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# Geospatial Mapping and Analysis of the 2012 Nigeria Flood Disaster Extent in Yenagoa City, Bayelsa State, Nigeria

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**Abstract**
This article provides a spatial analytical framework for using Geographic Information Systems (GIS) technology in flood mapping. It examines the geospatial mapping and analysis of the 2012 Nigeria flood disaster extent in Yenagoa city, Bayelsa State. Landuse map of 2012 was generated from the imagery of the study area sourced from Google Earth 2012 version. The imagery was geo-referenced and geo-processed in ArcGIS 9.3 to world coordinate system while the flood extent map was generated from the Radarsat of October 2012. The extent of flood in each landuse was determined by overlaying the flood extent map on the landuse map of 2012 using INTERSECT operator. Findings show that the 2012 flooded area extent was 64.42 sq km and 7.0% of total land area of Yenagoa LGA. The built up area had the highest spatial coverage which was 355.90 (38.68%) of the total land area in 2012. The flood affected area was also highest in the built up area as 18.88 sq km was covered which was 9.16% of the built up area and 50.62% of the entire flood extent. The correlation coefficient of the relationship between size of landuse and flood extent within each landuse was 0.487 and $r^2$ was 0.237 suggesting that the coefficient of determination was 23.7%. The relationship was direct but low correlation coefficient and students' t- test proved that there was no significant relationship between flood extent in the landuse and size of the landuse at p=0.05. The article recommends periodic flood hazard and risk mapping to reduce flood damages in the flooded areas of Yenagoa LGA and construction of dams across the major rivers to regulate the volume of water.

**Key words:** Geospatial, Mapping, 2012 Nigeria Flood, Disaster Extent

## Introduction

Floods are the most costly and wide reaching of all natural hazards. They are responsible for up to 50,000 deaths and adversely affect some 75 million people on average worldwide every year. Borrows and De Bruin (2006) indicated that among natural catastrophes, flooding has claimed more lives than any other single natural hazard. According to data from the Spatial Hazard Events and Losses Database for the United States (SHELDUS), floods claimed the lives of 2,353 people from 1970-2000. In support of this observation, the Federal Emergency Management Agency (FEMA) estimates that flood events are responsible for the death of more than 10,000 people in the US since 1900. The study undertaken in Texas established that socially vulnerable populations suffer disproportionately in terms of property damage, injury, and death as a result of physical impacts of disaster. For reasons of economic disadvantage, low human capital, limited access to social and political resources, residential choices, and evacuation dynamics are the social factors that contribute to observed differences in disaster vulnerability and economic class. Different population segments can be exposed to greater relative risks because of their socio-economic conditions of vulnerability. Because of this, disaster reduction has become increasingly associated with practices that define

efforts to achieve sustainable development. The links between disaster and the economic system, another pillar for sustainable development are essential for disaster reduction. Risk Management planning should, therefore, involve an estimation of the impacts of disasters on the economy, based on the best available hazard maps and macroeconomic data (Living with Risk, 2002).

Floods are the most taxing of water related natural disasters to humans, material assets as well as to cultural and ecological resources affecting people and their livelihoods and claiming thousands of lives annually worldwide. According to the Australian experience, the emotional behaviour of many flood victims was shocking. The emotional cost of flooding was long lived. Follow-up studies found that about one-quarter still had not recovered from the emotional trauma of the event. Factors that contributed to the non-recovery included the severity of the flooding, the degree of the resulting financial hardship, age and socio-economic status. Elderly people on low incomes whose houses were deeply flooded were the most ill- affected (Flood Management in Australia, 1998).

Thus, a severe flood can impose a range of emotional costs on flood victims, many of them quite severe. Moreover the emotional strain may linger for years after the event. Flood aware communities can be expected to suffer less social and financial disruption than communities with a low level of flood awareness (Flood Management in Australia, 1998). Lindsell and Prater (2003) argued that social impacts can cause significant problems for the long term functioning of specific types of households and businesses in an affected community. A better understanding of disasters' socio-economic impacts, therefore, can provide a basis for prediction and the development of contingency plans to prevent adverse consequences from occurring.

Smith and Ward (1998) and Mwape (2009) argued that direct losses to floods occur immediately after the event as a result of the physical contact of the flood waters with humans and with damageable property. However, indirect losses which are less easily connected to the flood disaster and often operate on-long time scales, may be equally, or even more important. Depending on whether or not losses are capable of assessment in monetary values, they are termed tangible and intangible. Some of the most important direct consequences of flooding such as loss of human life or the consequent ill health of the survivors are intangible. Indirect and intangible consequences of flooding are probably greatest in Least Developed Countries (LDCs), especially where frequent and devastating floods create special impacts for the survivors. In addition to economic loss and loss of life and injury, there may be irreversible loss of land, of historical and cultural valuables and loss of nature or ecological valuables.

The African continent has not been spared by floods. According to UNEP (2006), the continent, home to approximately one (1) billion people is more vulnerable than any other continent to climate change. Almost two (2) billion people were affected by disasters in the last decade of the 20$^{th}$ century. Eighty-six percent (86%) of these were floods and droughts. Heavy rains destroyed homes and crops, leaving whole communities vulnerable. Rising flood waters across Africa are intensifying health risks for millions of people.

Kundzewicz *et al.* (2002) argues that floods are natural phenomenon for which the risks of occurrence are likely to continue to grow; increasing levels of exposure and insufficient capacity are among the factors responsible for the rising vulnerability. For thousands of years, people have settled in flood plains attracted by the fertile soils, the flat terrain appropriate for settlements, and they have access to safe water. It is observed that floods are natural phenomenon that has always existed and people have tried to use them for their advantage to the extent possible. However, increased population density, urbanization and agricultural expansion in flood prone areas have steadily increased society's vulnerability to the negative effects of floods. As a consequence, floods have become more and more disastrous to human settlements.

Economic development of flood prone areas is a factor that increases flood risk. Population pressure and shortages of land cause encroachment into flood plains. Mushrooming informal settlements often form enlargement zones around mega cities in developed countries (Kundzewicz, *et al*, 2002). On the one hand, it is related to a wider global ecological crisis to do with climate change and rising sea levels but on the other hand, it is also the effect of more-localized human activities. A whole range of socio-economic factors such as land use practices, living standards and policy responses are increasingly influencing the frequency of natural hazards such as floods and the corresponding occurrence of disasters. Statistical trends suggest that floods have become more numerous and more devastating in recent years.

