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Flood hazard analysis of Ede, Osun State, South West, Nigeria

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Abstract: Flood hazard is a rare or extreme event that may adversely affects human life, property or activity to the extent of causing a disaster. The objectives are to generate terrain analysis and map flood vulnerability mapping. The methods used are drainage basin delineation and hydrological parameter evaluation, Arcmap and ENVI software was used. While the analytical hierarchy process method was used to compute the priority weights of each criterion. Multi-Criteria Decision Analysis (MCDA) for Flood vulnerability mapping were used. Geospatial technology is integrated with (MCDA) to evaluate potential flood risk area and mitigate. The dataset are Ground Control Point (GCPs) using GPS and field measurements, Topographic maps (1:50,000) Rainfall data (1998-2015) – TRMM, Landsat ETM (30m) 2015 - USGS Archive, Digital Elevation Model (DEM) (30m). Six factors has been account for as a cause of flood, these includes; mean annual rainfall, digital elevation, slope, soil map, drainage density, and landuse. Using AHP, the percentages derived from the factors were mean annual rainfall (MAR) 33.33%, digital elevation model (DEM) 12.6%, drainage density (DD) 9.39%, slope 19.94%, soil class 17.79%, and landuse/landcover (LULC) 6.93%. The study concluded that livelihoods of people in the flood vulnerable areas of 70metre buffer are endangered, and recommends preparedness for potential flood hazards in the area.

Keywords: *Drainage Density; DEM; MAR; AHP; Migitation; Geospatial; Vulnerability.*

I. INTRODUCTION

Flood is a temporary covering of land by water as a result of surface waters escaping from their normal confines or as a result of heavy precipitation Baloye (2016). This is one of the most common hazards around the globe; there are several types depending on their causes and method or method of formation. Some floods develop slowly, while others can develop in just a few minutes and without visible signs of rain. Also, floods can be local, impacting a neighborhood or community, or very large, affecting entire river basins and multiple regions. Emmanuel, et al (2015), says that flooding occurs most commonly from heavy rainfall when natural watercourses do not have the capacity to convey excess water, can also result from other phenomena, particularly in coastal areas where inundation can be caused by a storm surge associated with a tropical cyclone, a tsunami or a high tide coinciding with higher than normal river level.

Natural phenomena are extreme climatological, hydrological, or geological, processes that do not pose any threat to persons or property. A hazard is a rare or extreme event that may adversely affects human life, property or activity to the extent of causing a disaster, According to Baloye (2016), a hazard occurrence (the earthquake, the flood, or the cyclone, for example) becomes a disaster when it results in injuries, loss of life and livelihoods, displacement and homelessness and/or destruction and damage to infrastructure and property.

A. Statement of research problem

Rainfall is an important determinant of health (WHO, 2018). Nigeria is not located in high-prone natural disaster (e.g. earthquake, hurricane) zones, but the country has experienced cases of floods, coastal erosion, sand storms, landslides, oil spillage, and desertification disasters. These disasters have resulted in the loss of lives as well as properties. For example, about 100 people died in Ibadan due to flood in 2011 while 5,000 people were displaced with severe economic impacts Godstime et al., (2013). The flood disaster occurred on the 9th of September, 2010 affecting Sokoto and Kebbi States in North-West Nigeria. The flood disaster was driven by heavy down pour of rain in the days leading up to the 9th of September. This resulted in the failure of the Goronyo Dam and the subsequent overflowing of River Rima. The Kogi state flood event took place on the 25th of September, 2012. This was as a result of rising water levels in both Rivers Niger and Benue. Drainage is an important physical factor that greatly contributes to flood disaster. The stream order is also important in the evaluation of flood's impact over an area occurrence Eguaroji et al., (2015).

Although natural disasters cannot be avoided, studies have shown that adequate disaster management plan can reduce its impacts on lives and properties. Moreover, disasters often do not respect national or international boundaries. As a result, governments and international organizations are cooperating to promote global and regional initiatives to address the full/partial disaster management cycle consisting of mitigation, preparedness, response and recovery Niekerk, (2007). Geospatial technology should be considered as a method to reducing the effect of flood through planning and management, providing capability to map the extent of drainage networks and basins, flood prone areas and suitable place to build relief. This study will therefore give insight to the decision makers, ways to preserve the economy and to combat continuous loss of lives and properties to flood on a yearly basis.

B. Aim and Objectives

The aim of this research work is to analyse flood hazard and map out vulnerability area within the study

The specific objectives are to;

i. generate terrain analysis of the study area; and
ii. map flood vulnerable zones.

