GEOSPATIAL ASSESSMENT OF POTENTIAL FLOOD PRONE AREAS IN ILORIN SOUTH LOCAL GOVERNMENT AREA KWARA STATE NIGERIA

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Abstract: Floods take the largest number of human lives and cause the most property damage among direct natural disasters that occurs in the world. It is a point of concern that the major environmental problems associated with the resident state of the study area is flooding which has led to loss of lives and properties worth millions of naira yearly as well as distortion of socio-economic activities in the environment. The aim of this study is to carry out the geospatial assessment of flood prone areas in Ilorin South Local Government Area Kwara state Nigeria, with the view of proffering flood hazard control and management.Thedata sets of the study area used for this research are Global Positioning System (GPS) ground coordinates, Shuttle Radar Topographic Mission(SRTM), Digital Elevation Model (DEM) data of 30 meter resolution, obtained from USGS website on which hydrologic analysis was performed to produce drainage pattern and density data of the study area;2021 Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) image (30m resolution) from USGS database. The software used for the study is ArcMap 10.2 software and Microsoft Excel. The acquaired Ground coordinates were arranged in Microsoft Excel Spreadsheet and processed in ArcGIS 10.2 software environment. Drainage density and slope were processed from the SRTM and DEM, while the study area clipped from the Landsat 8 image was subjected to maximum likelihood classifier algorithm of supervised classification to generate the landcover classes. False color combination, band 5, 4, 3, was composited and the bands were stacked for image classification operation. The maps of these factors were produced and analyse for the proneness of the study area. The result of the research revealed twelve places in the study area are prone to flooding. These are places of low elevationof less that 271m above mean sea level, located along the water channel and of gentle slopes between 0°-5°. The research finding is recommended to be adopted for a sustainable flood control and management in the study area, and as a stimulant to flood-prone study of other areas, while the government and concerned authority should adopt the research to provide necessary measure to avoid, ameliorate and manage flood occurrence in the Study area.

Keywords: Area, Environment, Flood, Proneness, Research,

1.0 INTRODUCTION

Floods take the largest number of human lives and cause the most property damage among direct natural disasters that occurs in the world (Cunningham and Cunningham, 2012). On average, 20,000 people lose their lives due to flooding each year and it affects 75 million people globally, most of whom become homeless (Smith, 2001). There has been an increase in the rate at which flooding is experienced today in most parts of the world. This has been attributed to climate change which has increased the rate at which precipitation is received in some parts of the world and reduced it elsewhere. Urban area flooding is not just related to heavy rainfall and extreme climatic events; it is also related to changes in the built-up areas themselves (Douglas *et al.*, 2008).

In Nigeria, floods are the most important natural hazard in terms of the population affected, frequency, areal extent, and socio-economic damage (Yerima, 2013; Adefuye, 2015). According to Adefuye (2015), flood has affected Ibadan in 1985, 1987, 1990, 2012; Osogbo in 1992, 1996, 2002, 2008, 2012; Yobe in 2000; Akure in 1996, 2000, 2002, 2004, and 2006. Yerima (2013) also noted the occurrence of flood in Bauchi in 2011, 2012, 2013; Yola in 2010, 2012, 2013; Jos in 2010, 2012, and 2013.

