Geospatial Management of Urban Marginal Lands for Disaster Risk Reduction in Nigeria's Confluence Town

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ABSTRACT

The current trends in global urbanization as summarized by UNDP stands at 2.4 billion in 1990 and will rise to 3.2 billion in 2000 and 5.5 billion in 2025. The developing countries' share (including Nigeria) in these totals - 63 per cent in 1990 - will rise to 71 per cent in 2000 and 80 per cent in 2025. There is crisis in the mismatch between urban land demand and supply; hence the encroachment on marginal lands. The geographical location of Lokoja that is sandwich between Mount Patti and Niger-Benue Confluence exacerbate the land use pressure crises. Critical land area development in Lokoja is tending toward complex ecological problems. This study is therefore aimed at examining the urban marginal land encroachment using spatial analysis for disaster risk reduction in the town. Landsat and Nigeria SatX imageries were acquired and analyzed using ArcGIS 10.0 and Tera-Incognitia 2.42; Suffer 11 was used for the DEM production. This was complemented with Google Earth for the field work. The study revealed that a total of 3.65km^2 and 0.14Km^2 of vegetation and marshlands respectively, were lost annually within the 17 years period. It was also observed that a total of 657 buildings were constructed on marginal lands in 2000, and it increased to 868 in 2017. It is therefore recommended that urban planners and disaster managers should be fully trained in area of Geo-spatial management and SSDS in order to produce accurate multi-hazard maps as a pathway to Disaster Risk Reduction (DRR) in the state and the country at large.

1. INTRODUCTION

Cities in both developed and developing countries are experiencing rapid urbanization. It is envisaged that 70 percentage of the world's population will live in urban areas by the 2050 (UN, 2008). The urban population in the developing regions are expected to be 2.27% as against 0.49% that will be recorded in the developed countries; this is an indication that a significant bulk of this growth will be experienced in the developing countries (UN, 2009). Over the years, the pace of urban growth experienced in the developing countries is often associated with unhappiness, especially in countries where less regard is given to urban management and planning (Olurin, 2003; UN, 2009). Problems that accompanied the kind of urbanization experienced in the developing countries range from emergence of slum, poverty and conversion of Agricultural lands and marginal lands in into human settlements.

The use of marginal lands has been a major issue in Nigeria in recent times, pressure of the growing population on land, particularly conversion of marginal lands has worsened the incident of drought and desertification in the North Eastern parts of the Country (Federal Ministry of Environment, 2001). In the south-south States and south west States of Nigeria, the conversion of marginal lands has contributed to the reduction in the carrying capacity of channels from tributaries and this is reflected in the inability of channels to accommodate peak surface runoff which often leads to flooding (Gobo *et al*; 2014). This implies that, the demand for more urban space by the teeming population has pushed the populace most especially the urban poor onto the marginal lands which are environmentally vulnerable to disasters (Clarke and Munasinghe, 1995). This phenomenon is evident in Lokoja, the Kogi State capital.

In the quest for urban space as a result of increase in land price in the city centre and the highlands, poor residents of Lokoja are forced to occupy marginal lands where they have less access to pre and post disaster protection. The 2012 and 2017 flooding in Lokoja where 332 communities and 10,000 persons were displaced respectively can be attributed to building on the marginal Lands (Agada, 2012; Davies, 2017). To tackle this incessant crisis in Lokoja and the entire State at large, there is a need to employ an integrated approach in disaster risk reduction. Disaster risk reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disaster (UNISDR, 2009). This definition aim at reducing exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events (UNISDR, 2009).

Sutanta *et al* (2009) opined that the use of geospatial techniques be used to improve disaster risk reduction effort when incorporated with urban and rural land use planning. Against this background, geospatial techniques were employed in the management of urban marginal lands in Lokoja.

This study aims at examining the urban marginal land encroachment using spatial analysis for disaster risk reduction in Lokoja. In achieving this, the Digital Elevation Model for Lokoja was analysed to assess the land use and the level of marginal land encroachment in Lokoja within a period of 17 years.