Urbanization aggravates flooding by restricting where flood waters can go. In an urban area, large parts of the ground are covered with roofs, tarred roads and pavements. These obstruct sections of natural channels and builds drains that ensure water movement to rivers faster than it could under the natural conditions (Ojigi et al, 2013). Another factor in an urban setting is the population density. As more people crowd into cities, so the floods effects intensify. Consequently even quite moderate storm could produce high flows in rivers because there are more hard surfaces and drains (Action Aid International, 2006). In extreme cases urban floods can result in disasters that setback urban development by years or even decades. Given the high spatial concentration of people and values in cities, even small scale floods may lead to considerable damages. Recent statistics clearly indicate that economic damages caused by urban floods are rising (MunichRe, 2005). The frequency of events and the number of people affected have increased steadily as human related activities such as deforestation, overgrazing and urbanization aggravate environmental conditions, making communities more vulnerable (Bankoff, 2003).

The 2012 rainy season in Nigeria was worse than earlier years. Heavy rains at the end of August and the beginning of September, 2012 led to serious floods in most parts of the country. The Nigerian authorities contained the initial excess run-off through contingency measures, but during the last week of September, water reservoirs were overflowing and authorities obliged to open dams to relive pressure in both Nigeria and neighboring Cameroon and Niger, leading to destroyed river banks and infrastructure, loss of property and livestock and flash floods in many areas. By 29$^{th}$ September, the floods had affected 134,371 people, displaced 64,473, injured 202 and killed 148. By the end of October, more than 7.7 million people had been affected by the floods, and more than 2.1 registered as Internally Displaced People (IDP). About 363 people were reported dead; almost 600,000 houses had been damaged or destroyed. Out of Nigeria's 36 states, 32 have been affected by the floods (Office for the Coordination of Humanitarian Affairs (OCHA), 2012).

Previous studies on flood in Nigeria concentrated on flood for a region or a city in Nigeria and none of them really emphasized the effect of flood on landuse type and flood extent mapping. This article therefore, focused on the flood extent in Yenagoa LGA and its effects on the landuse types. Moreso, the article investigated the variation in the extent of flood in each landuse and its attendant problems.

**The Study Area**

The study area is Yenagoa LGA of Bayelsa State. The study area lies along latitudes between $4^o$ 48′ 00″ North and $5^o$ 24′ 10″East; and longitudes between $6^o$ 12′ 00″E and $6^o$ 39′ 30″E It is bounded by Rivers State on the North and East, Kolokuma/ Opokuma LGA on the North West and West, Ogbia LGA on the South East and Southern Ijaw on the South west. Yenagoa LGA has a population of 352,285 by 1996 estimate.

The climate of Yenagoa LGA is an equatorial type of climate. Rainfall occurs generally every month of the year. The mean monthly temperature is $25^oC$ to $31^oC$. The hottest months are December to April. Relative humidity is high throughout the year and decreases slightly during the dry season.

Yenagoa LGA is located within the lower delta plain believed to have been formed during the Holocene of the quaternary period by the accumulation of sedimentary deposits. The major geological characteristic of the state is sedimentary alluvium. The entire state is formed by abandoned beach ridges and due to many tributaries of the River Niger in this plain, considerable geological changes still abound. Generally, Yenagoa is a lowland local government with the elevation between 3m and 7m above mean sea level and characterized by flood plains. The net features such as lagoons are dominant relief features in the study area. Yenagoa LGA is drained with many rivers and creeks among which area Epie Creek, Nun River, Orashi River, and Ekole Creek. The major soil types in the state are young, shallow, poorly drained soils and are acid sulphate soils. There are, however, variations; some soils occupy extensive areas whereas, some are of limited extent. The soil texture ranges from medium to fine grains.

Like any other area in the Niger Delta, the vegetation in Yenagoa LGA is freshwater swamp and lowland rain forests. These different vegetations are associated with the various soil units of the area. Generally, along the ridges above the tideline exists a vegetation of palms with scattered trees while mangroves dominate the water courses. This vegetation belt is also characterized by low salinity-tolerant fresh water plants such as avicinia species of mangroves. Palms such as phoenix reclivata and other species such as uapecia, xylopia and land terminalia are predominant. Commercial timber species are also found in the area.

Yenagoa LGA is one of the areas with oil mineral and natural gas deposits. As a result, petroleum production is one of the sustaining economic activities in the LGA. The study area has a riverine setting and thus fishing is another occupation which is in vogue in the area. Agriculture or farming is another mainstay of the study area economy. Thus, another main occupation for the people is farming which involves planting of both annual crops like maize and perennial crops. The secondary occupations include trading, dressmaking, carpentry, gold smithing, food vending, bicycle and auto repairs. Therefore, the greatest potential for future industries in the study area lies in the fields of agriculture, fish processing and petro-chemicals.

 

