International Journal of Innovative Environmental Studies Research 3(2):36-46, April-June 2015

© SEAHI PUBLICATIONS, 2015 www.seahipub.org ISSN: 2354-2918

FLOOD HAZARDSCAPE MAPPING IN JALINGO METROPOLIS, TARABA STATE, NIGERIA

ORUONYE, E. D.

Department of Geography,
Taraba State University,
P.M.B. 1167, Jalingo,
Taraba State Nigeria.
eoruonye@gmail.com Tel: 07039271480

ABSTRACT
The increasing frequency and losses associated with flooding has made it imperative to find ways of preventing flood hazards and its associated risk to the barest minimum. One important way of achieving this, is by obtaining the flood hazard map of the study area. Geographical Information System (GIS) and Remote Sensing techniques have been successfully applied all over the world for flood monitoring, vulnerability, management and control. This study therefore attempts to fill in the gap in traditional approach to flood risk management by mapping the flood hazardscape of the study area. Data from field work, topographical maps, Landsat Enhanced Thematic Mapper plus (Etm+ 2015) and Shuttle Radar Topographic Mission were used as base map for the GIS technique. A flood buffer was produced based on 30m, 50m, and 100m distance from the river and elevation height of 118m. The floodscape was zoned into high risk, medium risk and low risk zones. The findings of this study show that most of the buildings along the floodplains of Rivers Lamurde and Mayogwoi in Jalingo town falls within the high risk zone. The buildings are typical of low-cost informal settlements in urban areas. The findings show that, apart from heavy rainfall, encroachment of residential buildings on the floodplain constitute a major cause of flood hazard in the area. The medium risk zones are areas within 118meter above sea level. Beyond this height elevation are considered low risk zone. In other places within the centre of the town, lack of drainage network, small size of drainages and blockage of the drainage channels are the causes of flooding. The study recommends the need to limit floodplain development and enforcement of various legislative provisions on this and emergency planning such as forecasting, early warnings, evacuation plans and post flood recovery measures.
Keyword: Buffer, Flood, Hazardscape, Jalingo and Vulnerability

INTRODUCTION
With an increasingly urbanizing world, flood disasters are reportedly increasing in urban areas and particularly negatively impacting on poor people (Alam *et al*, 2008) and urban development in general. Flood has historically been conceived of as large areas of land being inundated with water because of rivers overflowing (Benjamin, 2008). Flooding incidents have claimed many lives, rendered many others homeless and disrupted a wide range of environmental factors and socio-economic activities related to agriculture, vegetation and sustenance of human and wild life (Jeyaseelan, 1999; EC, 2007). One of the most common natural hazards in Jalingo metropolis is periodic flooding from the local stream, River Lamurde and its tributary, the Mayogwoi River. The increasing frequency and intensity of flood in Jalingo and other parts of Nigeria in the last decade, is an indication of staggering risk all over the world. Although different parts of Jalingo Local Government Area (LGA) is exposed to flood almost every year, the 2005 and 2011 floods break all records of the past. The 2011 flood devastated three north eastern states of Borno, Bauchi and Taraba, washing away over 4000 farms and destroying over 5000 houses (Timothy, 2011). In Taraba state alone, the flood destroyed over 2,068 farms, 363 houses and partially

affected 1,562 houses. Over 6,213 persons were internally displaced and 1,420 families affected by the flood in 4 LGAs, Jalingo, Lau, Ardo Kola and Yorro (Timothy, 2011). The most exposed populations to the flood hazard are usually the most vulnerable which constitute the urban poor living in the informal settlements along the floodplain. They are more vulnerable because of their lack of social protection and poor economic situation. Over the years, the response of government and relief agencies to flood hazards in Jalingo and other parts of the country has been in the area of rescue and supply of relief materials to victims of flood (Hodo, 2011). Little or not much is done to ensure that the hazard is prevented and its associated risk reduced to the barest minimum (Jeb and Aggarwal, 2008). This makes it imperative to explore modern day techniques in developing measures that will help government and relief agencies in the identification and mapping of flood hazardscapes and in planning against flooding events in the future. Although most of the developed countries are well equipped with detailed flood hazard maps, up-to-date flood insurance maps and post-disaster hazard mitigation technical support (FEMA, 2003), there is hardly any detailed spatial database for flood prevention and mitigation in the developing countries (Sanyal and Lu, 2005).

Reduction of the impacts of flood hazards will depend largely on the amount of information available and knowledge of the areas that are prone to flood hazard (Hodo, 2011). Obtaining an overall picture of the flood hazardscape is therefore very essential in identifying areas at risk in the study area. This will help in building information infrastructure for emergency management in the area. Thus, one way to mitigate the effects of flood is to ensure that all areas that are vulnerable are identified and adequate precautionary measures taken to ensure adequate preparedness, effective response, quick recovery and effective prevention (Suleiman *et al,* 2014).