2. STUDY AREA

Lokoja lies within latitude 7° 44''N and 7° 49'N and longitude 6° 42'E and 6° 46'E (figure 1) with a land area of 3243.323Km^2 and a population of 196,643 (NPC, 2006). Apart from being the capital of Kogi State, Lokoja is a strategic transit route that links sixteen other States in Nigeria including the Federal Capital Territory (Abdulrazaq, 2013). Lokoja is very famous for being the confluence point of the river Niger and river Benue. The city has a tropical savannah climate with an annual average temperature of 34^{0}c and an average annual rainfall of 870mm

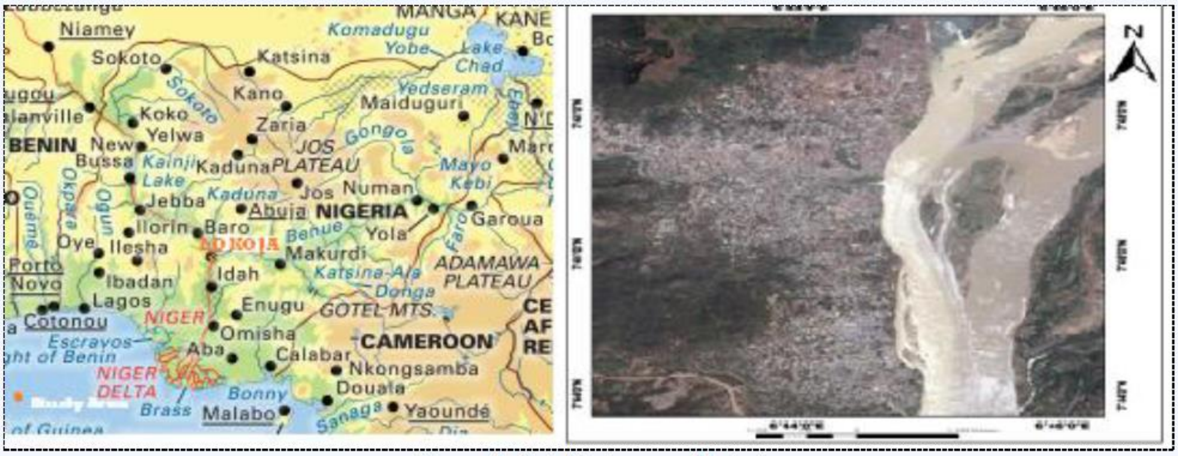

Figure 1: Satellite Image of Lokoja

3. METHODOLOGY

The primary and the secondary data were used for this study. Data on vague features on the images were obtained during ground "truthing" in Lokoja. The secondary data for this study include the satellite images collected from the NCRS Jos, and other relevant journals/materials referenced in the course of the study.

To determine the Digital Terrain Model of the Study area X, Y, Z coordinates of Lokoja were generated on the Zonums site. Data gathered were collated in excel and these data were imported into surface 11 where the contours of the study area was generated. The contours generated were then interpolated to determine the Digital Elevation Model (DEM) for Lokoja. To determine the land use of the study area, the Landsat images (ETM$^+$) of 2000 and 2017 were captured on the Nigeria SatX, on path 189 and row 55, (Table 1).

Table 1: Images Properties

Year	Path and Row	Sensor	Resolution	Date
2000	189/55	ETM$^+$	30m	09/01/2000
2017	189/55	ETM$^+$	30m	31/12/2017

Source; Author's Compilation, 2017

On each of the satellite images, band 4,3and 2 was used to form the false colour composite. On this band, Vegetation appears in shades of red and urban areas in cyan blue. This band combination is good for Urban Studies and drainage monitoring. The area of interest (Lokoja) was clipped out of the false colour composite created using Arcgis 10.2. On the same platform (Arcgis 10.2), five sample sets (Built-up area, Marshland, Vegetation, Rock Outcrop, and Water Body) were created and these sample sets were subjected to full Gaussian maximum likelihood classification. On the classified images, the rivers were digitized and a buffer of 100m as stipulated by the government was created along the rivers using the analysis tools on "arc toolbox". Built-up areas that fall within the buffer were digitized in order to determine the land area on marginal lands.

To ascertain the numbers of buildings encroaching onto the marginal lands, the Landsat images obtained were corroborated with a high resolution of 20meters downloaded via the use of Tera-Incognitia 2.42 software. Consequently, the image downloaded on Tera Incognitia was also imported into ArcGIS 10.2 wherein a buffer of 100 meters was created using the analysis tools in "arc toolbox". The raster image imported was then vectorized into polygons using the raster to polygon feature in the arc toolbox. A polygon feature that was not on buildings were identified and deleted. Furthermore, the feature to point on the data management tool under the "arc toolbox" was used to create point at the centre of each polygon, to determine the total number of building polygon. Thus the total numbers of buildings on the marginal lands were determined using these techniques.

