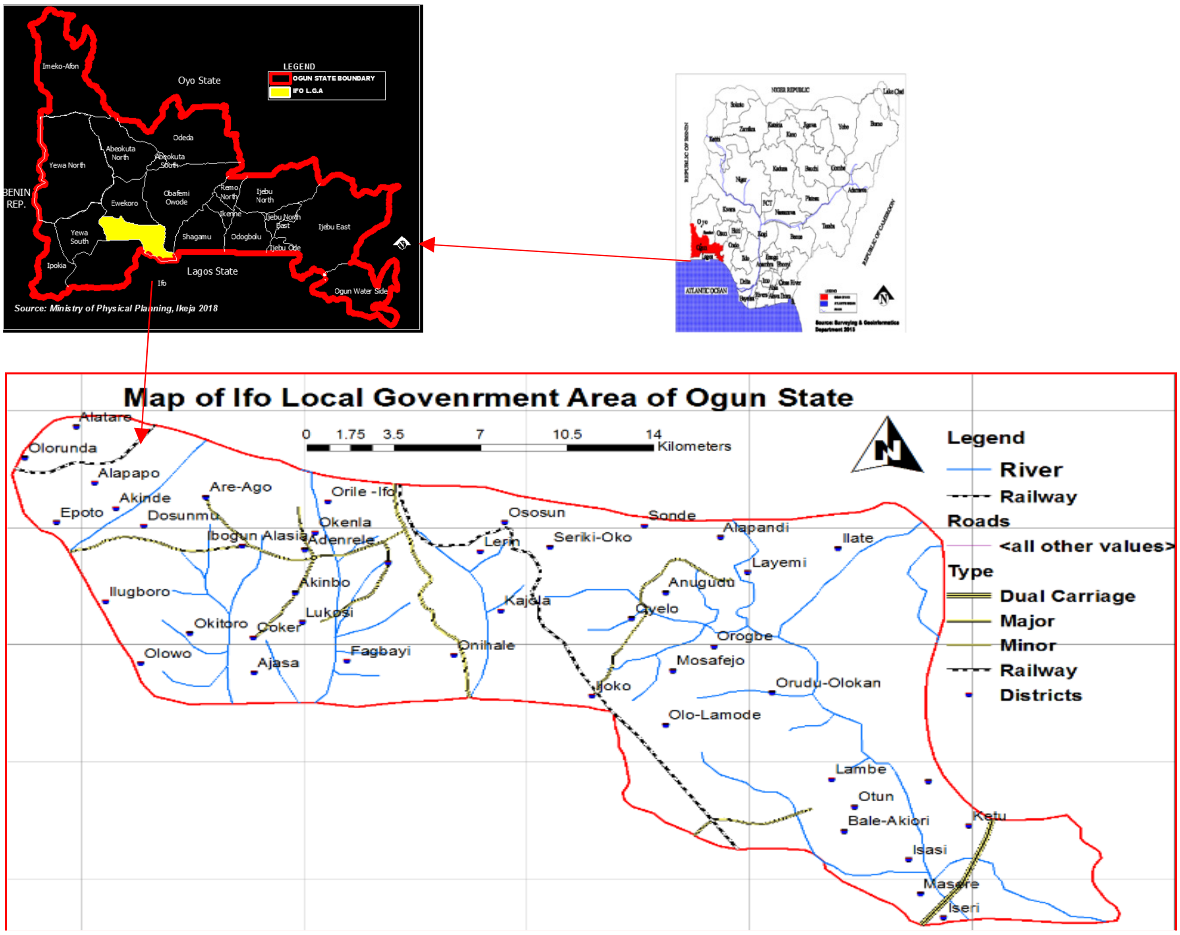

Figure 1: The Study Area

It is bounded in the North and South by Ewekoro Local Government and Ado-Odo/Ota Local Government respectively. It also shares boundaries with Obafemi/Owode Local Government and Lagos State in the Eastern part while it is bordered in the West by Egbado South Local Government. Transportation in the area is majorly land i.e railway and motor ways (Figure 1). Due to its narrow shape, undulated terrain and other characteristics of the catchment, the runoff time is limited and flash floods frequently affect the area. The total catchment area of the basins is 10,830 km^2. The mean annual rainfalls of the study area is 1280 mm. The soil types in the basin are: mixed red and black, yellow, red sandy soils, coastal soils and some forest soils. The land use in the area is majorly characterized by scattered cultivation, residential and commercial (built up) areas (Figure 2).