C. Study Area

The study area is Ede metropolis and its environments; Ede is one of the local governments in Osun State, Nigeria. Geographically, It is situated on latitude 7° 44' 0" and 7° 48' 16" N of the equator and longitude 4° 26' 0" and 4° 39' 4"E of

Greenwich Meridian (see figure 1 below) showing the topographic map of study area. The climate is tropical, Like every other Southwest area, the rainy season starts April to October while the dry season lasts October to March (Ogunyemi, 2009). The population of the two according to the 2006 National Census is put at 159,866 and 188,027 respectively.

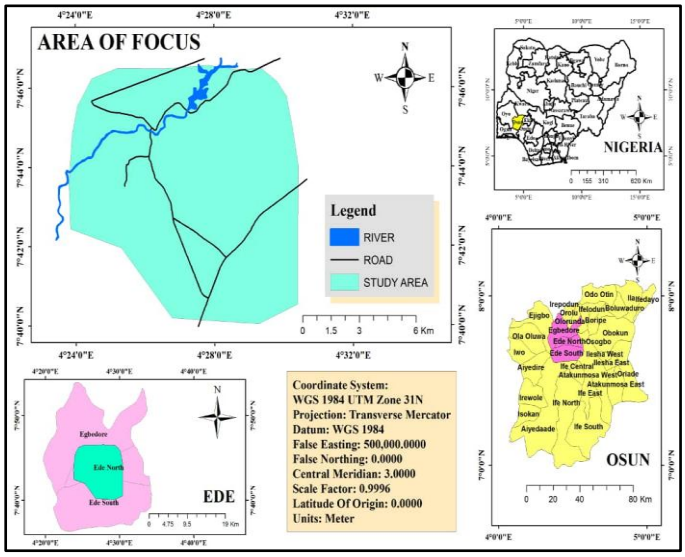

Figure 1: Study Area Map

II. LITERATURE REVIEW

This literature review is aimed to provide background evidence flood hazard analysis, whilst highlighting relevant issues addressing on flood situation. The impact of flooding does not only affect a person's state of bodily health, but also their feelings of wellbeing and general ability to cope with everyday life. Flood is a temporary covering of land by water as a result of surface waters escaping from their normal confines or as a result of heavy precipitation. Flood is the commonly hazards around the globe; some floods develop, slowly, while others can develop in just a few minutes and without visible signs of rain. The effect of flood in different parts of the world especially in Nigeria, has led to deplorable living of people which has made many people either to evacuate or abandon their houses, farming is no longer encouraged, commuters and transporters are faced with route flooded by water especially in the area concerned (Benjamin, 2017). Factors that may be responsible for the flood include (see figure2); improper disposal of waste, blockage of the drainage system, lack of flood early warning system, no structured maps showing the areas that are prone to flood, building along the flood plain and lack of technology and personnel to manage the environmental hazard.

III. MATERIALS AND METHOD

A. Data types and sources

The various sources of data used for the study include:

Ground Control Point (GCPs) using GPS and field measurements, Topographic maps (1:50,000) Rainfall data (1998-2015) – TRMM, Landsat ETM (30m) 2015 - USGS Archive, and Digital Elevation Model (DEM) (30m)

B. Data Analysis

Drainage basin delineation and hydrological parameter evaluation was used to generate the following factors; Slope, Elevation map, Landuse classes, Drainage density, Rainfall, buffering, Drainages, and (Reclassify of all the factors), Multi-Criteria Decision Analysis (MCDA) for Flood vulnerability mapping, the software are; ArcMap, ENVI, Excel and Microsoft office. The strahlar stream ordering system was used to order the entire drainages of the study area. A drainage basin morphometry study involves analyzing area, linear and relief parameters of the basin which help us to understand the natural environment of the basin, and they also summarize spatial characteristics of the basin. Morphometry is and mathematical analysis of the configuration of the earth's surface, shape and dimension of its landforms Samson et al., (2016).

IV. RESULTS AND DISCUSSION

A. Results

The results of the analysis is based on the objective set for this flood hazard analysis in Ede, to generate terrain analysis and map flood vulnerable zones of the study area.