4. DISCUSSION AND FINDINGS

The elevation analysis for Lokoja is explained in the digital Elevation analysis in figure 1. The DEM analysis reveals an elevation range of 4.6 to 595.4 meters for Lokoja. The highlands in the city tend towards mount Patti with an elevation 450meters to 590 meters, while the lowland tends towards the river banks with an elevation of 4-15 meters. Analysis reveals that some buildings were erected on the low lands. At the foot of mount Patti buildings were also erected along the slope. This development makes the inhabitant of these buildings highly vulnerable. A slope of 0-4.9° and 25.0 - 31.0 was deduced from the analysis of the DEM.

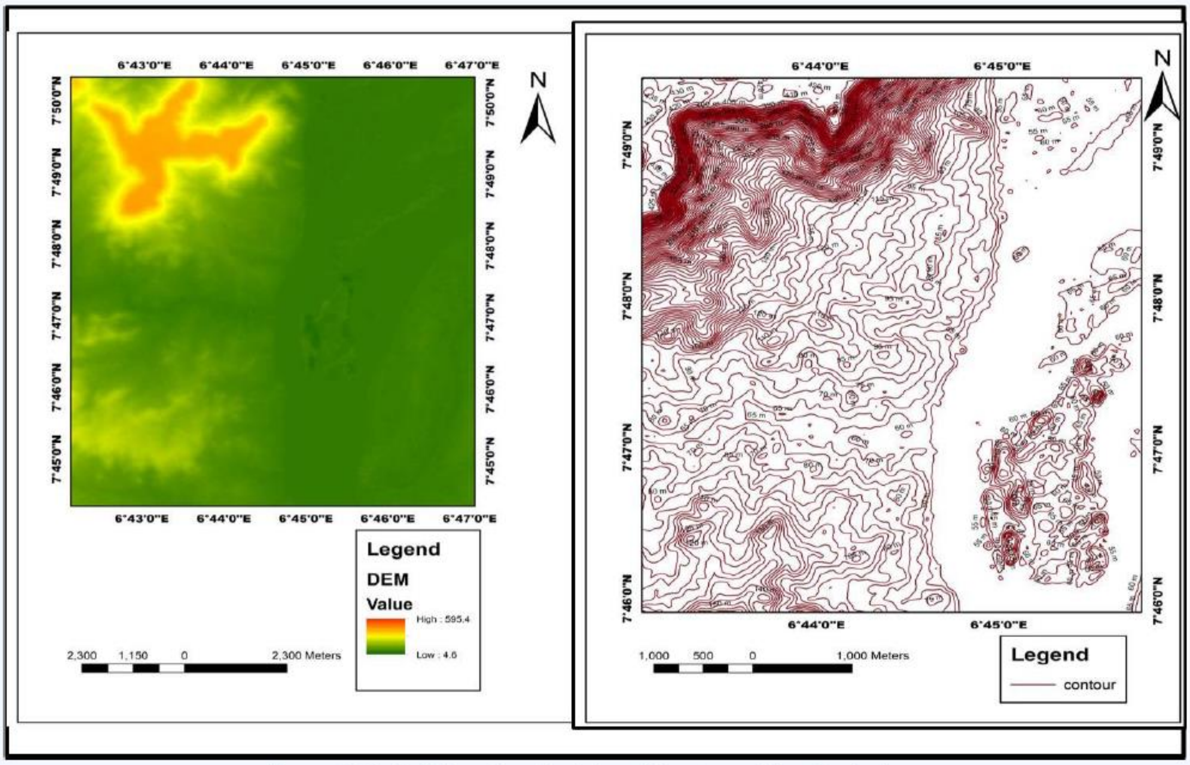

Figure 2 Digital Elevation Model and Contour of the Study Area
Source: Author's Field survey, 2017

Land Use and Marginal land Encroachment in Lokoja

Table 2: Land use of Lokoja between 2000 and 2017

Sample Set	2000 (Km^2)	2017 (Km^2)	Magnitude of Change (km^2)	Annual Change Frequency	Percentage of change
Built-up Area	16.44	29.92	13.48	0.79	82.00
Marshland	34.64	32.29	-2.35	-0.19	- 6.78
Rock Outcrop	23.39	16.45	-6.94	-0.41	-29.67
Vegetation	26.18	22.53	-3.65	-0.21	-13.94
Water body	14.76	14.07	-0.69	- 0.04	- 4.67
Total	115.41	115.26	-0.15	-0.06	26.94

Source: Author's Field Survey

Table 2 explains the trend of change in the land use and urban growth of Lokoja between 2000 and 2017. It is observed that between 2000 and 2017 the built-up area in Lokoja increased with a land area of 13.48Km^2 with an annual increase of 0.79 Km^2. As a result of the increase in urban growth 2.35Km^2 of marshland that ought to control impending flooding by storing and slowing run off were converted to built-up area by the teeming population in the quest for land. The conversation of the marshland in Lokoja has reduced the retention capacity of any runoff that might arise from high precipitation. This is an indication that Lokoja is highly vulnerable to flooding. Between 2000 and 2017 a total of 0.19Km^2 of marshland was lost annually.