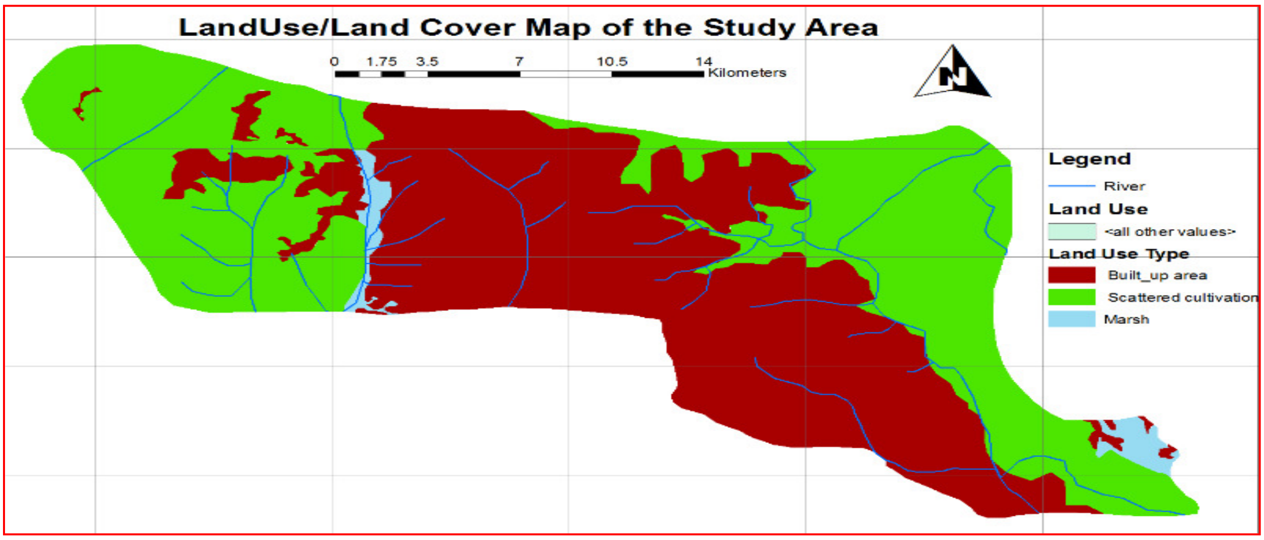

Figure 2: Land Use Map of the Study Area

2. METHODOLOGY

2.1 Data Acquisition

Implementation of the GIS model for the study requires collection of spatial data such as a digital elevation model, soil map and land Use/land Cover map in order to define the catchment boundary and the various physiological characteristics of the study area. The digital elevation model (DEM) was acquired from Shuttle Radar Tropical Mission (SRTM, 2008) with a spatial resolution of 30 m. The land use land cover map of the area was digitized from 2016 Google earth image covering the area. Global Positioning System (GPS) coordinates of flood prone locations (a total of 46 locations) in the study area. Flooding, urbanization trends, climate change

2.2 Data Processing

The data processing involved the following:

i. The GPS positions for all locations prone to flooding were acquired from the field and a database was created for them.

ii. DEM preprocessing was carried out using ArcGIS such as basins, catchment, watershed boundaries and pour points.

iii. The land use map acquired was vectorized from 2016 Google earth image using ArcGIS 10.2

iv. A criteria selection process was carried out and they were selected based on their relevance to the study. These criteria are considered to be indicators or factors that influence flooding. Four factors were considered in this study and they are given as follows:

a) Elevation

b) Flow direction

c) Flow accumulation

d) Stream order

d) Land use

v. Thematic raster maps were produced for these factors using the Reclassification method as provided in the ArcGIS environment.