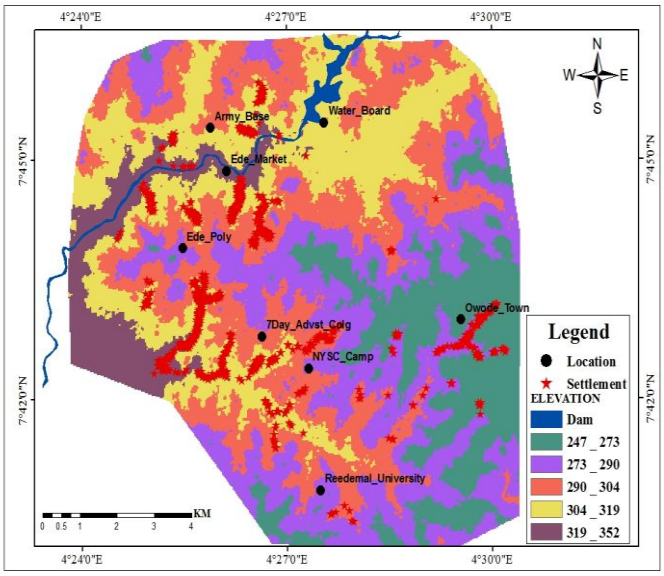

Figure 2: Digital Elevation Map (DEM)

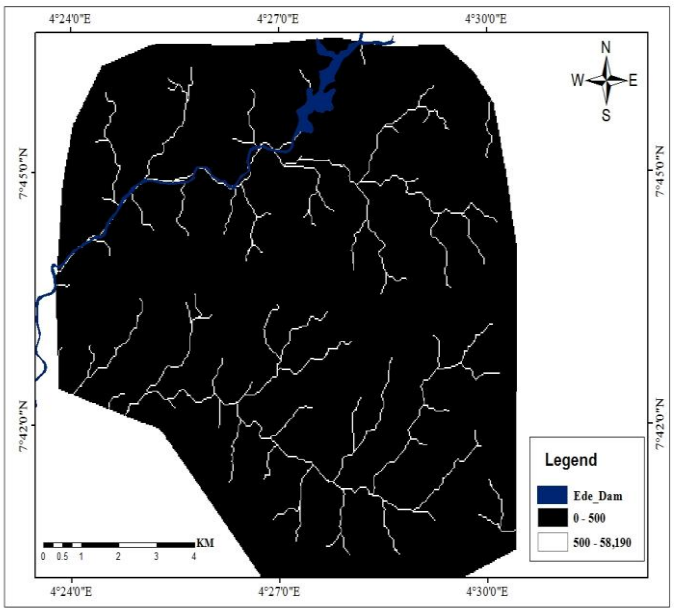

Figure 3: Drainage System

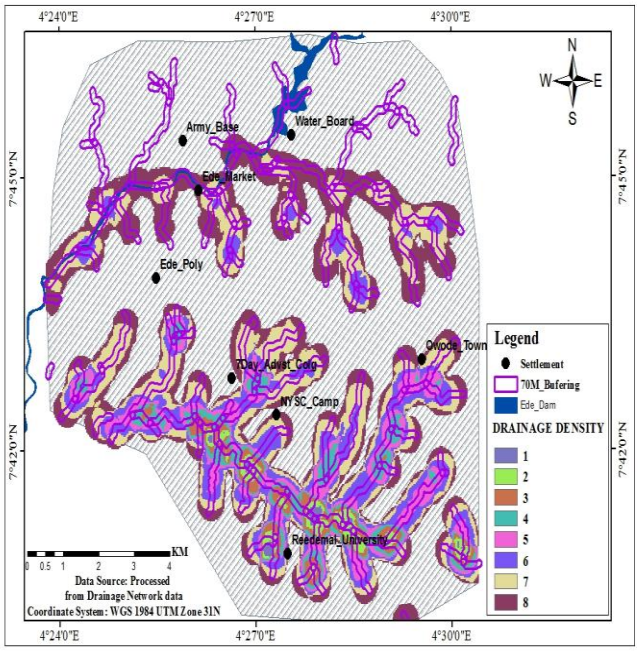

Figure 4: Drainage Density (DD)