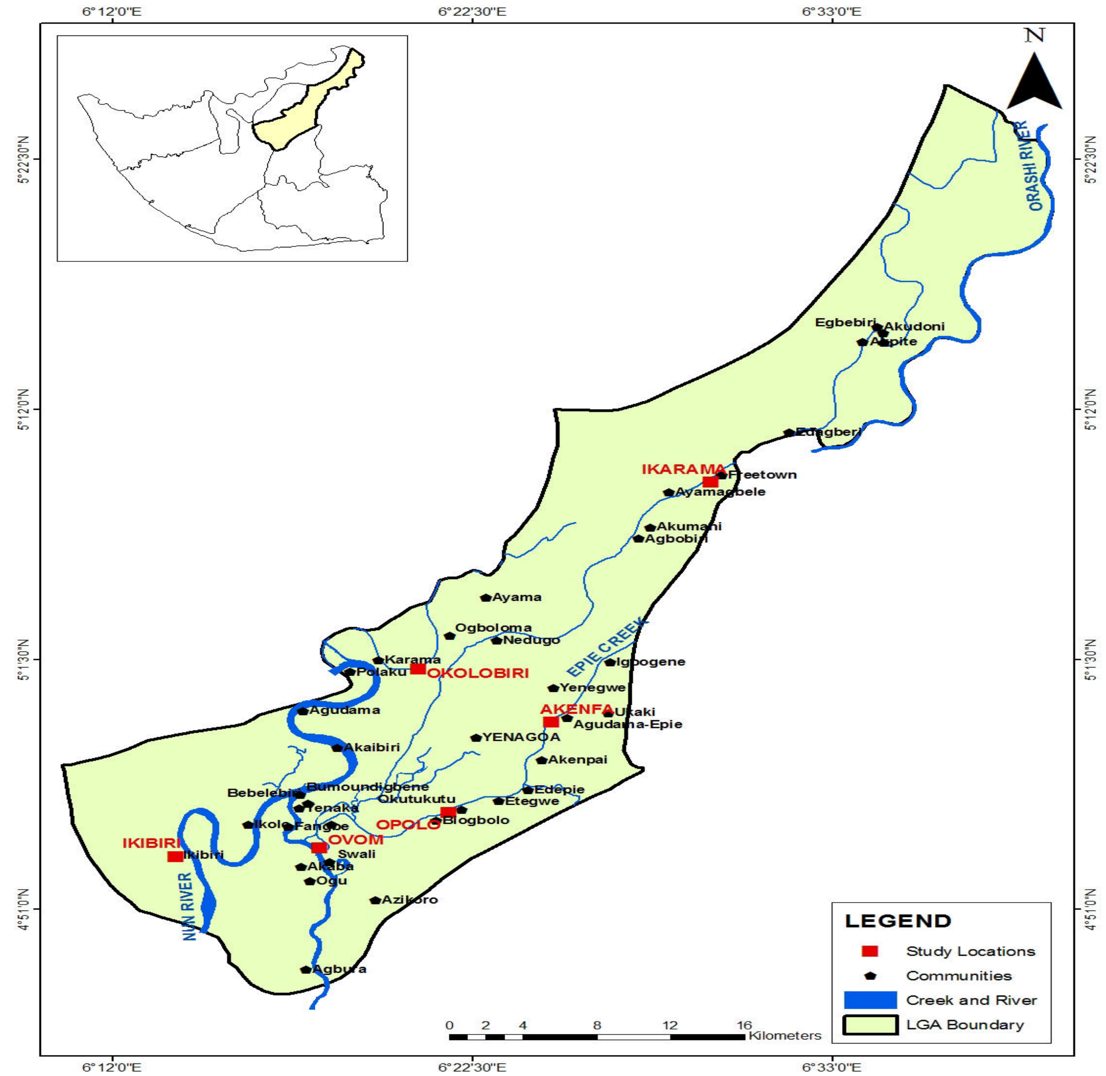


Figure 1: Map of Yenagoa LGA showing the study locations (Source: GIS Laboratory, Department of Geography and Environmental Management, University of Port Harcourt, Nigeria)

**Methodology**

Landuse map of Yenagoa LGA was acquired from the imagery of the area sourced from Google Earth 2012 version. The imagery was georeferenced in ArcGIS 9.3 to world coordinate system. From the groundtruthing of the land use types in the area through reconnaissance survey, four landuse types were identified namely built up area, farmland, forest cover and water body. The image was geo-referenced and geo-processed in ArcGIS 9.3. The boundary of Yenagoa LGA was derived from the topographic map and this was used to clip the geo-referenced imagery so as the boundary of the study area can be maintained. Training sites were generated from the imagery by capturing similar spectral reflectance in the imagery as same landuse based on the knowledge gained from the ground-truthing. The

training sites were used to carry out Supervised Classification using the Maximum Likelihood Classification Algorithm. The spatial coverage of each landuse type was determined in squared kilometers using the calculate geometry module of ArcGIS 9.3. Several studies have used this technique. This include Wizor (2014), Eludoyin et al (2012), Fabiyi (2002) and so on.

The flood extent map was acquired from Radarsat captured in October 2012. The imagery was 10m x 10m resolution. The imagery was also geo-referenced to world coordinates system in ArcGIS 9.3. The geo-referenced imagery was imported to Idrisi Taiga whereby the bands of the imagery were combined through the use of COMPOSITE module. This helps to view the spectral reflectance of the same values in the imagery and therefore easy to capture flood extent coverage in vector format in ArcGIS 9.3. The flood extent coverage area was thereafter calculated in squared kilometres using the calculate geometry module of ArcGIS 9.3.

The flood extent map was overlaid on the landuse map of the study area using INTERSECT operator. This resulted to determining the extent of flood in each landuse identified in the study area.

**Statistical analysis and data presentation**

Descriptive statistics was employed in this article to explain the percentages of variables derived from the area of landuse and flood extent. Inferential statistics was employed to test the hypothesis and these included Pearson correlation statistics and linear regression. Pearson correlation statistics (Equ. 1) was used to test the hypothesis which states that size of the landuse type significantly influences the flood extent in each landuse. The flood extent was the dependent variable (Y) while the size of landuse was the independent variable (X). Student's t-test was used to test the level of significance of the hypothesis (Equ. 2). Linear regression analysis was used to determine the relationship between the flood extent in landuse and size of the landuse type (Equ. 3) and presented graphically using scatter diagram.

$$r = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}}$$ ……………………..Equ. 1

Where r – correlation coefficient

X- Independent variable (Size of landuse)

Y-Dependent variable (Flood extent in landuse)

$\bar{X}$- Mean of X

$\bar{Y}$- Mean of Y

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$ ……………………………………………………………….. Equ. 2

Where

t- Calculated value

n- Number of samples

r- Correlation coefficient

The linear regression model is Y= a+bX+e ……………………………………………… (Equ 3)

whereby
Y is the dependent variable which is the extent of flood
a is the slope
b is the regression coefficient
X is the independent variable which is the size of landuse type
All these analyses were performed using Statistical Package for Social Scientists (SPSS) 16.0 Version. Results of the data were presented in tables and appropriate graphs like pie chart, bar graphs and line graphs.

**Results and Findings**

Table 1 below presents the spatial coverage of flood extent in Yenagoa LGA. It is observed that the 2012 flood covered 64.42 sq km (7.0%) of the total area of Yenagoa LGA. Figure 2 below presents the flood extent map in 2012 in Yenagoa LGA. It is observed that areas such as Okolobiri, Swali, Agbura, Ovom, Ayamagbele, Yenaka, Akaibiri, Polaku, Opolo, Karama and Akenfa were flooded during this time.