Interestingly, many cities of the world have been experiencing house construction explosions. This explosion is contingent upon the population upsurge experienced in these cities. Thus, people have been tempted to erect their structures wherever they can lay claim to a parcel of land. In most cases, it is observed that in the course of house construction for instance, people have often encroached on the river valleys and have not given enough allowance to the incidence of river flooding. Victims of this act, therefore, suffer a number of loses from the river when in it flood. For example, Olaniran, (1983) observed three flood incidents in the decade 1971-1980 in Ilorin and these were in 1973, 1976 and 1979. These extreme climate events left untold sufferings and destruction in Ilorin. Some of the destructions are limited to the built up areas. Olaniran reported that one person was drown due to the effect of flooding in 1973, and on the 19th Oct.1976, 24 houses were almost submerge under flood water.By the 3rd day, 56 other houses were affected as the water reached window height.Vegetables and sugarcane farms were washed away, many roads in the city were rendered impassable as erosion created deep pot holes. The situation was so devastating that the state government had to donate the sum of 10,000 naira and Ministry of Agriculture donated two boats to evacuate the properties of the victims. On 30th August 1979, one house and two cars were submerged, resident of the submerge houses took shelter on the river banks. In the flooding occurrence of Agbabiaka, Gaa-Akanbi, Offa garage on the 21st of August 2015 which caused a resultant flooding around the Royal Shekinah hotel and some areas along Offer garage road, properties worth several millions of naira were destroyed. On the said date, rainfall started around 4.00 p.m in some areas like Omosebi, Offa- Garage, Gaa- Akanbi, Pipeline, and Royal Sekinat among others, and rapidly turned the joy of the residents into sorrow. THISDAY daily revealed that the downpour which lasted for almost three hours in the city destroyed shops, houses, cars and other household goods and services. It was reported that four people lost their lives in the incident. It was also gathered that most drainages along major roads and streets in the areas were flooded, just as the flood entered into nearby houses and shops in which properties were destroyed (Thisday News Paper, 2015).

Jamba-oda (2018) observed that there is relationship between urbanization and hydrological characteristics; decrease infiltration, increase in run-off, increase in frequency and flood inundation. All hazards have spatial components and adequate geographic information on hazards and areas prone to hazards is required to be able to simulate and mitigate flood hazards. In practice, a lack of sufficient data is a main constraint in disaster risk assessment, especially in data scarce regions, such as developing countries like Nigeria.According to Ogunlade (2018), Geographical Information System according to Abah (2013) plays an important role in mapping and analysis of projects. It is a general term that refers to the use of computers to create and depict digital representations of the earth surface, and a general-purpose technology for the treatment and management of digital geographic data for meeting varying specific needs.With the advancement in Global Positioning Systems (GPS) and software tools such as the Geographic Information Systems (GIS), Ahmed *et al.,*(2013) observed it is possible to map out areas liable to flood and delineate drainage patterns. This will provide the opportunity to manage flood since it cannot be avoided in totality.

There is almost no year that havoc is not wrecked by flooding in Ilorin. The affected communities are always those found on places of lower elevations and those built on floodplains. With increased storm frequency resulting from climate change and continuous increase in population of the city, there is an urgent need for putting in place improved drainage systems and proper river management, better planning and reviewing laws guiding erecting of structures and refuse disposal (Shiru *et al.*, 2018).

Till date flooding remains a serious problem that occurs yearly in the study area (Figure 1)

Figure 1: Flooded Building and Roads in the study area
Source: THISDAY 28th May 2017

As observed in Figure 1, roads and buildings in the study area are damaged as a result of flooding and many are suffering from this problem on yearly basis as it affects the economic activities and hinders free movement of the

Pedestrians, vehicles, cyclist and even sometimes leads to loss of life. Thus, utilization of Remote Sensing and GIS mapping provide improved ways of assessing, analyzing and presenting hazard and hazard risk through flood risk mapping which helps urban planners in flood warning, preparedness to mitigate the impact of flood for sustainable urban flood risk management.Therefore, the urgent need to identify the flood extent in the study area, analyse the causative factors and to assess flood hazard within Ilorin South Local Government Area in order to map out the flood prone areas that will assist in the production of flood risk map for proper decision making.

THE STUDY AREA

Ilorin South L.G.A (Figure 2) is one of the four Local Government Area in Ilorin metro polis in Kwara State, Nigeria. Others are Ilorin East and Ilorin West. It's headquarter is in the town of Fufu. It has an area of 174 km² and a population of 777,667 at the 2006 census (https://en.wikipedia.org/wiki/Ilorin_South). It is located on latitude 8°24'N and 8°30'N and Longitude 4°33'E and 4°45'E with an area of about 100km (Kwara State Diary, 1997). The study area is situated in the transitional zone between the forest and savanna region of Nigeria between the very North and West coastal region. It is abundantly blessed with surface and underground waters. It is therefore appropriate to say that the city is a middle belt state serving as a gateway between the North and the South (Oyebanji, 1993). The geology consists of Pre-Cambiian basement complex. The elevation varies from 273m to 333m in the West with isolated hill (Sobi hills) of about 394m above sea level and 200m to 364m in the East. A large part of Ilorin town is laid by sedimentary rock which contains both primary and secondary laterites and alluvial deposits (Oyegun, 1983).