Remote sensing and Geographical Information System (GIS) has emerged as an indispensable tool in the study of flood hazardscapes, particularly with its capacity to provide near real-time data, enabling mapping of the flood hazardscape. Several studies connected with floods (areal extent, zonation, damages) have been undertaken on the basis of Remote Sensing Techniques (Jain and Sinha, 2003; Sankhua, *et al*. 2005; Jain *et al*, 2005; Prasad, *et al*, 2006). GIS techniques have been successfully applied all over the world for flood monitoring, vulnerability, management and control (Ikusemoran, et al, 2013; Sanyal and Lu, 2003; Bapalu and Sinha, 2005; Kartic et al, 2012). GIS and remote sensing provides required information on important indices of flood hazardscape mapping such as elevation, slope orientation, proximity of buildings to rivers and floodplains, network of drains, presence of buffers, extent of flooding and altitudes among others. Hence, GIS and remote sensing were integrated in this study to examine and map the flood hazardscape in the study area. This will help in periodic monitoring of flood events in the study area and proffering of solutions. This study therefore attempts to fill in the gap in traditional approach to flood risk management by mapping the flood hazardscape, zones and the range of the flood hazard impact in the study area. This will involve determining the extent of flood inundations in the study area, mapping areas liable to flooding and creating flood risk zone based on distance from the river valley (30m, 50, 100) and height elevation of 118meter above sea level.

Conceptual Framework

Hazardscape have been used in recent times interchangeably with concepts such as, riskscape and disasterscape in the literature (Corson, 1999; Cutter et al., 2000; Gray, 2001; Mustafa, 2005; ODESC, 2007; Kapur, 2010). Khan (2012) acknowledges that the three terms are related but finds them conceptually distinct and therefore have different methodologies for assessment and planning. Khan (2012) noted that while a hazardscape represents the existing and potential sources of threats (hazards), riskscape portrays potential damage (risks) and disasterscape demonstrates the actual damage (disasters). In this study, the term hazardscape is preferred and used to map the areas that are vulnerable to flooding in the study area.

According to Khan (2012), the term “hazardscape” was first defined by Corson in 1999 with a focus on technological hazards. Hazardscape was defined by (Corson, 1999) as “the spatial distribution and attributes of human engineered facilities. . . that contain or emit substances harmful to humans and environment”. Khan (2012) observed that even though this definition is relevant to most technological hazards, it does not fully apply to hazards in general or to natural hazards. Cutter et al, (2000) used the word "hazardscape" interchangeably with "riskscape" but they did not define the term. Gray (2001) used the word hazardscape to describe the collective areas of risks associated with hazards. This definition again interpreted the hazardscape in terms of risk rather than specifying its source (Khan, 2012). Mustafa (2005) described hazardscape as an integrative concept, and defined it as "both an analytical way of seeing that asserts power, and as a social environmental space where the gaze of power is contested and struggled against to produce a lived reality of a hazardous place". Hazardscape according to Khan and Crozier (2009) can be defined as a dynamic scape, which reflects the physical susceptibility of a place and vulnerability of human life and assets to various hazards in a given human ecological system. Hazardscape refers to the knowledge we have of the intensity and frequency of hazardous event (Gray, 2003). Hazardscape substitutes for the term natural hazards which alludes to some ''external nature as the key causative elements in the hazardous and vulnerability of life'' (Benjamin, 2008). From the above, it can be seen that hazardscape is the vulnerability of a particular place to any human and physical hazards and disaster. In this case, we look at flood hazardscape as all the areas that are vulnerable or at risk of flood hazards in Jalingo metropolis. The concept of flood hazardscape would be more appropriate to include localized flooding due to inadequate drainage, flooding from small streams in urban areas, flooding in urban areas located on major river banks and urban areas experiencing coastal flooding (Benjamin, 2008).

Description of Study Area

Jalingo LGA is roughly located between latitudes 8^o 47' to 9^o 01'N and longitudes 11^o 09' to 11^o 30'E. It is bounded to the north by Lau Local Government Area, to the east by Yorro Local Government Area, to the south and west by Ardo Kola Local Government Area. It has a total land area of about 195km^2. Jalingo LGA has a population of 139,845 people according to the 2006 population census, with a projected growth rate of 3% per annum (Shawulu et al, 2008). Presently, it has a projected population of 165,774 in 2014 (Oruonye, 2014). The relief of Jalingo LGA consists of undulating plain interspersed with mountain ranges. This compact massif of rock outcrops (mountains) extends from Kona area through the border between Jalingo and Lau LGAs down to Yorro and Ardo Kola LGAs in a circular form to Gongon area, thus given a periscopic semi-circle shape that is almost like a shield to Jalingo town. Jalingo metropolis is drained by two major rivers Mayogwoi and Lamurde (Fig. 1), which took their source from the mountain ranges in Yorro LGA and emptied there content into the Benue river system at Tau village. The valley of River Lamurde is dotted with ox-bow lakes which is as a result of depositional activities. Jalingo LGA has tropical continental type of climate characterized by well-marked wet and dry season. The wet season usually begins around April and ends in October. The dry season begins in November and ends in March. The LGA has a mean annual rainfall of about 1,200mm^3 and annual mean temperature of about 29^{o}C. Relative humidity ranges between 60-70 per cent during the wet season to about 35 – 45 per cent in the dry season. Vegetationally, Jalingo is located within the northern guinea savanna zone characterized by grasses interspersed with tall trees and shrubs. Some of the trees include locust bean, sheabutter, eucalyptus, baobab and silk cotton tree. The major ethnic groups of Jalingo LGA are the Fulani, Jibu Kona and Mumuye, while other ethnic groups such as Hausa, Jenjo, Wurkum and Nyandang are also found. Hausa language is widely spoken as a medium of communication for social and economic interactions.

