

EVALUATION OF IMPOSED SAND DEPOSIT OCCASIONED BY FLOOD ON FARMS AT JIMETA-YOLA, ADAMAWA STATE, NIGERIA

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ABSTRACT

The Benue River Basin provides more than 200 hectares of productive flood plain used for farming vegetables. Major flood events usually bring serious changes to the landscape, with large hectares of productive flood plains buried under thick deposits of river sand. This research was carried out to estimate the hectare of productive flood plains that had been buried under river sand along the Benue River basin in Jimeta, Adamawa State from the year 2014 to 2016. Gongola Topo-Sheet 156 NE (1:50,000) was used as the base-map, in addition to Google Earth images of the area for planning the field and sampling procedure. Satellite imagery and remotely sensed data were used to analyze the land use changes in the floodplain and further information on the sedimentation patterns. Results showed about 569,732m² (60 hectares) of farm lands under vegetable cultivation were buried under thick river sand following the flood event in 2012. This value decreased to 166,471m² and 136,037m² in 2014 and 2016, respectively. This showed the clear impact of sedimentation problem and resilience of the soils to restore itself after a major flood. GIS usage was found to be a very important tool for water shed management in investigating sedimentation. This will also help availability of arable land for cultivation of arable crops. It was recommended that an agency should be created to formulate policy to monitor and evaluate geomorphologic dynamics of watershed and dredging of river Benue.

Keywords: floodplain, flood, Fluvisols, Remote Sensing, Sand deposit.

INTRODUCTION

Utilization of flood plains for food production is a common practice in North Eastern Nigeria, mainly because the soils are silt loams to clay loams in texture, fertile and high in water retention capacity. The soils along the flood plain are also known to undergo seasonal flooding with prolonged submergence during rainy seasons, which imply seasonal redox transformations within their profiles. These soils are locally known as *Fadama soils* (Adeyeye 2005). In the United States Department of Agriculture Classification System (USDA, 2014), they are classified as *FluvicEntisols* or *Vertisols* when a uniformly high clay content exists through the profile; while the World Soil Reference System describes such soils as *Fluvisols* or *Vertisols* (FAO, 2006).

The Benue River Basin provides more than 200 hectares of productive fadama land (Fluvisols) adjacent to Jimeta Bridge, an area locally known as Kukan PRP at Jimeta-Yola.

The area has been utilized for over 30 years by local peasant farmers for vegetable production under irrigated and rain-fed cultivation systems. Irrigated cultivation takes place in November-May; while the rain-fed cultivation is usually from June-October, except in heavy flooded years. Due to its location at the city's edge, the area is also notoriously utilized as the city's refuse dump site. A major flood event on River Benue in 2012 brought serious changes to this landscape, such that large hectares of the productive flood plains were submerged under thick deposits of river sands. However, flooding had been reported many times to leave behind infertile sands and degraded soils (Megan2,019).

Farming on a sandy soil, particularly in flood prone areas, need greater efforts in lands reclamation due to the issue of sand deposition. Sandy soil have some limiting factors in agricultural usage, which includes nutrient deficiencies, acidity, low water retention and poor physical attributes (Zhao, *et al.*, 2007). Sand

deposition have far reached effects on soil physical and chemical properties (Ostendorp, *et al.* 2004; Werner and Zelder, 2002). For example; the concentrations of fine particles (clay plus silt) and organic matter usually decreases with increasing sedimentation rate because of extremely low concentration of fine particles (Zeng *et al.*, 2009). Decreased in soil fine particle concentration generally leads to high rates of nutrient leaching in soil (Gajic *et al.*). In addition, sedimentation reduces the aptitude of the daily temperature fluctuation in deep soil and alters soil pH depending on the acidity of the deposited sediments (Maun, 1998; Mutins and Brumetis, 2008). Such sedimentation affects the growth conditions of sand dune plants because of the altered soil physical and chemical properties (Zhao and Fang, 2007). Generally, heavy sedimentation is harmful to the growth of almost all plant species due to low oxygen and light availability in buried soils (Pan *et al.*, 2012).