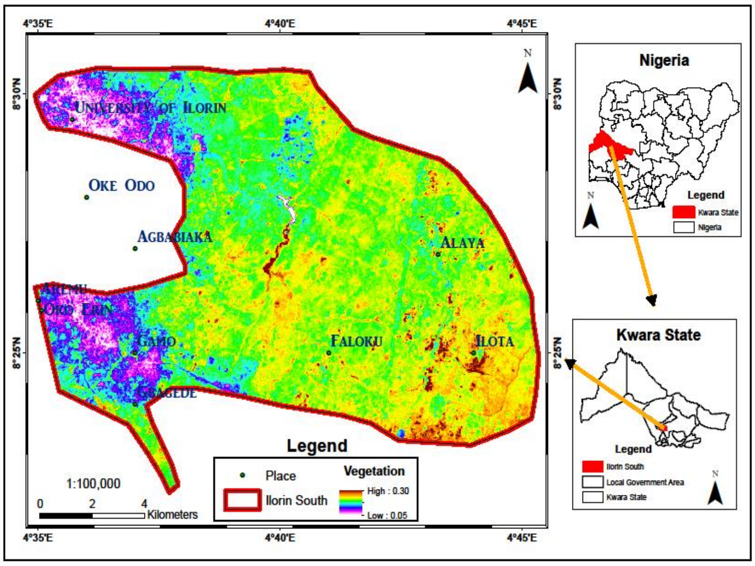

Figure 2: Map of the Study Area: Nigeria-Kwara-State-Ilorin South L.G.A

Materials and Method

Thedata sets used for this research are (Table 1): Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM) data with 30 meter resolution, obtained from USGS website on which hydrologic analysis was performed to produce drainage pattern and density data of the study area; Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) image (30m resolution) from USGS database for the production of Land Cover Information. The software used for the study is ArcMap 10.2 software and Microsoft Excel for assignment and calculation of weights for flood factors.

Identification of potential flood prone areas

To identify the potential flood prone areas, places that have been observed to be characterized with flood during downpour or with the signs of flooding during dry season were visited with Global Positioning System (GPS) instrument and their coordinates were obtained and tabulated (Table 2) using Microsoft Excel spread sheet. These coordinates were imported into ArcMap 10.2 softwareenvironment and mapped to have a holistic view of the likely areas which may be susceptible to seasonal flooding.

Drainage density

The drainage density was obtained as the total length of all the rivers in a drainage basin divided by total area of the drainage basin. The drainage length density as explained by Greenbaum (1985) is the total drainage length per unit area. Drainage was extracted from the SRTM data and expressed as the density map for easy characterization of rainfall runoff and accumulation of rain water in the catchment area. The drainage density map was analyzed in ArcMap 10.2 software using the kernel density tool.Stream density analysis was carried out from the result of watershed analysis using the drainage patterns. The stream density is the total length of the stream network divided by the basin area. It was generated with line density in spatial analyst tools in ArcMap 10.2 workspace. The drainage/stream density map was produced by using the “Line Density Tool” on the ArcToolbox, in which the stream in the study area was used as input layer

Slope

Using the Digital Elevation Model data, the Slope of the study area was generated. The study area boundary was used in clipping out the required spatial extent. A 3D analysis raster surface slope was generated using the derived basin boundary DEM data. The slope was produced from the Digital Elevation Model (DEM), in which the DEM was clipped using the “Extract by mask” tool and the slope was produced using the “Spatial Analyst Tool” in the ArcMap 10.2 software environment.