The Rivers Lamurde and Mayo Gwoi form a confluence in Jalingo town around Magami ward. River Lamurde has extensive flood plain on both sides of the river. The northern bank of the river is heavily occupied by residential settlements despite the increasing devastating effects of recent floods in the area, while the southern bank is intensively cultivated. The farmers in the area cultivate the land three times per year through irrigation (Oruonye, 2011). With the construction of the new roads and bridges along these rivers and increasing urban population, the land uses along the floodplains of the river is fast changing (Oruonye, 2015). River Lamurde is the major source of recharge for underground water in the area with a typical minimum yield of 648,240m^3 per year from the boreholes located within the flood plain of the river (Musa, 2002). The river has also over the years limited the growth of the town on the southern part for a long time. Hitherto, lands across the Lamurde River remained open fallow land and generally reserved for rainfed agricultural use only. The construction of new roads and bridges along these rivers that bordered the town on the southern part (Fig. 1) has in recent times opened up the areas (including the river banks) for urban growth (Oruonye, 2013). These roads include the Jalingo byepass and the Nassarawa–Mile six roads, while the bridges include the second and third bridges along Mayogwoi River at Pantinapu and Nyabu Kaka (Nassarawa-Mile six road) and the new bridge across Lamurde river at Karofi (Jalingo byepass road). These are some of the recent developments that are encouraging and stimulating urban growth and land use changes in the study area. These changes in land uses along the banks of the Lamurde River have resulted in large scale transformation of the landscape. The magnitude of this transformation of the landscapes resulting from changes in land uses along the floodplains of the river has been a matter of great concern because of the increase in the devastating effects of flooding in recent times in the area (Oruonye, 2012a,b). This makes it imperative to map the flood hazardscape of the area.

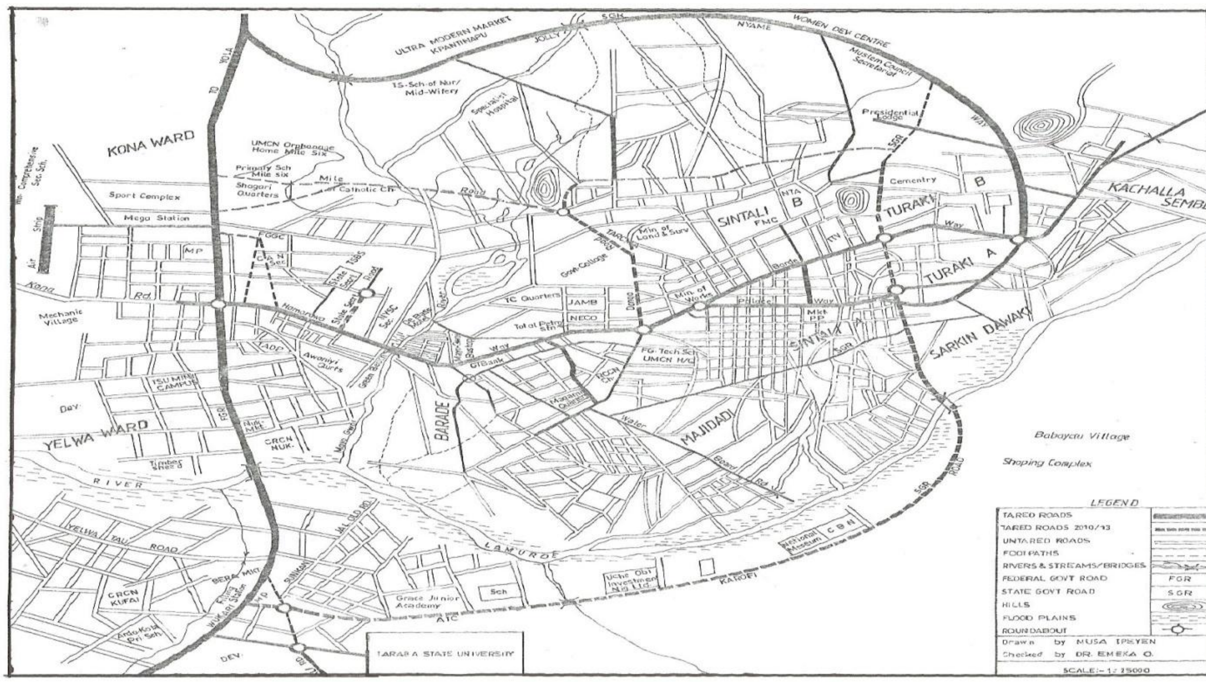

Fig 1. Map of the study

METHODOLOGY

The data used in this study includes field generated data and data derived from topographical map as well as Landsat Enhanced Thematic Mapper plus (Etm+ 2015) and Shuttle Radar Topographic Mission (SRTM) data that was obtained from the United State Geological Survey (USGS) online open resources. The map of the study area was obtained from the Taraba State Bureau of Land and Survey. Satellite images of Landsat 8 were used as base map for the GIS technique. The images were retrieved on 15th March 2015 and the projection type is UTM and spheroid is WGS 1984. The datum is the Minna datum, UTM zone 32N and the pixel size is 15 meter. Flood hazardscape mapping of the study area was based on the integrated use of remote sensing and GIS technique. The flood hazardscape mapping of the study area was prepared using geo-coded data and verified with survey of Jalingo toposheets. The toposheets and satellite data were geometrically rectified and georeferenced to World space coordinate system using ERDAS IMAGINE 9.2 software package.