A total of 6.94Km^2 of rock outcrop was lost due to the increasing anthropogenic activities in Lokoja. The study revealed that between 2000 and 2017 an annual change of -29.67 km^2 with a percentage of change of -29.67 Km^2 was detected for the changes recorded in the land area occupied by rock outcrop (Table 2). A significant decrease in vegetal cover was also recorded within the period under study. Table 2 reveals that 3.65 Km^2 was of vegetal cover was lost between 2000 and 2017, the study also shows that 0.21 Km^2 of vegetal cover is lost annually due to the immerse pressure exerted on land by the increasing population. Table 2 further reveals that a total of 0.69 km^2 of water body was lost in Lokoja due to the unprecedented urban growth. The decline in the size of water bodies in Lokoja can be attributed to silting of the river/ reclamation of land for other activities. A total of 0.04km^2 of water body is lost annually between 2000 and 2017. The land use classification maps of the Lokoja in 2000 and 2017 are shown in figure 2.

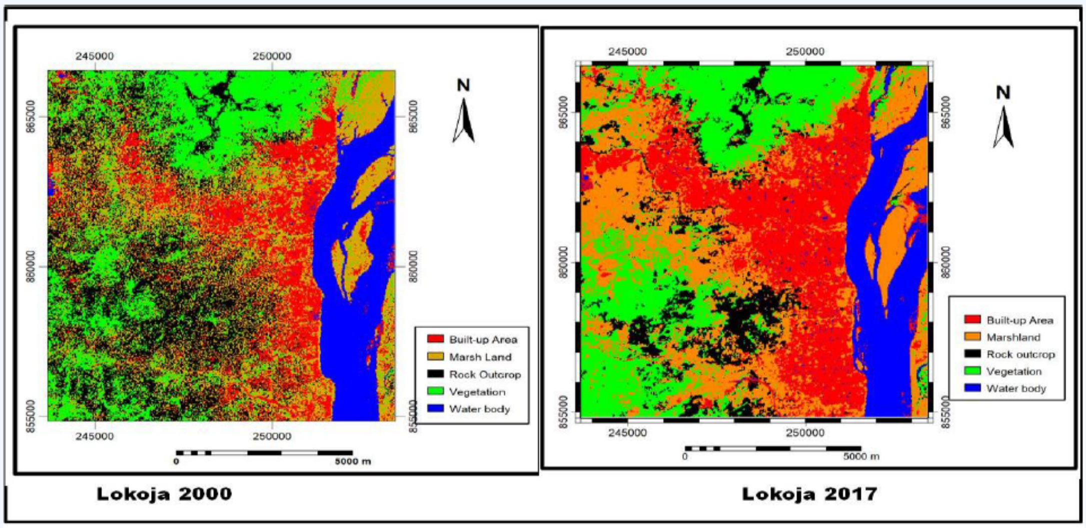

Figure 3 Land use Classification of Lokoja in 2000 and 2017
Source: Author's Field survey, 2017

Encroachment of Built-up Area on Marginal Lands

Table 3: Development Encroachment on Marginal Land

Year	Buildings on Marginal Lands	Land (Km^2)	Percentage of increase
2000	657	0.68	-
2017	868	0.77	100

Source: Author's Field Survey

The total built areas and buildings on the marginal land are explained in Table 3. The table (3) revealed that 657 buildings covering a total land area of $0.68Km^2$ have encroached into the marginal lands in the year 2000, while 2017; the number had increased to 868. A total land area covered during this period (2017) was 0.77 Km^2 with a percentage of 13.2%.

5. RECOMMENDATION AND CONCLUSION

Based on the findings above, there is a need to enforce strictly the development control laws and zoning ordinances in order to preserve the ecological state of the confluence area. This will go a long way in averting recurrent flood disaster in the state. Full scale geospatial planning technique should be adopted by the state and other stakeholders while developing the human capacity at all levels in the built environment.

In conclusion, it is no doubt that urban centres in the world are experiencing unprecedented growth, which has led to the encroachment on marginal lands which ought to be preserved. The incursion onto marginal lands by urban populace in quest for space have exposed Lokoja and its environs to lots of disasters which range from flooding, mud slid and fire outbreaks. To reduce the problem that accompanies the incessant encroachment of marginal lands, there is a need to employ disaster risk reduction approach in the management of marginal lands in Lokoja and the country at large.

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