Table 1: Spatial coverage of flood extent in Yenagoa LGA

| Spatial entity | Area (Sq km) | Percentage |
|---|---|---|
| Flooded area | 64.42 | 7.0 |
| Unflooded area | 855.65 | 93.0 |
| Total | 920.07 | 100.0 |

Source: Author's Fieldwork, 2013

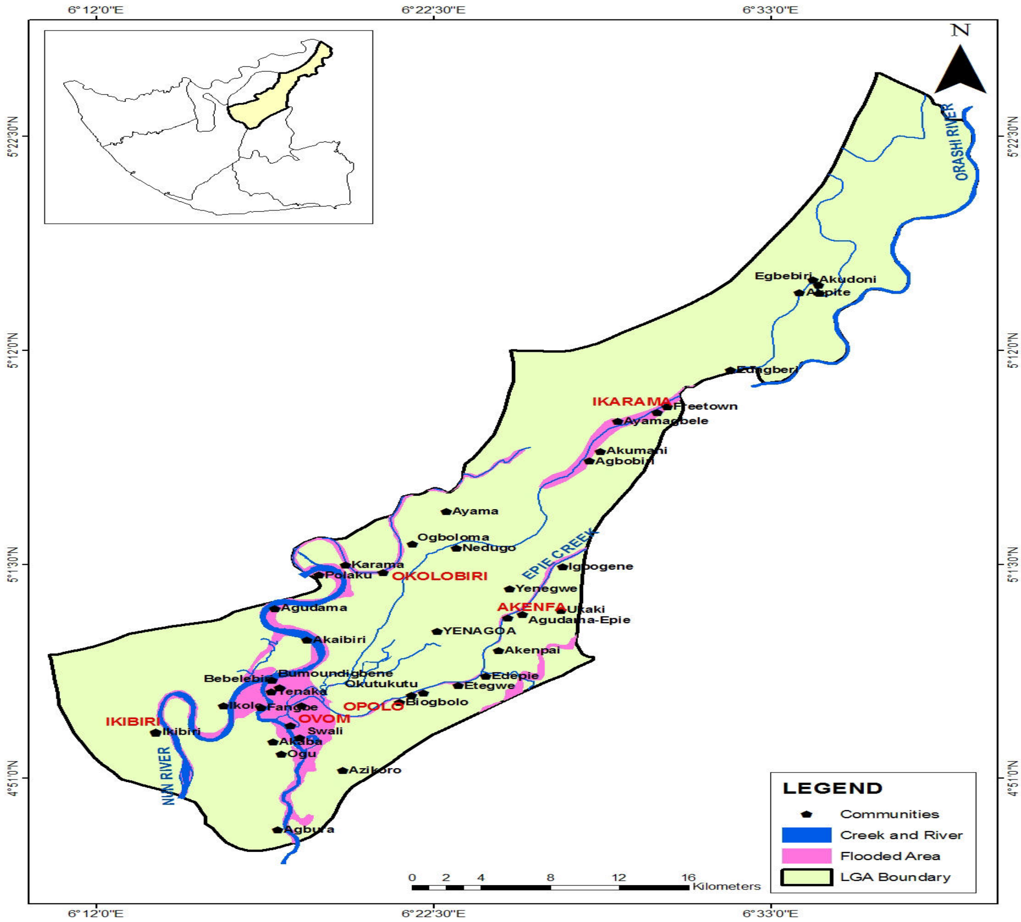


Figure 2: Flood extent map in Yenagoa LGA (Source: GIS Laboratory, Department of Geography and Environmental Management, University of Port Harcourt, Nigeria)

Table 2: Extent of flood in major landuse types

| Landuse type | Total Area (Sq km) | Percentage (%) | Affected Area (Sq km) | Total Percentage Affected Area (Sq km) | Percentage of Affected Area per landuse (%) |
|---|---|---|---|---|---|
| Water Body | 141.85 | 15.42 | 18.88 | 29.31 | 13.31 |
| Built Up Area | 355.90 | 38.68 | 32.61 | 50.62 | 9.16 |
| Forest cover | 305.16 | 33.17 | 6.24 | 9.69 | 2.04 |
| Farmland | 117.16 | 12.73 | 6.69 | 10.38 | 5.71 |
| Total | 920.07 | 100.0 | 64.42 | 100.0 | |

Source: Author's Fieldwork, 2013

Table 2 above presents the extent of flood in major landuse type in Yenagoa LGA. It is discovered that four major landuse types were identified in the area namely water body, built up area, forest cover and farmland. The landuse analysis shows that water body had a spatial coverage of 141.85 sq km which was 15.42% of total area of Yenagoa LGA, built up area had 355.90 sq km (38.68%), forest cover was 305.16 sq km (33.17%) while farmlands was 117.16 sq km (12.73%).