Mapping the extent of sand deposit with the aid of a soil map or aerial photo can help determine the appropriate movement and extent of spread of sand deposit in the landscape. Using soil probe or tile probe may quickly help to determine the sand depth. New spatial technology such as GIS, LIDAR and remote sensing are veritable tools for assessing extent of disaster(s) (Londono and Hart, 2013; Godwell, *et al.*, 2011). When the sands deposit depth is thin, they can easily be incorporated into the silt by tillage equipment. However, deeper deposits many require the spreading or removal as depth of sand increases and mixing becomes impossible, while the allowable depth of sediments for mixing into the soil depend largely on the underlying soil type and tillage method. Although a number of significant studies had been made on the impact of the 2012 floods on agricultural lands in Jimeta area, the data available is still scanty and there is need to investigate further in order to know the impact of the flood on the land forms.

MATERIALS AND METHODS

Location and Extent

Jimeta-Yola, located between latitude 7° and 11°N and between Longitude 11° and 14°E, is the city capital of Adamawa State, Nigeria. It is bounded by River Benue to the North, North-East and Eastern edges. Residents are mainly civil servants (government

workers), while the commercial base and private sector are weak and restricted to a number of banks, very few industries, and a series of small and medium scale retail outlets for goods brought in from nearby states and adjoining African Countries. Jimeta-Yola however, has a strong agricultural base in cereals and leguminous crops cultivation.

In this study, the Gongola Topo-Sheet 156 NE (1:50,000) was used as a base-map, which was in addition to Google Earth images of the area that were used for the field planning work and sampling procedures (Fig 1). Satellite imagery and remote sensed data were used to analyze the land use changes in the floodplain, and information on the sedimentation patterns. A land area of 1,235,000 m² (123.5 hectares) of the flood plain was delineated using satellite images, and evaluated for change in land use and land cover at Jimeta-Yola from 2 years before the flood event in 2010 to four years after the flood event in 2016. The data for the various land use which includes the lake, sand deposit and cultivated land were obtained from remotely sensed data such as aerial photo and aerial photos as shown in the various figures presented during the period of the studies. Five satellite scenes of Landsat-TM in 2010, 2012, 2014 and one picture of 2016 were used.

Spatial Data Acquisition

The coordinate of the study area was used in obtaining the image of the study area on googleearth. The image was georeferenced, with the help of coordinates obtained from known features within the study area. The delineation of the area of interest was carried out on the georeferenced image through digitizing of the study area into shapefile.

The spatial Landsat data imageries were obtained from <https://earthexplorer.usgs.gov>, through the path and row (185/54) search techniques for the area of interest (AOI). The images were acquired from Landsat TM at collection 2 Level 2 and set at a cloud cover of less than 10% for clarity purposes during analysis. The Landsat data collected were Landsat 5 TM, of 2010, 2012, 2014 and 2016 (Table 1). The shapefile of the AOI was overlaid on the sets of Landsat images downloaded and the AOI were extracted from the images of the four study periods. The various land use land cover identified (Lake, Sand and Cultivated area) were calculated over the study periods (2010, 2012, 2014 and 2016)

as presented in table 2 which were used for further analysis.

Table 1: Landsat Spatial Data Images and the Pattern of their Collection

Year	Sensor Type	Data Type	Resolution	Path and Row (scene/tile)
2010	TM	Spatial	30m	185/54
2012	TM	Spatial	30m	185/54
2014	TM	Spatial	30m	185/54
2016	TM	Spatial	30m	185/54



Figure 1: Boundary of the Study Area

RESULTS AND DISCUSSION

Changes in Landscape (land use/land cover)

Results for the changes in land use and land cover (Table 2) showed that with satellite imagery, there were only two major land use types as at year 2010 (Figure 2) which was 2 years before the flood event. In the year 2010, about 109.5 hectares ($1,094,504 \text{ m}^2$) of the total delineated area was being used for crop production, while the remaining 14.1 hectares ($141,419 \text{ m}^2$) was water logged. However, following the flood event in the year 2012 (Figure 3), a third type of land use/land cover was formed which amounted to about 56.97

hectares of the usually cultivated flood plains were buried under thick white river sand. Pathetically, area of the flood plains available for cultivation in 2010 that was made up of 88.62% (109.5 ha) of the total delineated study area (123.5 hectares), was reduced to just 43.5 ha after the flood event in 2012. This translates to a loss of more 60% of the land that had previously been available for crop production. It was also observed that in that same period, the area coverage of the water body (lake) increased by about 9 hectares (87.159 m^2), which indicates that, not all of the farmland was lost to sand cover. However, the flood had

resulted in the submergence of substantial amount of the cultivable lands. This was in trend with previous reports by, Megan, (2019).