2.3 Hydrological Model Development

River Network Model Development

The study area watershed boundary is delineated first using ArcGIS model builder (figure 3) and supplementary information, such as municipal drainage maps from ESRI's shapefile were imported to obtain an accurate depiction of the basin's extent. The basin model was created using the ArcGIS extension of HEC-GeoHMS. The basin is segmented into a number of sub-basins to determine the number and types of stream network components to be used in the model. Each sub-basin is intended to represent an area of the watershed which, on the average, has the same hydraulic/hydrologic properties. The sub-basins and their components are then linked together to represent the connectivity of the river basin.

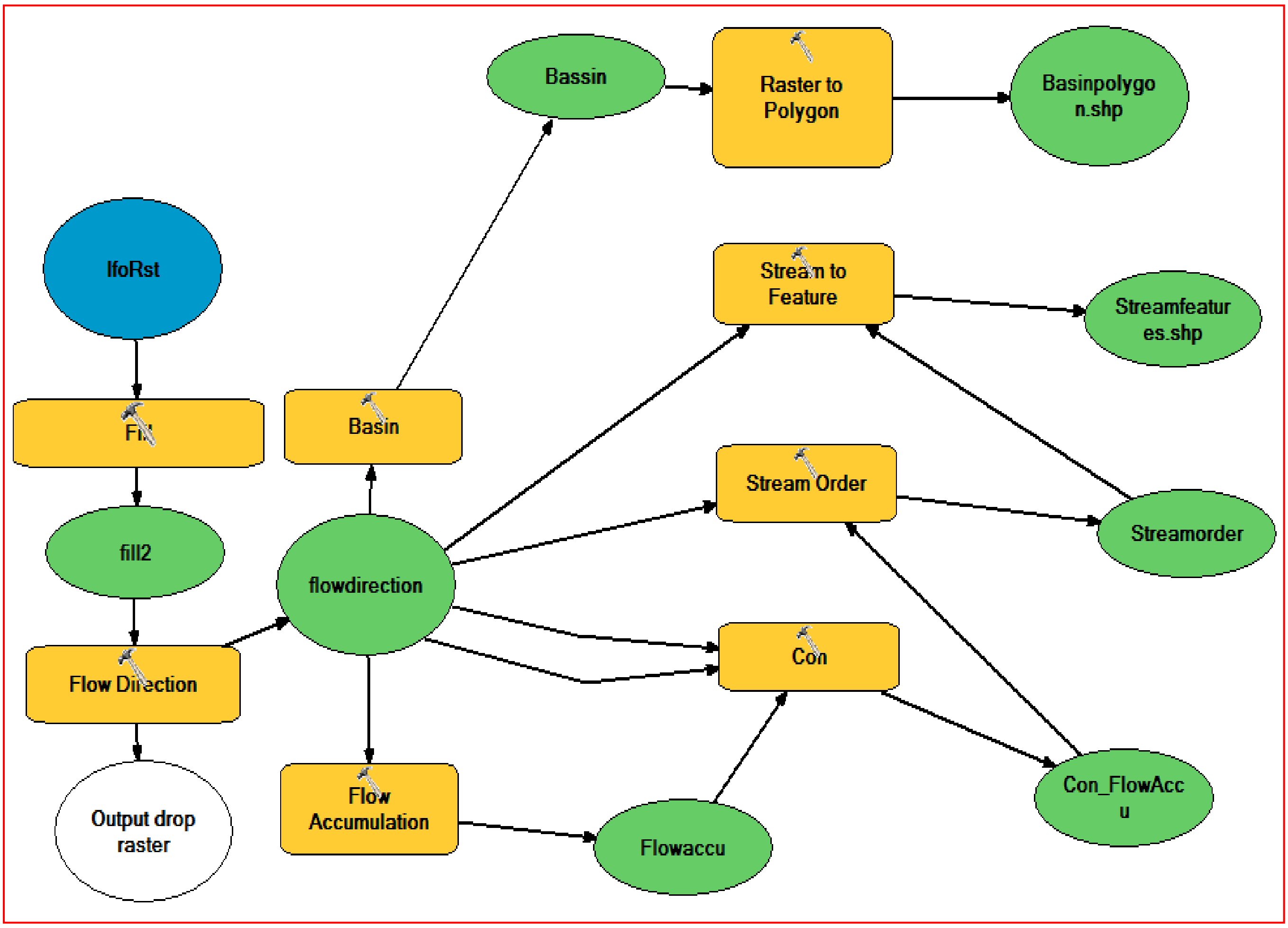

Figure 3: Model for Preprocessing the DEM

2.4 Catchment Delineation

HEC-GeoHMS in ArcGIS 10.2 was used to delineate the catchment area after which different sub-basins and river networks were created (figure 4). The raw DEM was pre-processed prior to the delineation of watershed boundary. This is to ensure that a well-defined watershed and river network are obtained. Catchment delineation uses advanced GIS functions to segment watersheds into several hydrologically connected sub-watersheds (figure 5). The number of sub-watersheds and the stream network that was created depended upon the threshold value of the area provided by during watershed delineation (Waikhom & Manoj, 2015).