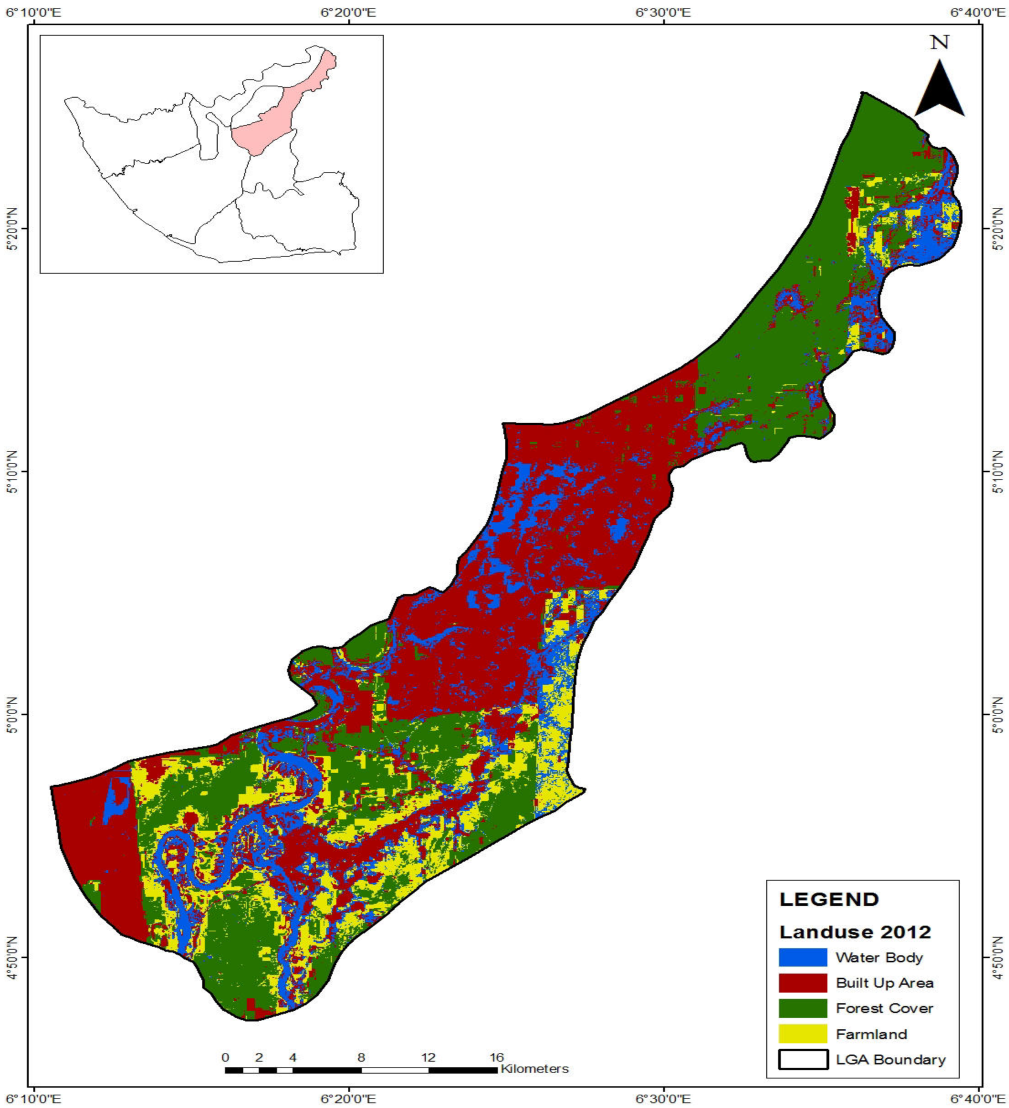


Figure 3: Landuse types of 2012 in Yenagoa LGA (Source: GIS Laboratory, Department of Geography and Environmental Management, University of Port Harcourt, Nigeria)

Figure 3 above presents the landuse map of Yenagoa LGA in 2012 while Figure 4 below presents the analysis on landuse types graphically. The overlay analysis between flooded area and landuse types using intersection module

reveals that 18.88 sq km which was 13.31% of the total area of water body were affected by the flood, 32.61 sq km which was 9.16% of the total area of built up area were affected, 6.24 sq km which was 2.04% of the total area of forest cover was flooded and finally, 6.69 sq km which was 5.71% of the total area covered by farmland was flooded. This shows that built up area was mostly affected by the flood in 2012 and the least affected landuse was forest cover.

 

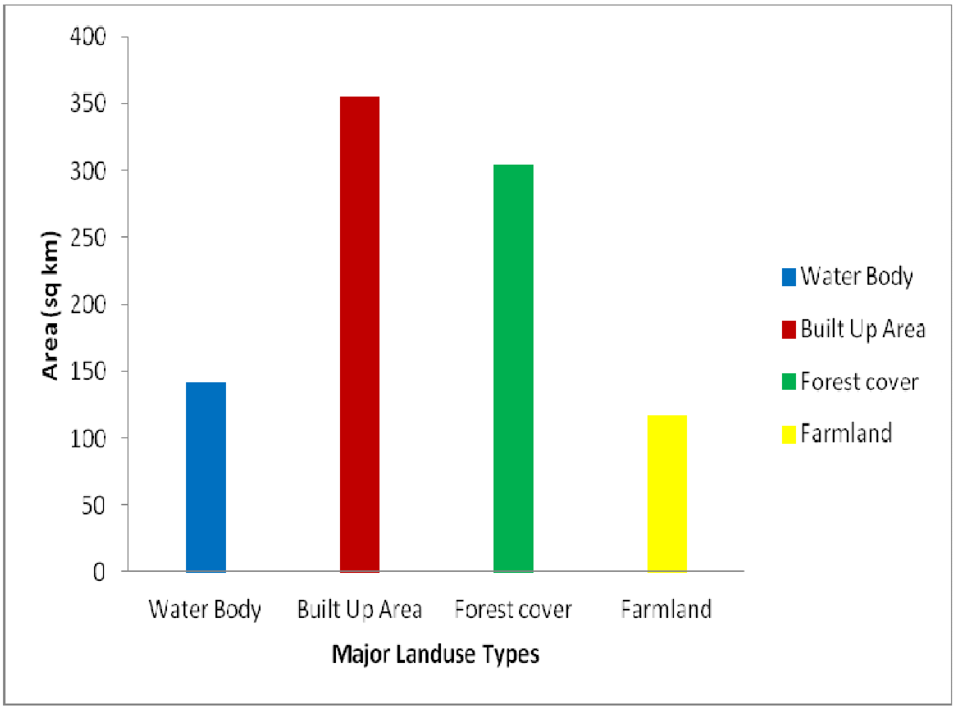


Figure 4: Major Landuse Types in Yenagoa LGA in 2012

Figure 5 below presents the overlay map between flood extent and landuse types, Figure 6 presents the flood affected area in each identified landuse types while Figure 7 shows the analysis on the flood affected area in each landuse type.

 