The major type of flood in the study area is flash flood resulting from heavy rainfall and overflow of river bank in the area. Hence, vulnerability to flood hazards largely depends on proximity to Rivers Lamurde and Mayogwoi in the study area and blockage of the urban drains. This makes it necessary to generate the terrain map of the area. Digital Elevation Model (DEM) creation package of ArcGIS software, using Digital Elevation Dataset from Shuttle Radar Topographical Mission (SRTM) was used. This tool automatically shows the topography and the heights of each of the components of the terrain as well as the proximity to the Rivers and floodplain. The extraction of the buildings on the floodplains and communities along the Lamurde Rivers was carried out by the use of the extraction module of ArcGIS so as to have the specific area of interest instead of working on the whole basin. Buffers along River Lamurde were created based on distance of 30m, 50m, and 100m from the river. Another buffer was created based on elevation height of 118m.a.s.l. on the floodplain. After determination of height elevation and 30m, 50m and 100m buffer areas, the next major step was the addition of these two resultant layers in the raster calculator to produce a new layer showing three risk zones:

i. High risk zone - areas within the floodplain buffer 30m, 50m, and 100m distance from the stream line.
ii. Medium risk zone - areas within the floodplain buffer on elevation height of 118m above sea level.
iii. Low risk zone - areas outside the above buffer zones (30m, 50m, 100m and 118m.a.s.l).

The communities/building layer, town layer and stream network layers were overlaid with the risk zones layer to create flood hazardscape maps (Fig. 1, 2 and 3) showing areas within the study area that are in the different risk zones.

Apart from the secondary data and literature on flood hazardscape, few findings of this study are also supported by the interviews conducted to assess local response to various flood hazards with officials of the State Emergency Management Agency and Ministry of Environment.

RESULT OF FINDINGS

Flood Hazardscape

The flood hazardscape is zone into three; high risk, medium risk and low risk zones. The high risk zone is the area that is buffered at 30m, 50m and 100m distance from the river valley. The findings of the study show that the vulnerability of any part of the town depends on the proximity of its location to the river valley, height elevation, size and availability of drainage networks. The high flood risk zone are the places that are located close to the river valleys and are low lying. They are the most vulnerable to flood hazards. As soon as there is heavy rainfall and the river valley is filled, it overflows its banks and these areas are submerged by flood. There are places also that are located almost at the edge of the river valley but on higher elevated grounds. These areas, despite their close proximity to the river valley are less vulnerable to flooding. However, they fall under the medium risk zone and can be flooded with increase in the height of the flood water.

The medium risk zone are the areas lying below 118m height elevation. These are areas that may be located some distance away from the river valley but are vulnerable to flooding because of their low lying elevation. River Lamurde has a wide floodplain that ranges between 500m to 1km or more in some places. Areas lying below 118m.a.s.l. are under this zone. They may not be affected by the annual periodic floods that result from the overflow of the river banks, but are very vulnerable to major flood incident in the study area. This is particularly for areas around Magami (confluence point of the rivers) and water board. Their low lying altitude makes them more vulnerable to major flood incidence in the area.

Low risk zone are the areas that are above 118m.a.s.l. Some of the areas located in the city centre are only vulnerable to flood after very heavy rainfall and blockage of the urban drainage channels. After few hours of such heavy rainfall, the flood water slowly drains away. The damages caused by this type of flood is very minimal when compared with that which result from the overflow of the river banks.

The flood hazardscape takes on localized forms of riverine-type flooding that are experienced by households. These localized forms of the flood hazardscape, although naturally triggered by heavy rainfall, are influenced by the natural environment, as well as political (e.g. poor planning), collective and individual action (e.g. dumping of household waste, site location, building practices) (Mustafa, 2005).

Furthermore, technological factors (housing, road and storm water design) also contribute to shaping the flood hazardscape (Mustafa, 2005). These technological factors are influenced by the physical environment, political, collective and individual action. Out of 10 wards of the LGA, 6 wards in the town are affected by flooding from the Lamurde and Mayogwoi Rivers. Using GIS generated maps, neighboring wards that may be affected due to further rise in the height of flood water were indicated (Fig. 2). Very high precipitation over a short period of time has been observed to be the most important factor responsible for triggering devastating floods in Jalingo metropolis (2012a,b and 2013).