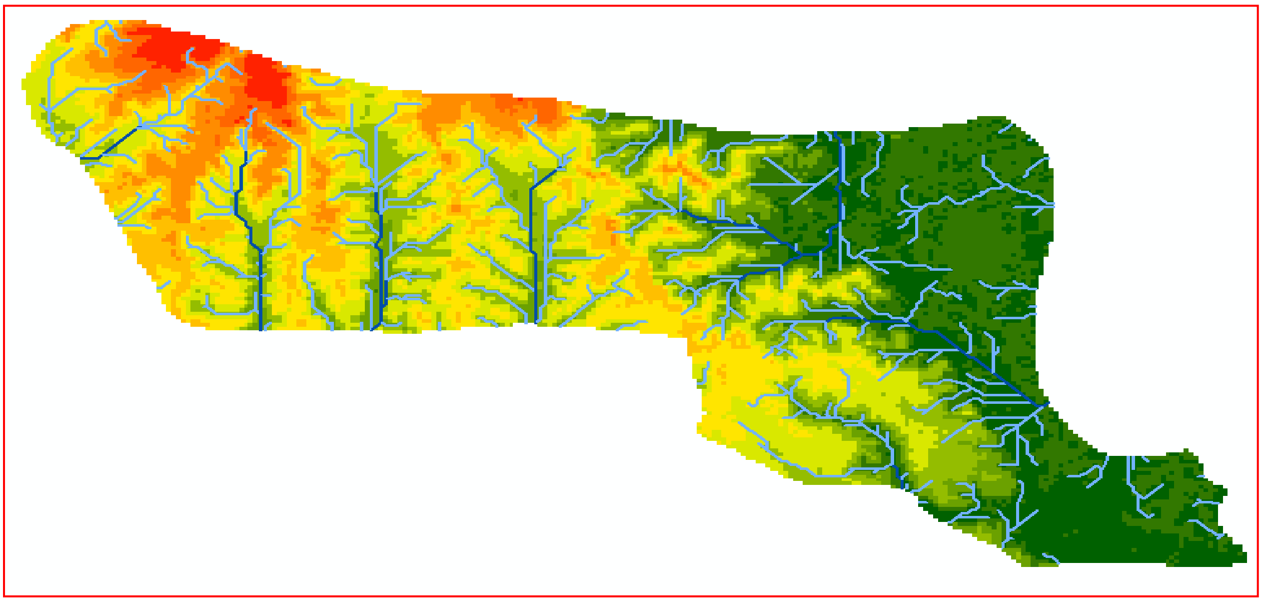

Figure 4: DEM Embedded with Drainage Network of the Study Area

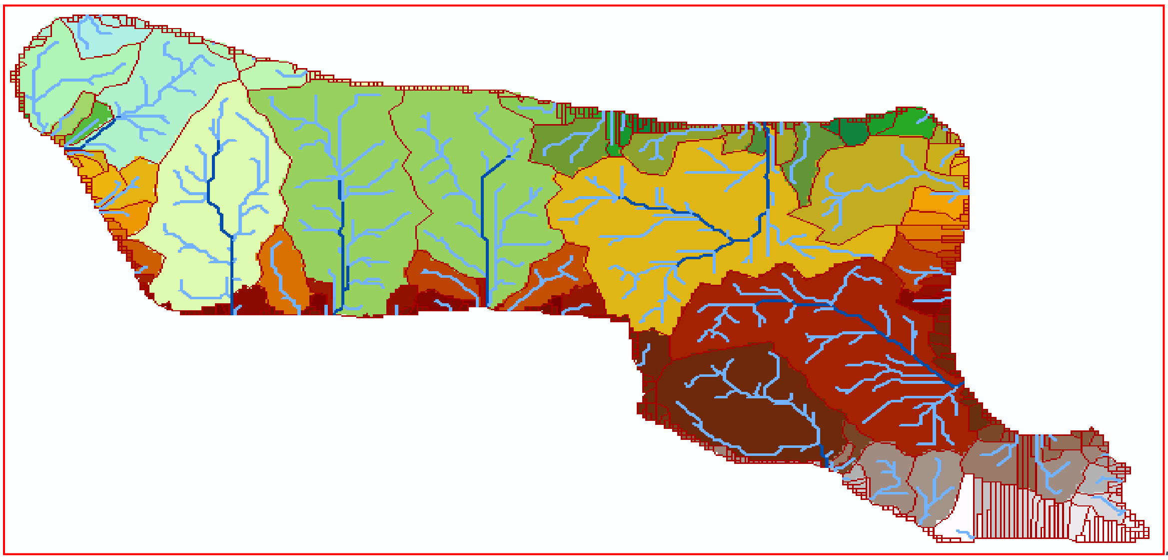

Figure 5: Hydrologically Connected Watersheds in the Study Area

3. RESULTS AND DISCUSSION

Flood hazard and intensity layers were overlaid. Consequently, the extent of the flood inundation was obtained and the final flood risk for the sub water sheds were determined as shown on Figure 6.