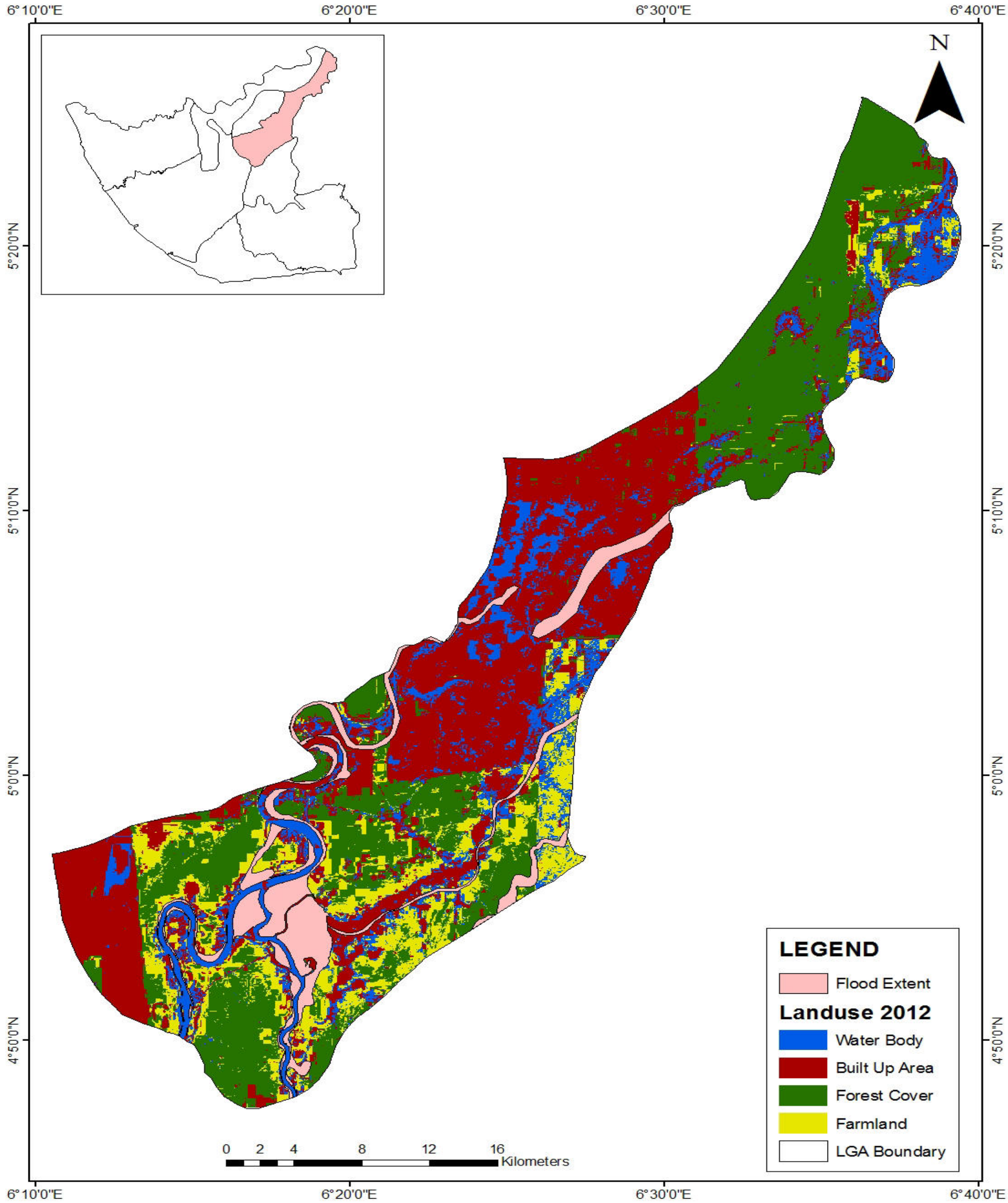


Figure 5: Ovelay map of flood extent and landuse types (Source: GIS Laboratory, Department of Geography and Environmental Management, University of Port Harcourt, Nigeria).

 

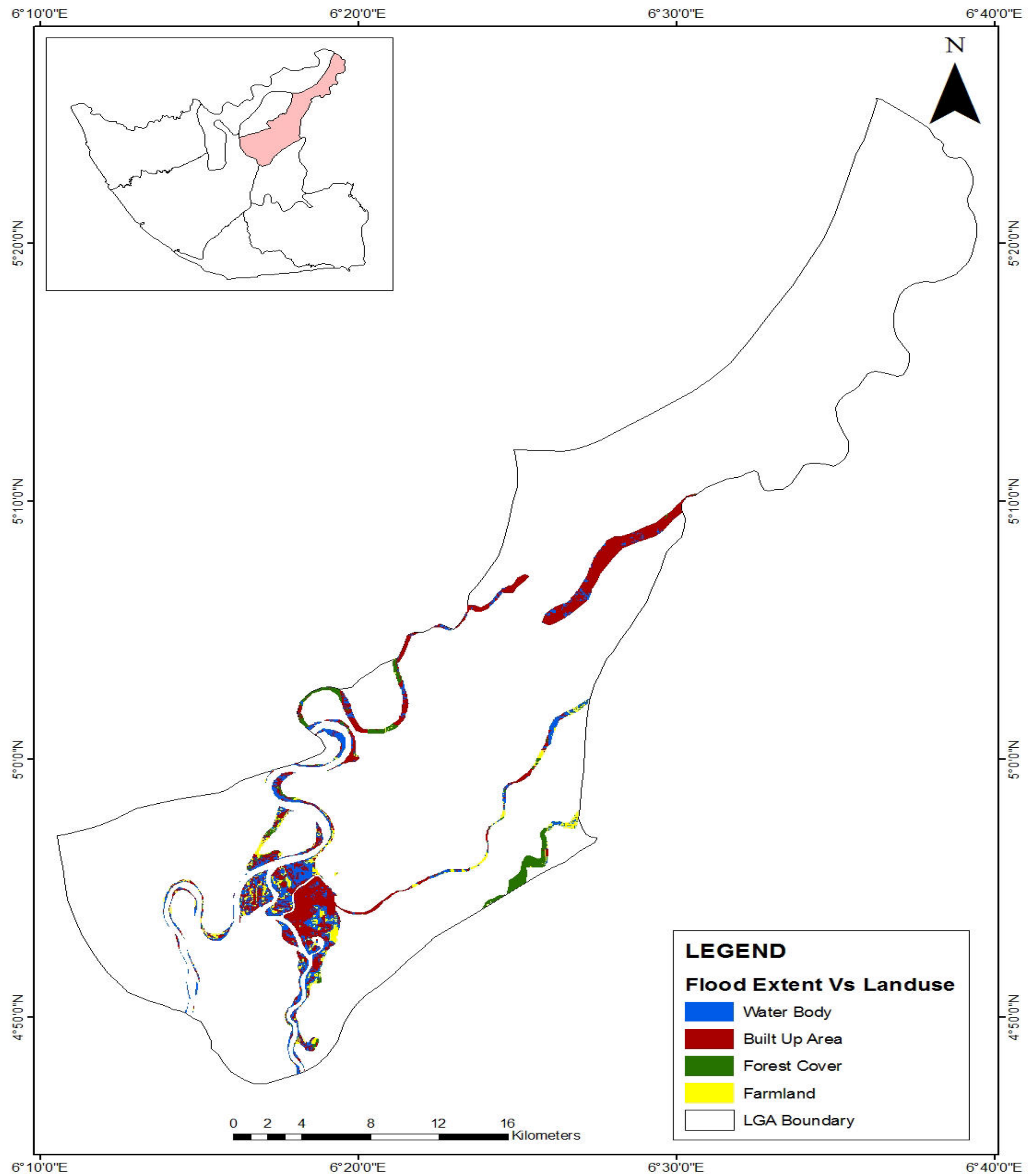


Figure 6: Flood extent in landuse types in 2012. (Source: GIS Laboratory, Department of Geography and Environmental Management, University of Port Harcourt, Nigeria).