Land Use Land Cover

The land cover map was produced from the Landsat 8 OLI-TIRS image data using supervised classification (maximum likelihood classifier). False color combination, band 5, 4, 3, was composited and the bands were stacked for image classification operation. With proper knowledge of the study site and strict adherence to Anderson Level 1 classification scheme, the training sites were selected (region of interest – ROI) and the various land use classes were diligently defined. Four LULC classes were identified and defined which are Urban, bare land, water body and vegetation. The image classification was then carried out on ENVI 4.5 Classic Software, in which the Supervised classification was used. Using the supervised classification method, region of Interest (ROI) was created using the “ROI tool” on ENVI 4.5 software. ROI was created by visualizing the image, selecting of sample pixels (training sites) for each land cover type and storing them. These samples were the used for the supervised classification, in which maximum likelihood method was employed. Four major land cover types were classified which were built up area, water, vegetation and bare surface.

Results And Discussion

The acquired GPS data showed twelve points have been observed to be prone to flooding identified potential flood prone areas are as displayed in Table1.

Table 1: Acquired GPS Data

S/N	Description	E(m)	N(m)
1	University of Ilorin	683293	936250
2	Unilorin Forest 1	688017	932016
3	Unilorin Forest 2	686975	934260
4	Unilorin Forest 2	687491	937158
5	Agbabiaka	680508	933791

6	Agbabiaka Inside	681506	932312
7	Ganmo	676034	931677
8	Amayo	678310	930534
9	Tanke	676715	939267
10	Tipper Garage Road	679749	940751
11	Jimba-Oja	688035	928050
12	Power line Jimba-Oja	689299	928896

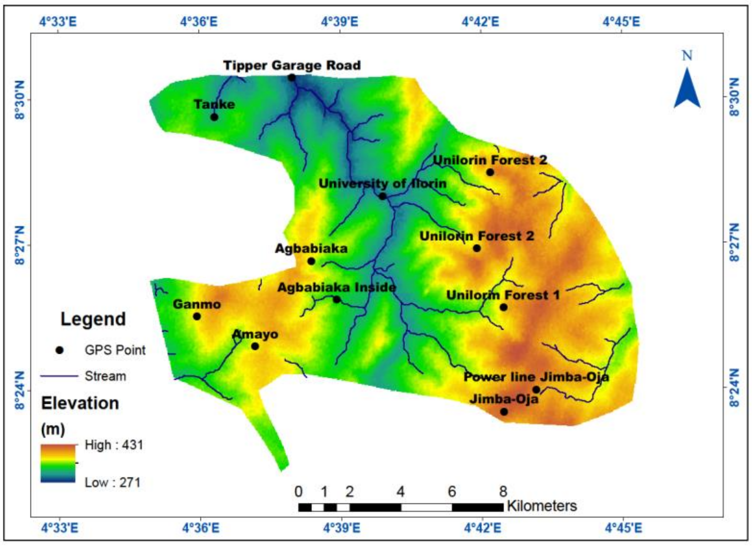

Figure 3: Potential Flood Prone Areas

The map of the potential areas prone to flooding (Figure 3), drainage density (Figure 43) and slope (Figure 5) were produced. Observation from Figure 3 revealed that the potential flood areas are places of low elevation. It was also observedfrom Figure 4that these places are along the water channeland water would naturally drain into the areas of low elevation. Hence these are invariably the areas that are highly prone to flood.