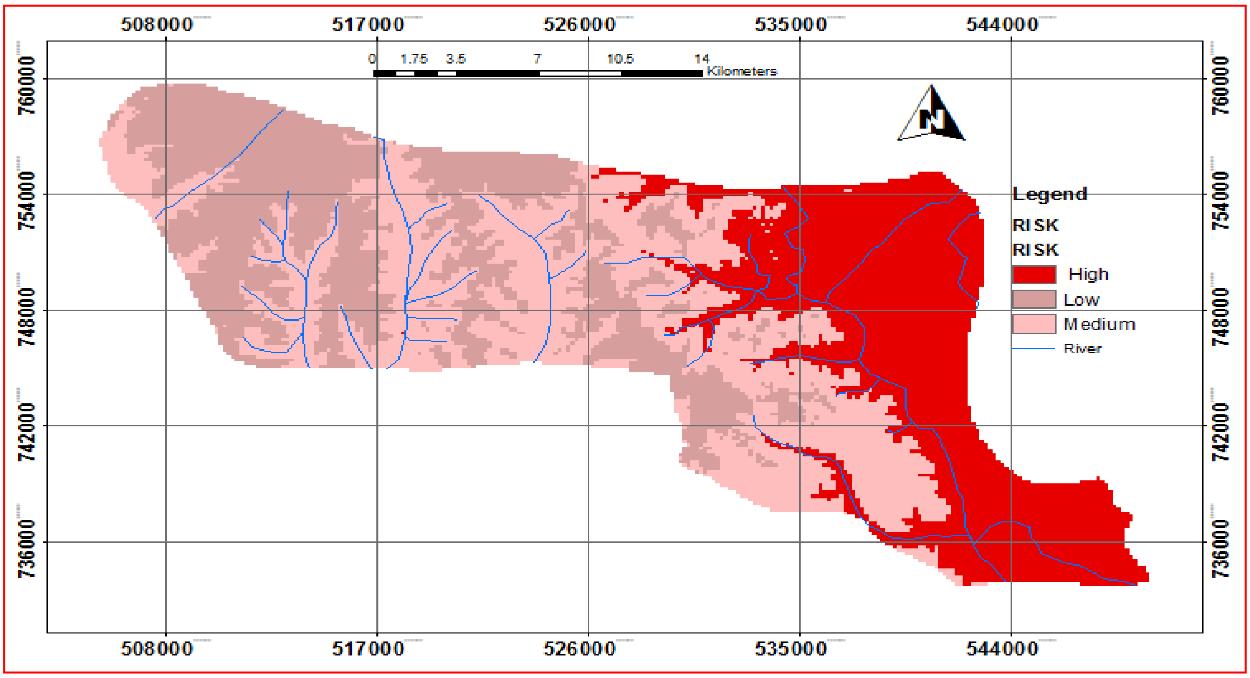

Figure 6: Flood Risk Map Showing High, Medium and Low Risk Areas

The Flood inundation map is required to understand the effects of flooding in a particular area and on important structures such as roadways, railways, streets, buildings and airport. Flood inundation map provides important information, like depth and spatial extent of flooded zones, required by the municipal authorities to inform the citizens about the major flood prone areas and adopt appropriate flood management strategies.