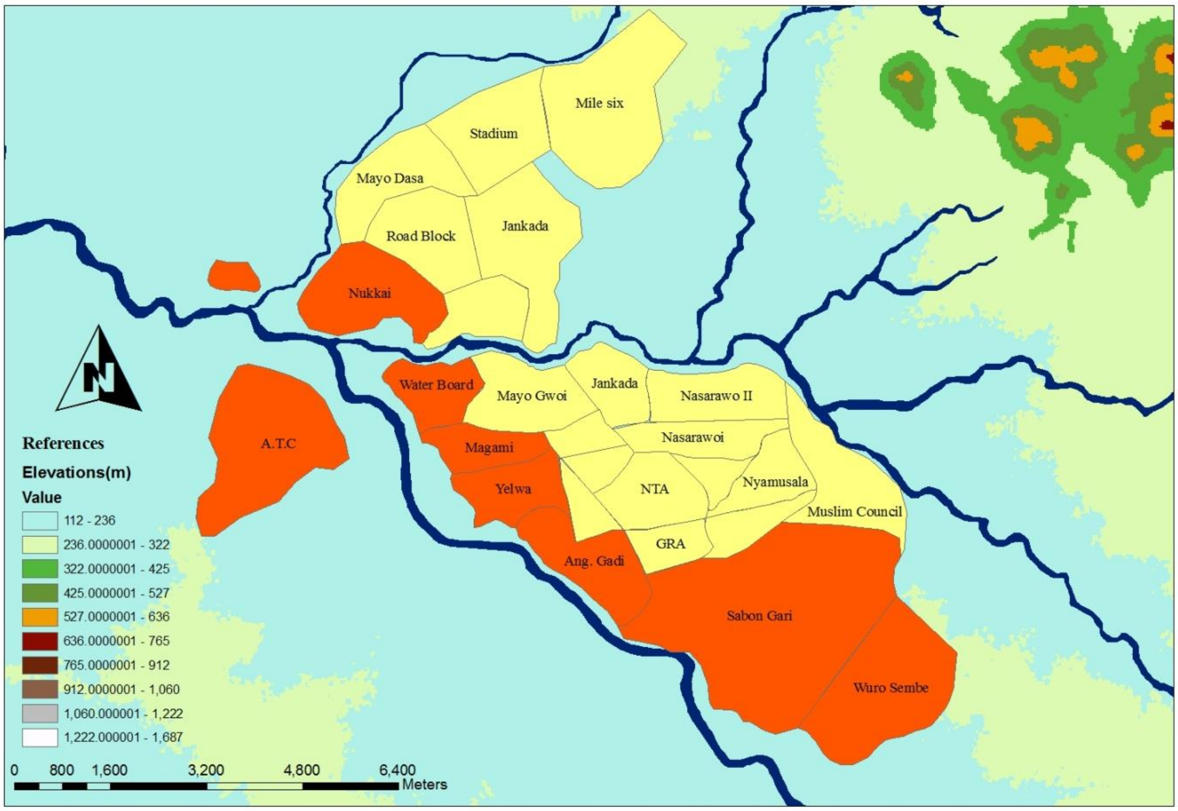

Fig. 2 Areas liable to flooding in Jalingo Metropolis

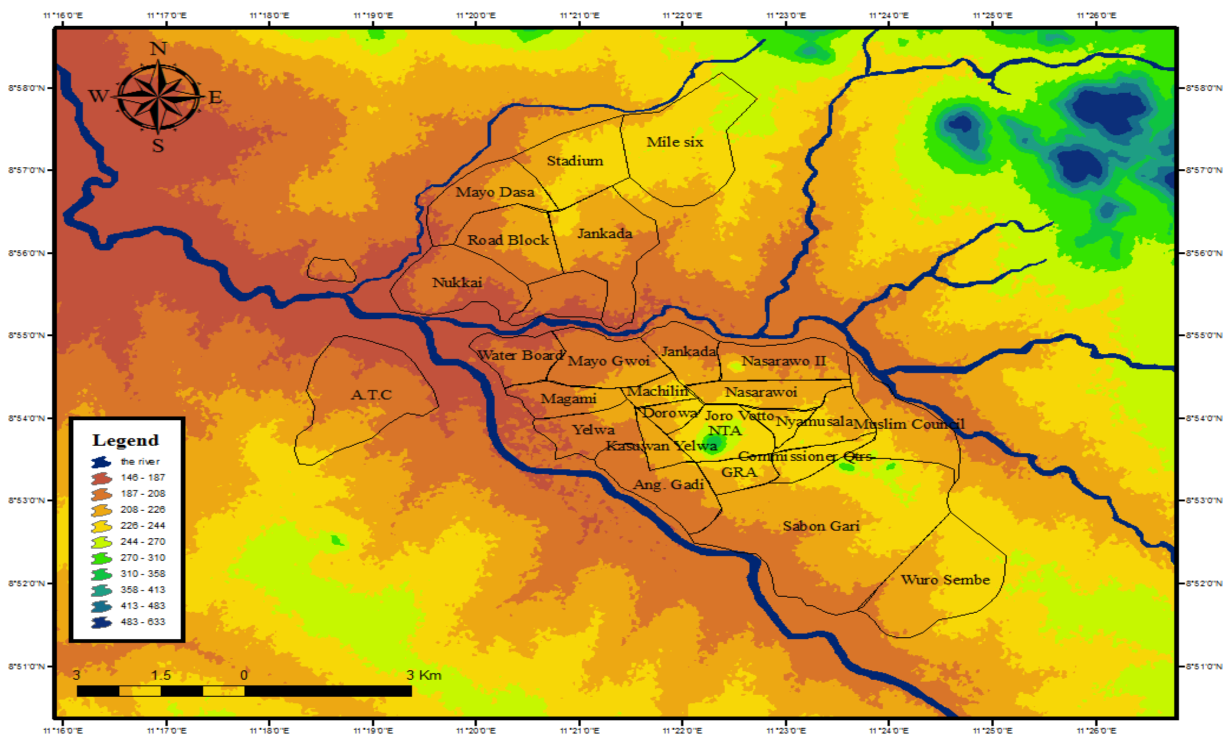

Fig. 3. Flood hazardscape Map of Jalingo town based on Terrain elevation (118m.a.s.l.)