Data for the depth or thickness of the sand deposit was not collected in 2012, but was however collected in the years 2015 and 2016 (Figure 4), with average values of 88 cm and 66 cm thickness, respectively. These values exceeded the 60 cm standard depth of sand permissible for mixing into the soil by using deep tillage implements like the chisel plough as a management method for flooded land reclamation (USDA, 1993). In such a situation, a total evacuation of the sand stockpile is recommended, provided it is economically feasible to execute (Zhao *et al.*, 2007). Zhao *et al.* (2007) opined that farming in sandy soils, particularly in flood prone areas needs longer and greater efforts in such land reclamation, especially with heavy sand deposition.

The results obtained for subsequent years (fig. 3 and 5) suggested that a gradual decline in sand coverage and depth occurred and by the year 2016, only about 13.8 hectares

of the flooded plain farms remained under sand cover as against the initial value of 56.9 hectares in 2012 (Table 2). This reduction might be due to reclamation efforts by the local farmers, especially where the deposit was shallow. This finding was also corroborated by Kafle *et al.* (2017) who reported that in areas of light sand deposit of less than 1m the land can be reclaimed for usage, but if the thickness is greater than 2m then, the land becomes uncultivable deposit.

Considering the management methods, Fig 6, shows some management methods being adopted by farmers in the study area due to sedimentation by river sand. Where light deposition occurs, the sands were gathered in heaps to expose the soil surface for cultivation. The sands were later transferred to dumpsites. This method had been adjudged to contribute immensely to the reduction of sands deposit problems in the study area, especially when all the farmers adopted such management practices.

Table 2: Area Coverage of Water Body (Lake), Sand Deposits and Cultivation in Jimeta-Yola

Year	Lake Cover (m ²)	Sand Cover (m ²)	Cultivated (m ²)	Cultivated (hectares)	Cultivated (% of Total)	Total (m ²)	Area
2010	141,419	0	1,094,504	109.5	88.62	1,235,923	
2012	228,578	569,732	435,348	43.5	35.25	1,233,658	
2014	172,803	166,471	896,228	89.6	72.57	1,235,502	
2016	150,664	138,037	946,052	94.6	76.60	1,234,753	
*Total area average (1,234,959 m ² ≈ 123.5 hectares)						1,234,959	

*Average of total area delineated and digitized on the maps/images of years monitored in the study