The flood risk is dependent upon the depth of the flood. Results showed that Ifo LGA is categorized into three flood depth levels; 3m, 2m and 1m, (Figure 7). This means areas with the largest depth (greater than or equal to 2m) are susceptible to high risk flood, while areas with the least depth (less than 2m) are low risk areas (Figure 7).

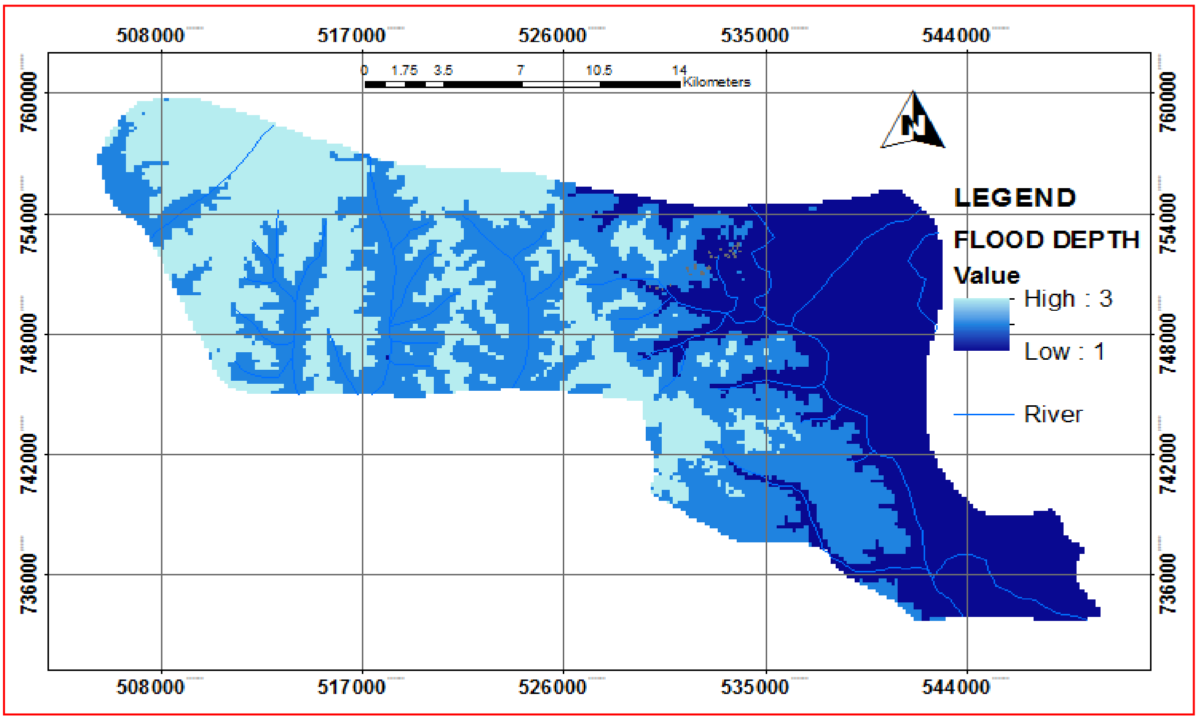

Figure 7: Flood Inundation Map showing Flood Depth and Extent:

The coverage area for this flood risk extent was calculated from the flood risk map to be 32%, 38% and 30% (High, Medium and Low risks) respectively, (Table 1 and Figure 8). The implication of this is that there is the tendency that the coverage area of the high risk zone will increase in the next flood year and this will have adverse effect on the agricultural produce from the study area as well as lives and properties.

Table 1: Flood Risk Coverage Area

SN	Risk	Coverage area (Km2)	Coverage %
1	High	167.989	32
2	Medium	198.525	38
3	Low	159.903	30
	Total	526.417	100

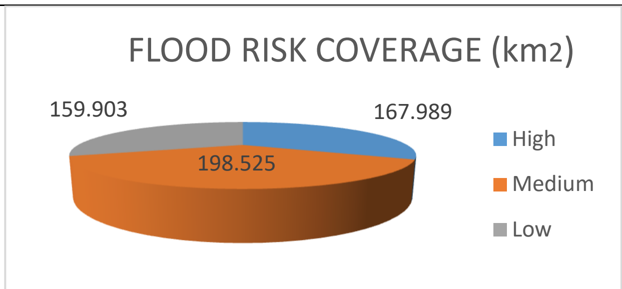

Figure 8: Flood Risk Coverage Area

Flood risk maps will be used to increase awareness of the likelihood of flooding in the study area. It will also encourage people living and working in the flood-prone areas to find out more about the local flood risk and to take appropriate action. Since the severity of the flood tells the level of destruction on the lives and properties in the study area, it becomes imperative to make a count of the building types that lie within these areas (Adewara *et al*, 2018). This will help us to know the structures that are at risk and the threat this poses on the lives of people and even the environment at large. Buildings and roads that fall within the inundation zones (Figures 9, 10 and 11) are at the greatest risk during flooding.