 

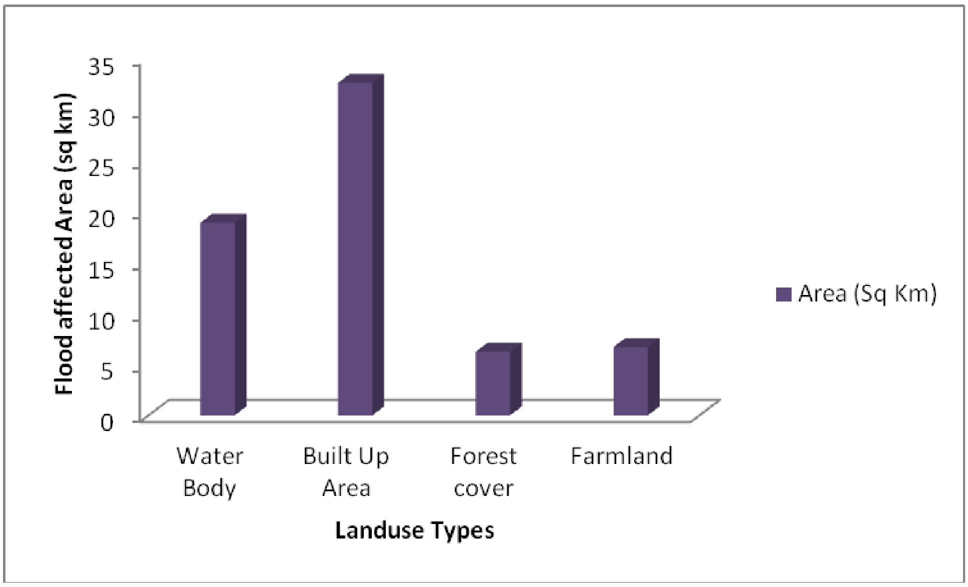


Figure 7: Flood affected area in landuse types

**Hypothesis Testing**

$H_o$: There is no significant relationship between the size of land use type and the extent of flood in the study area.

$H_1$: There is significant relationship between the size of land use type and the extent of flood in the study area.

Table 3: Size of landuse and flooded extent in landuse

| Landuse | Size of landuse (X) | Flood extent in landuse (Y) |
|---|---|---|
| Water Body | 141.85 | 18.88 |
| Built Up Area | 355.9 | 32.61 |
| Forest cover | 305.16 | 6.24 |
| Farmland | 117.16 | 6.69 |

Table 3 presents the size of landuse and flood extent in each landuse. The data was used to compute the significant influence of size of landuse on the flood extent in the landuse. The dependent variable (Y) was flood extent while the independent variable (X) was size of landuse. Table 4 below shows the correlation statistics and level of significance at p = 0.05 (two tailed). The correlation coefficient (r) was 0.487 while $r^2$ was 0.237 suggesting that the coefficient of determination was 23.7%. The coefficient of determination shows that size of landuse can only

explain 23.7% of the flood extent in each landuse suggesting that there are several important factors that must have accounted for the flood extent in the landuse types. Student's t-test was used to test the level of significance of the relationship between the size of landuse and flood extent in the landuse. The calculated t-value was 0.78 while the table t-value at p=0.05 at degrees of freedom of 3 was 3.183. It is therefore shown that t-calculated was lower than

t-table, thus null hypothesis was accepted while alternative hypothesis was rejected. Therefore, it can be concluded that size of the landuse does not influence the flood extent in the landuse. Table 5 shows the linear regression analysis between size of the landuse and flood extent in landuse while the scatter diagram of the relationship was represented in Figure 8. The regression model for the analysis was:

$Y_{\text{Flood extent}} = 4.307+0.051_{\text{Size of landuse}}$

The scatter diagram shows that a direct relationship existed between size of landuse and flood extent but the correlation coefficient (r) was low in the study area. This signifies that higher the size of the landuse, the higher the flood extent in the landuse.

Table 4: Correlation coefficient and Level of significance

| Correlation Coefficient (r) | $r^2$ | Coefficient of Determination (%) | t-test for t-calculated value $\frac{r.\sqrt{N-2}}{\sqrt{1-r^2}}$ | t-table value at 3 d.f. (two-tailed) at p=0.05 | Significance |
|---|---|---|---|---|---|
| 0.487 | 0.237 | 23.7 | 0.78 | 3.183 | NS |

Source: Author's Computation

Table 5: Regression analysis

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 4.308 | 16.383 | | .263 | .817 |
| | Size of landuse | .051 | .065 | .487 | .788 | .513 |