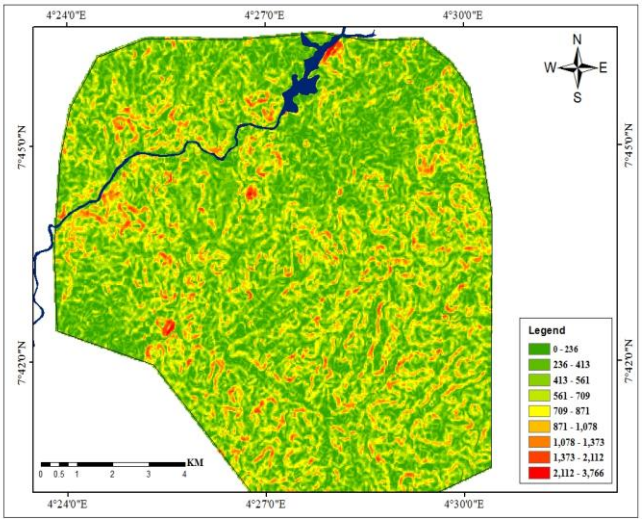

Figure 5: Slope (Height and Low level)

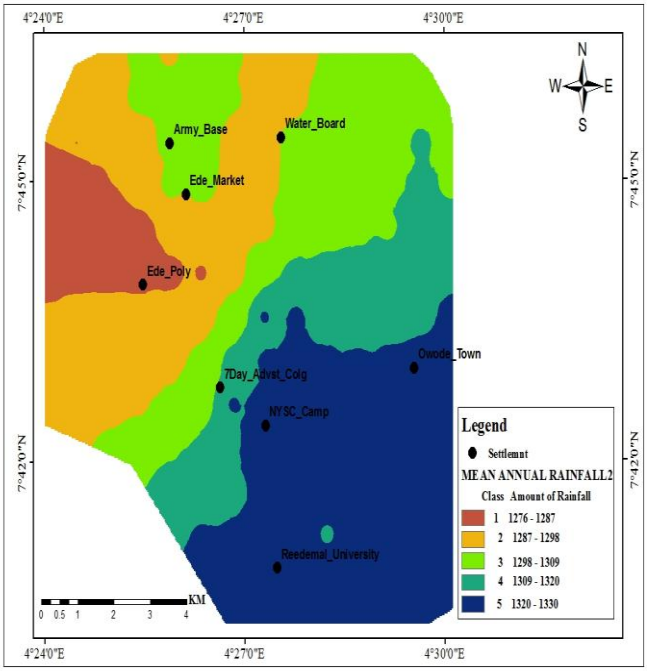

Figure 6: Rainfall Variation

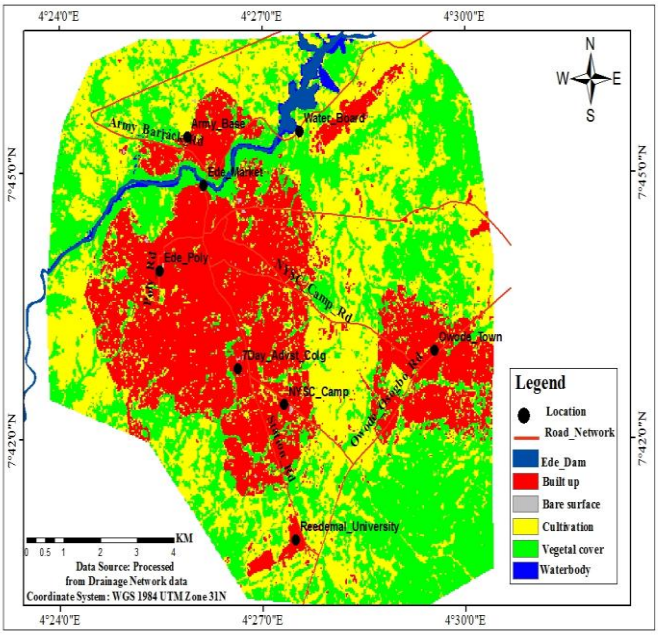

Figure 7: Landuse Landcover Classes (LULC) 2016

Table 1: Landuse classification of the area

Lulc Classes	Area Cover (Km2)	Percentage (%)
Built-Up	56275.2	6.79%
Bare-Surfaces	257.04	0.031%
Cultivations	138252.51	16.69%
Vegetations	631368.9	76.21%
Water-Body	2343.33	0.27%
Total	**828496.98**	100%