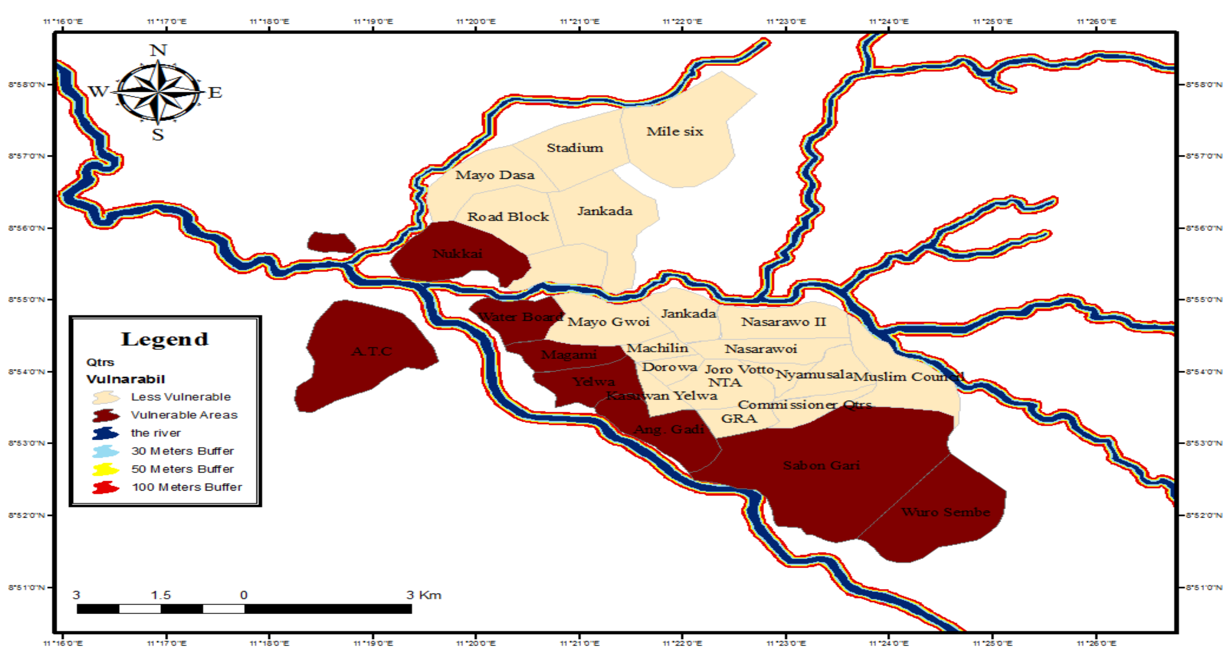

Figure 4. 30m, 50m and 100m Buffer Distance along Drainage Lines

Encroachment of Flood Plain

This is any action or development within the limits of the floodplain that could obstruct flood flows, such as fill, a bridge, or a building (Nwagwu *et al*, 2014). Study by Oruonye (2015) shows that the land use on the floodplain has changed drastically over the years despite repeated incidence of flooding in the area. Greater part of the floodplain has been encroached by human settlements. This was observed to be one of the contributing factors to flood hazards in the study area. This observation was in agreement with similar studies by Ishaya *et al*, (2009) in Kubwa area of the FCT, Nigeria. During the field work, the researcher observed that buildings were erected at the edge of the river bank, vegetation surrounding the river is cleared for fuelwood and illegal building purposes. Some buildings were found to be on the floodplain and natural water ways as observed by Nwagwu *et al,* (2014) and Ishaya *et al*, 2009) in similar studies.

The floodplain and the floodway can be characterized as that part of the flood-prone area having high velocities, high potential for erosion, and high exposure to significant flow of debris. No structures, other than critical infrastructure such as bridges, are allowed in these areas (Nwagwu *et al,* 2014). In essence, the floodplain is reserved for the river, not for humans. The floodplain represents a unique area of interaction between terrestrial and aquatic ecosystems and may improve water quality, reduce wind energy, modify microclimate, enhance habitat, reduce flood water levels and erosion and reduce hazards (Masoud *et al*, 2011). The floodplain can reduce public costs by serving as utility corridors and protecting high risk flood prone areas from development. The buffer can be likened to be a prohibited area if one is staying or carrying out any activity close to a river (Nwagwu *et al,* 2014). In most urban areas, it is regarded as green belt or 'no development area'. Any breech of this rule, should be seen as moving out of one's protective zone to danger. Areas within the 30m, 50m and 100m buffering falls within the floodway and floodplain of this study area, and they are the most vulnerable areas, while areas other than these are free from flood threat.