Figure2: Study area 2010



Figure 3: Study Area during Flood of 2012

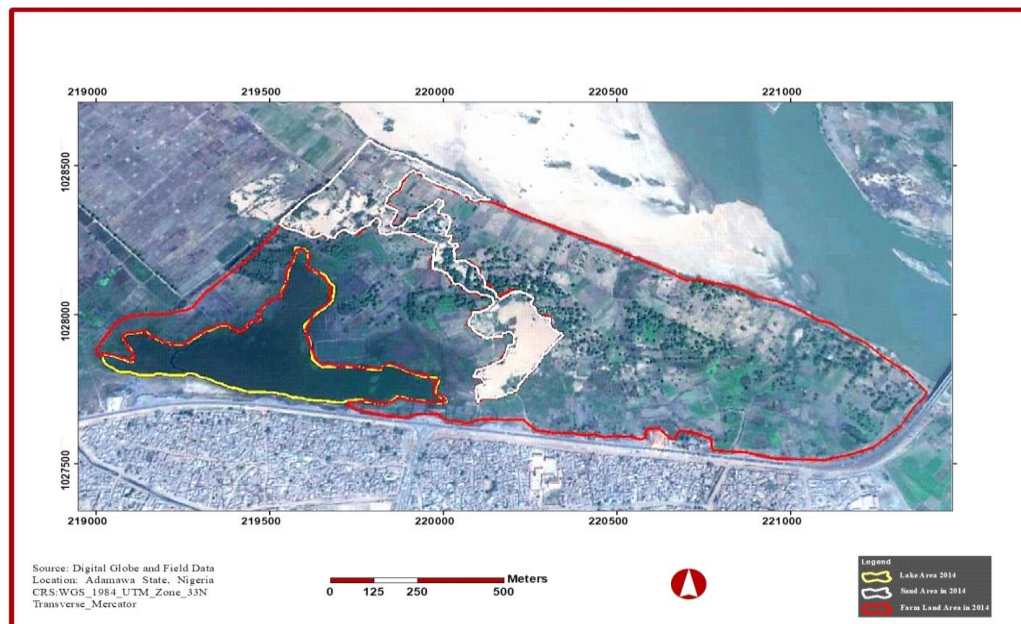


Figure 4: Study Area after the Flood 2014

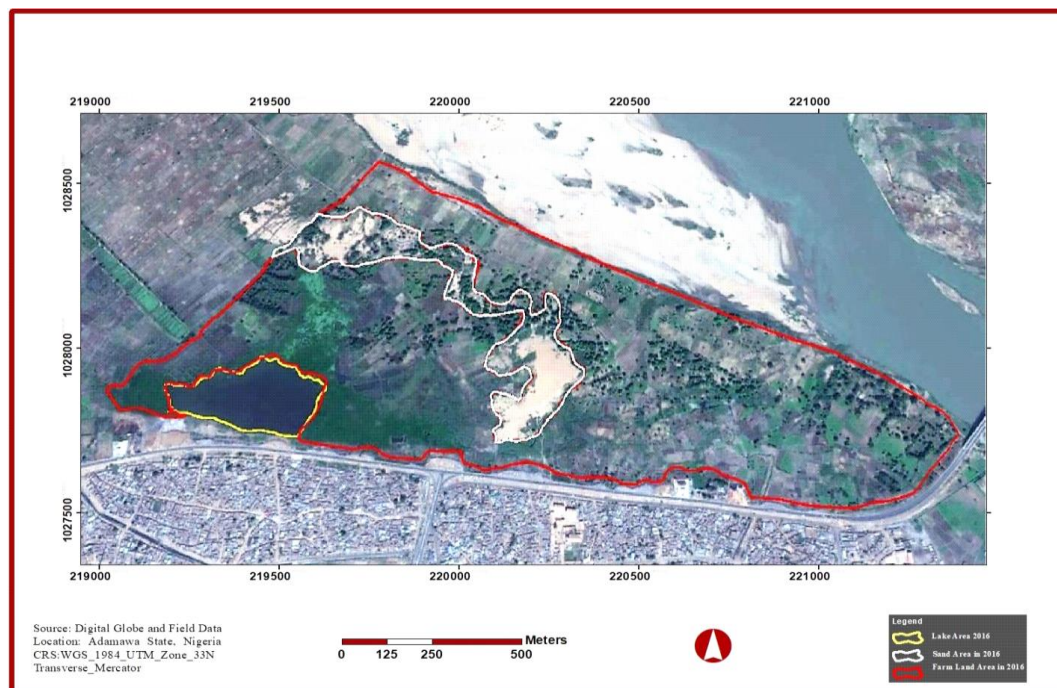


Figure 5: Study Area after the Flood 2016



Fig6: Excavation of sand deposit by local farmers

SUMMARY AND CONCLUSION

Flood is a recurrent event in the Benue River basin landscapes, it has many positive attributes but it can cause untold damages to farmlands by deposition of heavy sands which may hinder plant growth and affect soil fertility. In places of light deposition, the sands can easily be excavated while in cases of heavy deposition, the farmland is usually abandoned thereby causing economic lost to the farmers. This study reveals that in areas of light sedimentation, farmers were able to reclaim the land and used same for the cultivation of crops such as rice and vegetables. This study further shows a gradual increase in cultivated area which probably was due to reclamation efforts by the farmers and some geomorphological processes which causes the washing away of heavy sand deposit by rain water. The places of high deposition in the farmlands were usually abandoned. Levee should be constructed at the banks of the river to prevent unnecessary sand deposition; River Benue needs to be dredged to prevent reoccurrence of sedimentations.

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