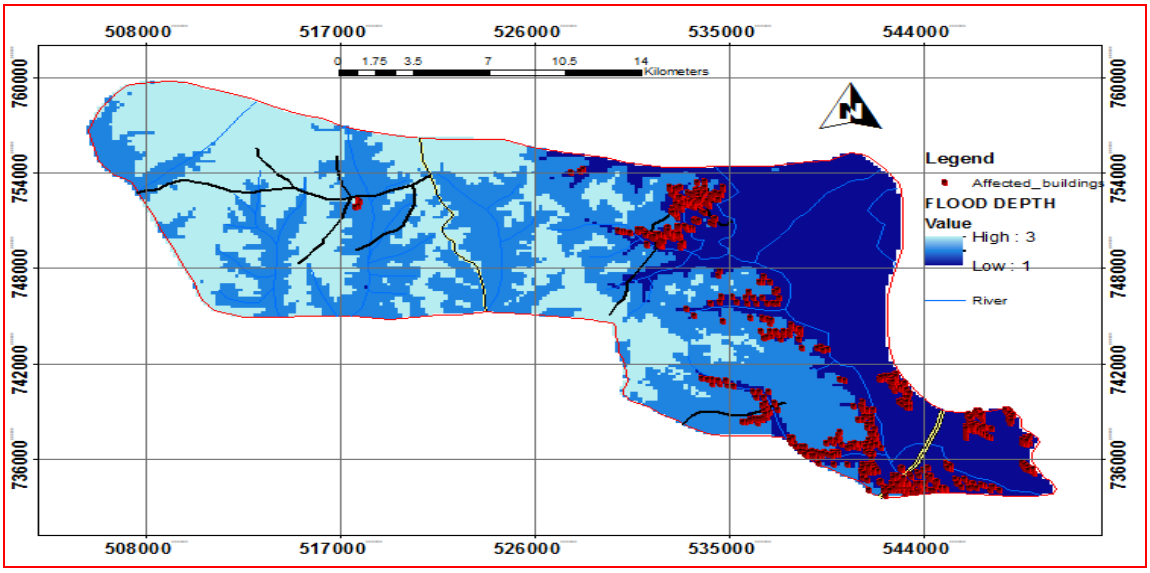

Figure 9: Buildings that Fall within The Inundation Zone

Figure 8: Some of the Flooded Buildings in the Study Area

Figure 9: A Flooded Road in the Study Area

The flood inundation maps and GIS analyses serve to show the level of risk of flooding and the extents to which these areas and the people present in it are vulnerable. Major areas such as Anugudu, Orudu-Olokan and Bale Akioriare highly at risk. This risk is attributable to the topography of the terrain and the hydrological characteristics of the study area.

4. CONCLUSION

Flooding as a global crisis is becoming pressing issues. Several attempts from different perspectives have been employed in its management. Its impact to socio-economy and livelihood calls for the inclusion of flood models in flood management strategies, hence, the use of GIS hydrological modelling tools.

Identification of those areas at risk of flooding will help inform emergency responses. For example, areas that are likely to require evacuation can be identified, and evacuation routes can be planned and clearly signposted so that local communities are made aware in advance of an emergency. The identification of flood risk areas will also help in the location of flood shelters for evacuees. This study envisaged the use of GIS as a step further to tackle flood issues. This present study envisaged the adoption and use of GIS as a tool for flood planning and management in the study area and indeed in other administrative capacities. The processed data from this study can serve as input for future research and the development flood warning systems for the area.

5. ACKNOWLEDGEMENT

This Paper was self-sponsored.

6. FUNDING

This Paper was self-sponsored.

7. REFERENCES

Adewara, M. B., Irivbogbe, H. E., Yusuf, W., & Akitoye, M. (2018). Analyzing flood risk in Lagos Island local government area of Lagos state. *FIG Congress 2018* (p. 2). Istanbul, Turkey: Federation of International Geomatician FIG.

Dang, N. M., Babel, M. S., & Luong , H. T. (2010). Evaluation of flood risk parameters in the Day River flood Diversion area, Red River Delta, Vietnam. Natural Hazard .

HEC-1, H. E. (1998). Flood Hydrograph Package User's Manual. US: US Army Corps of Engineers.

Ivan, D. H., Ozgun, O., Matthew, P. W., Robert, J. N., Shari, L. G., Thomas, W., & Jennifer, M. B. (2017). Data Descriptor: An improved database of coastal flooding in the United Kingdom from 1915 to 2016. UK: Scientific data.

Jha, A. K., Bloch, R., & Lamond, J. (2012). Cities and flooding: a guide to integrated urban flood risk management for the 21st century,. World Bank Publications.

Mahsa, S., Masoud, M., Mehdi, Z., Zahra, A., & Alireza, G. (2012). Flood Risk Assessment Using GIS. PolIsh Journal of Environmental Studies, 1817.

Olayinka, D. N., & Irivbogbe, H. E. (2017). Flood Vulnerability Mapping of Lagos Island and Eti-Osa Local Government Areas Using a Multi-Criteria Decision Making Approach. Nigerian Journal of Environmental Sciences and Technology (NIJEST), 244.

Waikhom , R. S., & Manoj, K. J. (2015). Continuous Hydrological Modeling using Soil Moisture Accounting Algorithm in Vamsadhara River Basin, India. Journal of Water Resource and Hydraulic Engineering, 400.

8. KEY TERMS AND DEFINITIONS

Climate change: The rise or fall in the average variables of weather such as temperature, humidity, atmospheric pressure, wind and precipitation.
Flooding: An overflow of water that submerges land that should normally be dry.
GIS: An integrated computerized system for capturing, storing, checking, integrating, manipulating, analysing and displaying information which are spatially referenced to the Earth
SRTM: An international research effort that produced high-resolution digital topographic database of the Earth from digital elevation models on a near-global scale. Data from this research work is known as SRTM data.