CONCLUSION

This study has examined the flood hazardscape and mapped the flood vulnerability zones of Jalingo metropolis. Data from field work, topographical maps, Landsat Enhanced Thematic Mapper plus (Etm+ 2015) and Shuttle Radar Topographic Mission were used as base map for the GIS technique. A flood risk zone was produced based on 30m, 50m, and 100m distance from the river and elevation height of 118m. The floodscape was zoned into high risk, medium risk and low risk zones. The findings of the study show that the vulnerability of any part of the town depends on the proximity of its location to the river valley, height elevation, size and availability of drainage networks. The findings of this study also show that most of the buildings along the floodplains of Rivers Lamurde and Mayogwoi in Jalingo town falls within the high risk zone. The buildings on the floodplains are typical of low-cost informal settlements in urban areas. The findings show that apart from heavy rainfall, encroachment of residential buildings on the floodplain constitute a major cause of flood hazard in the area. The medium risk zone are areas within 118meter above sea level. Beyond this height elevation is considered low risk zone. In other places within the centre of the town, lack of drainage network, small size of drainages and blockage of the drainage channels are the causes of flooding.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are suggested;

i. Limiting flood plain development and enforcing the various legislative provisions prohibiting this. Balancing between ecological integrity of the area and the needs of private and commercial landowners would be necessary to sustainable development in urbanizing rural floodplain.

ii. There is need to construct more drainage networks in the study area because of increase in urbanization in recent times. Some of the older drainages in the town are now too small to handle the volume of surface runoff generated in the town and will require expansion in the size of the drainages and culverts.

iii. Since several effort by the government to evacuate and relocate the residents of the floodplain over the years have failed, there is need to increase people's coping capacities by making information on flood incidence available at their disposal.

iv. Emergency planning such as forecasting, warnings, evacuation plans and post flood recovery, compensation and insurance schemes.

REFERENCES

Alam, K., Herson, M. and O'Donnel, I. (2008). Flood Disasters: Learning from Previous Relief and Recovery Operations. Prevention Consortium and ALNAP

Bapalu, and Sinha, (2005). GIS in Flood Hazard Mapping: A Case Study of Kosi River Basin,India, GIS Development, available onlinehttp://www.gisdevelopment.net.

Benjamin, M.A. (2008). Analysing Urban Flood Risk in Low-cost Settlements of George, Western Cape, South Africa: Investigating Physical and Social Dimensions. An M.Sc.Thesis submitted to the Department of Environmental and Geographical Science, University of Cape Town, South Africa.

Corson, M. W. (1999): Hazardscapes in Reunified Germany. In: Environmental Hazards. Vol. 1,pp. 57-68.

Cutter, S. L., Mitchell, J. T. and Scott, M. S. (2000): Revealing the Vulnerability of People and Places: A Case Study of Georgetown County, South Carolina. In: Annals of Association of American Geographers. vol. 90, no. 4, pp. 713-737.

European Commission (EC) (2007), "Directive 2007/60/EC of the European Parliament andof the Council of 23 October, 2007 on the assessment and management of flood risks", Official Journal of the European Union, L288/27-34, available at http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:288:0027:0034:EN:PDF, last assessed November 20, 2011.

FEMA. 2003. Federal Emergency Management Agency. http://www.fema.gov/nfip [20 September 2000] (in Bengali).

Gray, W. (2001). Research for Resilience, Tephra, 32–38.

Gray, W. (2003). Overview of Weather and Coastal Hazards in Northland Region. NIWA Client Report: WLG2003-57.

Hodo I. O. (2011). A GIS-Based Flood Risk Mapping of Kano City, Nigeria. An M.Sc. Thesis presented to the School of Environmental Sciences, University of East Anglia, Norwich.

Ikusemoran, M., Anthony, D. and Maryah, U. M. (2013). GIS Based Assessment of Flood Risk and Vulnerability of Communities in the Benue Floodplains, Adamawa State, Nigeria. *Journal of Geography and Geology,* Vol. 5, No. 4. Pp. 148-160.

Ishaya, S., Ifatimehin, O. O. and Abaje, I. B. (2009). "Mapping flood vulnerable areas in a developing urban centre of Nigeria", Journal of Sustainable Development in Africa, 11(4), pages 180-194.

Jain, et, al (2005). Delineation of Flood Prone areas Using Remote Sensing Techniques: Water Resources Management, Vol. 19, pp. 333-347.

Jain and Sinha, (2003), Geomorphological manifestations of the flood hazard: A Remote Sensing based approach: Geocarto International, Vol.18, pp. 51-60.

Jeb, D N and Aggarwal, S P (2008), "Flood inundation hazard modeling of the River Kaduna using remote sensing and geographic information systems", Journal of Applied Sciences Research, 4 (12), pages 1822 – 1833.

Jeyaseelan, A. T. (1999). "Droughts and floods assessment and monitoring using remote sensing and GIS", Satellite Remote Sensing and GIS Applications in Agricultural Meteorology, pages 291-313.