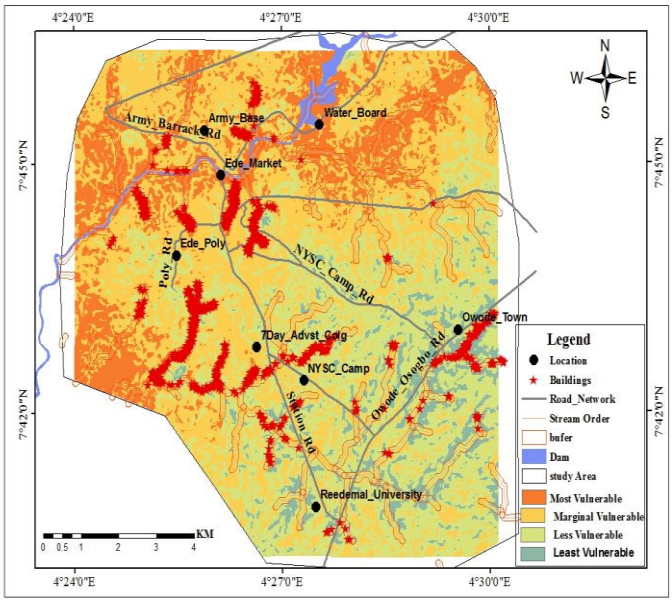

Figure 8: Vulnerability Map

B. Discussion

The study shows six factors that were analyzed using Analytical Hierarchy Processing (AHP) for decision making. These includes; mean annual rainfall (MAR) 33.33%, digital elevation model (DEM) 12.6%, drainage density (DD) 9.39%, slope 19.94%, soil class 17.79%, and landuse/landcover (LULC) 6.93%. The matrix and normalized principle eigenvector showed how important in ranking the contributing factors to flooding are, (Figure 9). The elevation map shows the varying lands height (less than 58 meters above the mean sea level) Low elevation area is more prone to flooding (Figure 2).

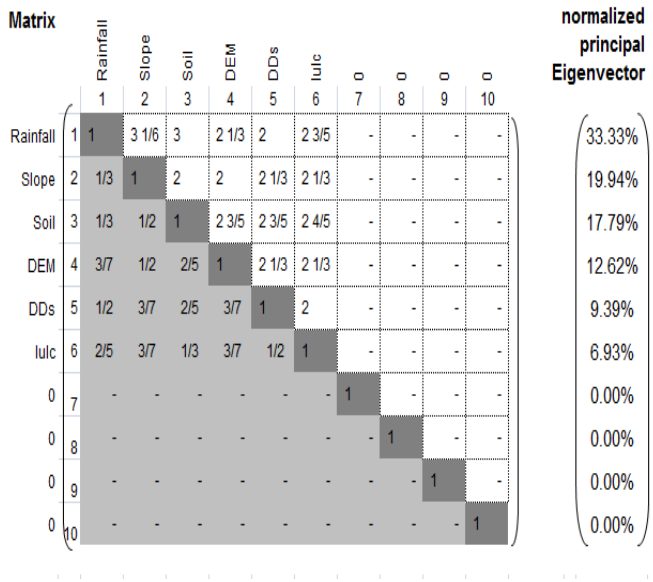

Figure 9: AHP matrix and normalized principle Eigenvector

Flat surfaces allows water accumulation and hence influence flooding, sandy soil tends to allow more infiltration to loamy soil, high rainfall intensity with long duration of storm event encourage more flooding, higher drainage density tends to be saturated and hence influence flooding, and The vulnerability map shows that water-body or wetlands area are more prone to flooding 996 buildings of 70m buffer zones are within low land areas.

CONCLUSION

Ede Local Government Area of Osun State is the most populated local government and as a result of its relative high elevation, they have not experienced any serious flood that have caused loss of life or property been destroyed, they usually experience flash flood during rainy seasons in the areas and it usually subsides quickly maybe dangerous. 70metre buffer was carried out in case of event that may likely occur and to adopt measures mitigation to handle situations. Based on that multi-criteria analysis model AHP was analyzed, to know areas that are vulnerable and geographically visualized areas that are susceptible to flooding.

Recommendation

Due to the effects of flood and unpredictable heavy rainfall, there is need to look forward for mitigating mitigate measures, Some arrangements must be put in place and evaluated to deal with the problems that might likely occur. Based on the study, the following recommendations are made to tackle the problem of flood and for further studies:

Urban development regulations should be strictly enforced by the relevant government agencies such as Lagos State Building Control Agency in the Ministry of Physical Planning and Urban Development. This will ensure that properties are not built on water ways. Environmental Agency should carry out their duties on sanitation in the Local Government. Drainage Systems, bridges, canals and construction of roads should be done at appropriate places and the existing blocked drainage system should be opened up. Provision of flood risk maps by surveyor general's office to know the areas that are more vulnerable or prone to flooding in the study area which will help during decision making. Construction of leaves and dams are necessary in order to prevent water from overflowing its banks.

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