Source: Author's Computation

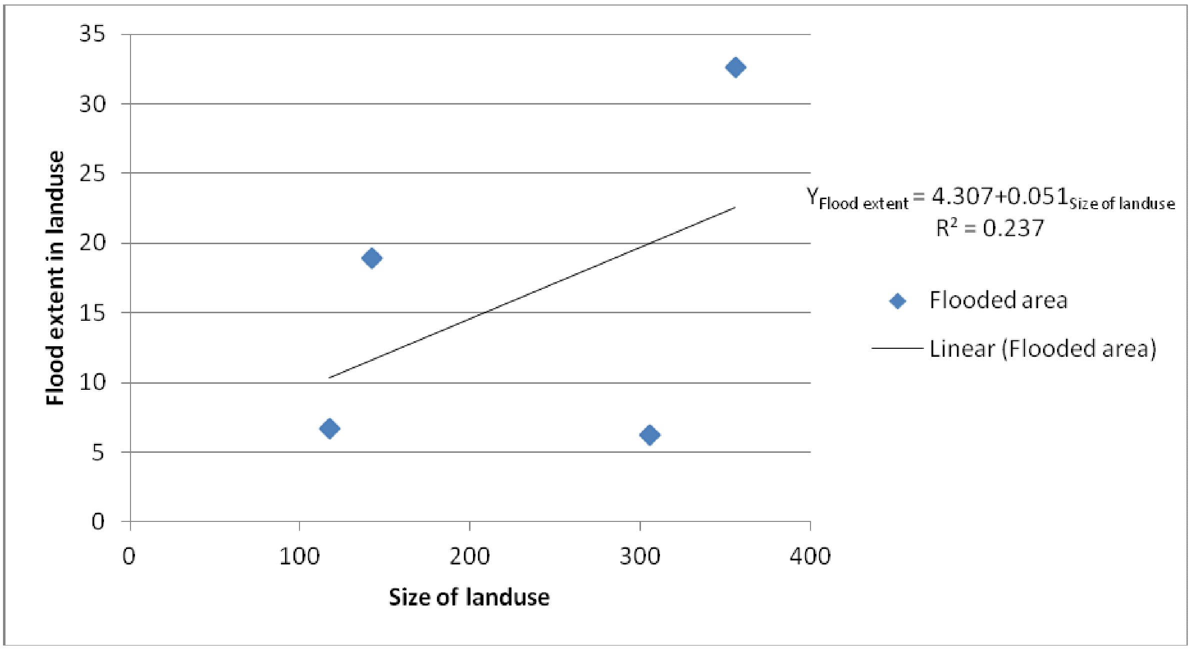


Figure 8: Scatter diagram

**Conclusion**

Findings from the landuse and land cover analysis of the study area in 2012 revealed that built up area had the highest size and followed by the forest cover. The overlay analysis of flood extent map and landuse map of Yenagoa LGA revealed that built up area and water bodies were affected mostly while the least affected landuse was forest. The increase in the spatial coverage and flood extent in the built up area could be attributed to the rate of urbanization in the area. Fabiyi (2002) in Eludoyin et al (2012) affirmed that urbanization has been a driving force towards the rate at a particular land use or land cover changes over time. It was also submitted by Lambin and Geist (2006) that humans are increasingly being recognized as a dominant force in global environmental change. Huong and Pathirana (2011) also corroborated that the increase in artificial surfaces due to urbanization causes an increase in flooding frequency due to poor infiltration and reduction of flow resistance.

It was also established by Huong and Pathiarana (2011) that the hydro-meteorological changes driven by urbanization, and resulting impacts on extreme rainfall could also be factors that brought about the increase in the flood extent in the built up area. The flood extent was least in the forest cover despite the fact that the size of forest cover was high. This is supported in Cotrone (2008) who submitted that forests make excellent watersheds chiefly because their soils usually have a high infiltration capacity which shows that the soils are capable of quickly absorbing large amounts of water. Therefore, rainstorms or melting snow in woodlands produce relatively little surface runoff with the associated problems of erosion (detachment and movement of soil) and sedimentation (the deposition of soil). Cotrone (2008) further explained that forest soils have a great deal of pore space and the abundance of organic matter from decaying plant parts creates a well-structured soil in which the individual soil particles tend to form aggregates.

It was observed that 64.42 sq km (7.0%) were flooded in 2012 in Yenagoa LGA and that water body and built up area were highly affected by the flood. 13.31% and 9.16 % of entire water body and built up area respectively were affected by flood. Built up area was mostly affected by the flood as 50.62% of the entire flood affected area fell within the built up area. There was no significant relationship between the size of landuse and the flood extent in the landuse but a direct relationship existed between the two variables with low correlation coefficient of 0.487. There was a significant variation in the loss of properties among the communities in Yenagoa LGA.
Therefore, the article suggests the following recommendations.

1. Flood hazard and risk mapping should be encouraged and adequately carried out periodically to reduce flood damages in the flooded areas of Yenagoa LGA.
2. Dams and reservoirs should be constructed across the major rivers to regulate the volume of water accordingly at a given time.
3. Government should play a better role to assist the flood affected people medically and financially
4. Tree planting should be encouraged and adequately practiced especially in the built up area to reduce the degree of impacts of flood and flood extent.
5. Every resident should be made aware of the vulnerability of Yenagoa LGA to flooding especially through public and private media.

**References**

Action Aid International (2006): Climate Change, Urban Flooding and the Rights of the Urban Poor in Afric: Key Findings from Six African Cities. *A Report by AAI, October, pp. 1-7*

Bankoff, G. (2003): Constructing Vulnerability: The Historical, Nattural and Social Generation of Flooding in Metropolitan Manila. *Journal, 27 (3): 224-238*

Borrows, P. and De Bruin, D. (2006): The Management of Riverine Flood Risk. *Journal, 55:5151-5157*

Cotrone V. (2008): The Role of Trees and Forests in Healthy Watersheds. Managing Stormwater, Reducing Flooding, and Improving Water Quality. *Forest Stewardship Bulletin #10, Penn State University.*

Eludoyin. O.S., Wokocha, C.C. and Ayolagha, G. (2011):GIS Assessment of Landuse and Land Cover Changes in Obio/Akpor LGA., Rivers State, Nigeria. *Research Journal of Environmental and Earth Sciences 3 (4): 307-313*

Fabiyi, O. (2002): Geographical Information System, Techniques and Methods. *Research Support Services*, Ibadan, Nigeria

Flood Plain Management in Australia (1998): A Disaster Risk Management Study Guide for DIM 605: Module 2. Bloemfontein: University of the Free State

Huong H.T.L. and Pathirana A. (2013): Urbanization and climate change impacts on future urban flooding in Can Tho city, Vietnam Hydrol. *Earth Syst. Sci., 17, 379–394.*

Kundzewicz, Z.W., Budhakooncharoen, S., Bronstert, A., Hoff, H., Lettenmaier, D., Menzel, L. and Schulze, R. (2002): Natural Resources Forum: Coping with Variability and Change: *Floods and Droughts. Journal, 26 (4): 263-274*

Lambin, Geist (2006): Landuse and Land Cover Change: Local Processes and Global Impacts (Global Change-IGBP Series). *Springer-Verlog; Berlin Heidelberg, Germany, pp:25*

Lindsell, K.M. and Prater, S.C. (2003): Abstract on “Assessing Community Impacts of National Disasters”:*176-178 (electronic), National Hazard Review, Vol. 4, No 4*

Living with Risk (2002): A Global Review of Disaster Reduction Initiatives, Geneva, Switzerland

MunichRe (2005): Megacities – Megarisks: Trends and Challenges for Insurances and Risk Management, http://www.munichre.com/publications/302-04271 en.pdf

Nwape, Y.P. (2009): An Impact of Flood on the Socio-Economic Livelihoods of People: A Case Study of Sikaunzwe Community in Kazungula District of Zambia. Unpublished Masters Thesis, University of Free State.

OCHA (2008): Situation Report 5-Southern Africa Floods. 31 January

Ojigi, M.L., Abdulkadir, F.I. and Aderoju, M.O. (2012): Geospatial Mapping and Analysis of the 2012 Flood Disaster in Central Parts of Nigeria. *8th National GIS Symposium. Dammam, Saudi Arabia. April 15-17, 14p*

Smith, K. and Ward, R. (1998): Floods: Physical Processes and Human Impacts. John Wiley and Son. England

Wizor, C.H. (2014): Residential Development Dynamics in Port Harcourt Metropolis: Implication for Efficient Urban Planning. *Journal of Environment and Earth Science, Vol. 4, No 6*

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