Kartic, B., Moumita, P. and Jatisankar, B. (2012). Application of Remote Sensing and Geographical Information System in Flood Management: A Case Study of Mongalkote Blocks, Burdwan, West Bengal, India. International Journal of Scientific and Research Publications, Volume 2, Issue 11, November 2012. Pp. 1-9.Kapur, A. (2010). Vulnerable India: A Geographical Study of Disasters, Sage Publication, New Delhi, 269 pp.

Khan, S. and Crozier, M.J. (2009). 'Hazardscape': A Holistic Approach to Assess Tipping Points in Humanitarian Crises. Annual Summer Academy on Social Vulnerability: "Tipping Points in Humanitarian Crises" Hohenkammer, Munich, Germany 26 July – 01 August 2009

Khan, S. (2012). Disasters: contributions of hazardscape and gaps in response practices. Nat.Hazards Earth Syst. Sci., 12, 3775–3787.

Masoud, S.S., Amin, M.S.M. and Mahdi, H. (2011). Study on Using Riparian Buffer in Urbanising Rural Floodplain. Research Journal of Environmental Sciences. 5: 714 – 721.

Musa Buba Siam (2002). Technical Feasibility study for the improvement of Jalingo Water supply scheme in Taraba State of Nigeria. A Thesis submitted to the School of Graduate Studies, Kwame Nkrumah University of Science and Technology, Kumasi in partial fulfillment of the requirements of Masters of Science, 2002.

Mustafa, D. (2005): The Production of Urban Hazardscape in Pakistan: Modernity, Vulnerability and the Range of Choice. In: Annals of Association of American Geographers. vol. 95, no. 3, pp. 566-586.

Nwagwu, H.O.J., Makwe, E. and Hassan, S.M. (2014). Flood vulnerability assessment and disaster risk reduction in Kubwa, Federal Capital Territory, Nigeria. *American Journal of Environmental Engineering and Science*. Vol. 1(2), pp. 55-66.

ODESC: National Hazardscape Report, Official's Committee for Domestic & External Security,Wellington, 140 pp., 2007.

Oruonye, E. D. and Abbas Bashir (2011). The Geography of Taraba State, Nigeria. LAP Publishing Company, Germany.

Oruonye, E. D. (2011). An Assessment of Fadama dry Season Farming Through Small Scale Irrigation System in Jalingo LGA, Taraba State. *International Research Journal of Agricultural Science*. Vol. 1 (1). Pp. 014 – 019.

Oruonye, E. D. (2012a). Socio-Economic Impact Assessment of Flash Flood in Jalingo Metropolis, Taraba State, Nigeria. *International Journal of Environmental Sciences*. Vol. 1 (3) pp. 135 – 140.

Oruonye, E. D. (2012b). The Challenges of Urban Flood Disaster Management in Nigeria: A Case Study of Jalingo Metropolis, Taraba State Nigeria. *Recent Scientific Journal*. Vol. No. pp. 37 -42.

Oruonye, E. D. (2013). An Assessment of Flood Risk Perception and Response in Jalingo Metropolis, Taraba State, Nigeria. *International Journal of Forest, Soil and Erosion*, Vol. 3. No. 4. Pp. 113 - 117.

Oruonye, E. D. (2014). "An assessment of the impact of road construction on land use pattern in urban centres in Nigeria: A case study of Jalingo LGA, Taraba State Nigeria," Mediterranean Journal of Social Sciences, vol. 5, pp. 82-88, 2014.

Oruonye, E.D. (2015). Assessment of the Impact of Land use Changes Along the Floodplains of River Lamurde, Jalingo LGA, Nigeria. Journal of Forests, Vol. 2(1), pp. 1-13

Prasad, et, al (2006). Potentiality of Multi-Sensor Satellite data in mapping Flood Hazard: Photonirvachack, v. 34, pp.219-231.

Sankhua, et.al (2005). Use of Remote Sensing and ANN in assessment of erosion activities in Majuli, the world's largest river island: *International Journal of Remote Sensing*.Vol. 26, p. 4445-4454.

Sanyal, and Lu, X.X. (2003). Application of GIS in Flood Hazard Mapping: A case study of Gangetic West Bengal, India. *Singapore Journal of Tropical Geography*. 27(2006)pp. 207–220.

Sanyal, J. and Lu, X. X. (2005). "Remote Sensing and GIS-based Flood Vulnerability Assessment of human settlements: a case study of Gangetic West Bengal, India", Hydrological Processes, 19, pages 3699–3716.

Shawulu, H.M., Adebayo, A.A. and Binbol, N. L. (2008). "Appraisal of the national poverty eradication programme (NAPEP) in Jalingo local government area, Taraba State Nigeria," Medwell Journals. The Social Sciences, vol. 3, pp. 291-296, 2008.

Smith K. (1992): Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge, London

Suleiman, Y. M., Matazu, M.B., Davids, A. A. and Mozie, M. C. (2014). The Application of Geospatial Techniques in Flood Risk and Vulnerability Mapping for Disaster Management at Lokoja, Kogi State, Nigeria. Journal of Environment and Earth Science. Vol. 4, No.5, 2014. Pp. 54-61.

Timothy, O. (2011). Flood Displaces 8 LG Residents in Bauchi and Taraba States – NEMA. The Sun Newspaper, Thursday, September, 2011. http://www.sunnewsonline.com/webpages/news/national/2011/aug/29/national-29-08-2011-021.html