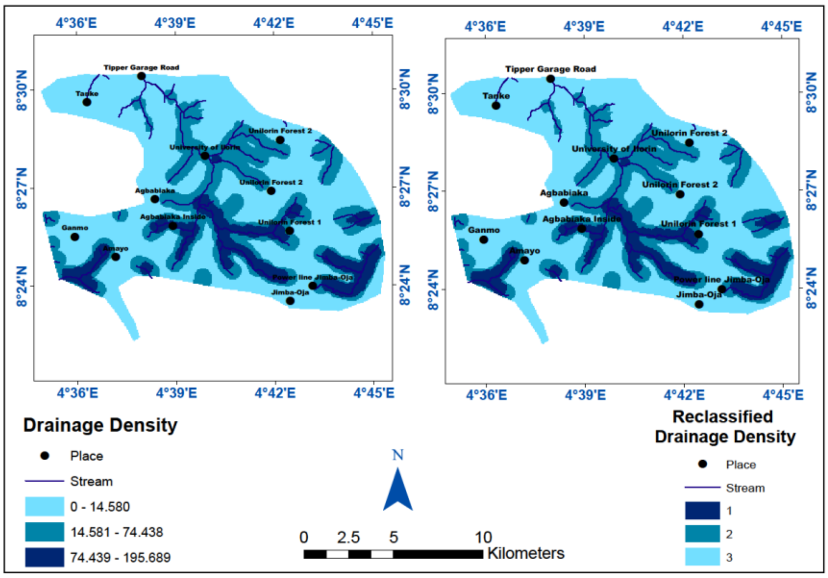

Figure 4: Drainage Densityand the ReclassifiedDrainage Density Map

Slope is a measure of steepness or the degree of inclination and one of the most significant flood influencing factors determines the velocity of water. From Figure 5Areas with gentle slopes are usually prone to flooding, as lower lying and less steep areas are the first to be flooded when a flood enters an area Bathrellos *et al.*, (2018).

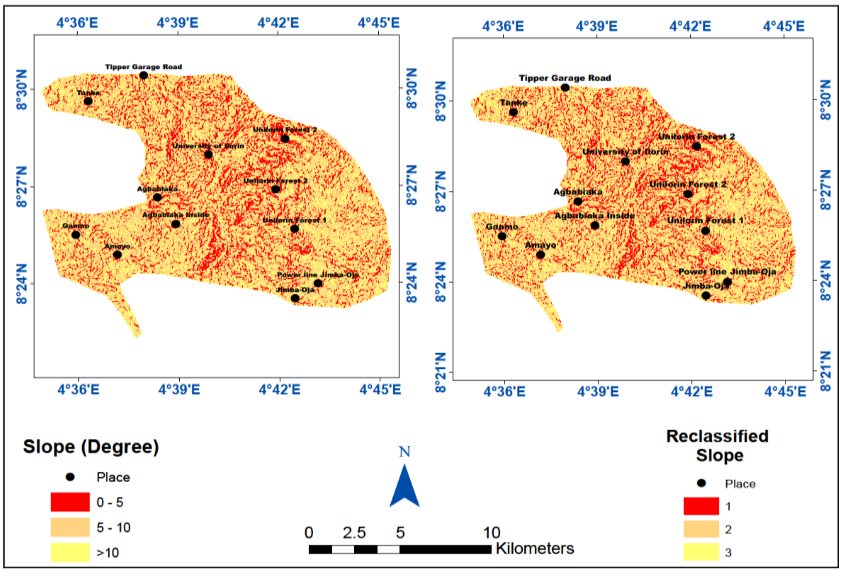

Figure 5: Slope and the Reclassified Slope Map

The slope of the study area ranges from 0-10° and was divided into three main slope classes and further reclassified into three classes (Figure 5). Slope of 0°– 5° are flat/almost flat areas and they are highly prone to flood. Slope of 5°–10° are gentle and are less prone to flood and slope greater than 10° are not prone to flood

Conclusion

The research has brought to light the proneness of the study area to flooding which is an insight into flood control and management in the study area. Twelve places were identified to be prone to flooding. The drainage density and slope analysis further illuminated on the proneness to flood. The result of this researchis a tool for an accuracy assessment and validity of the flood hazard map preparation and production. It is also a major tool in Environmental Impact Assessment of the study area. Planners, agriculturist and all environment managers will find this research a useful tool in the management of a sustainable development.

Recommendation

Flood has been a serious and dangerous environmental hazard all over the world and in the resident state of the study area. The research finding is recommended to be adopted for a sustainable flood control and management in the study area, and as a stimulant to flood-prone study of other areas. The government of and concerned authority should adopt the research to provide necessary measure to avoid, ameliorate and manage flood occurence in the Study area.

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