Flood Mapping and Landuse Change Analysis of Ogun River Catchment, Nigeria

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Abstract

There is evidence of lingering flood situation around Lagos and its environs in the Ogun River catchment area. The flood problem has destroyed properties worth millions of naira, claimed lives and rendered people homeless. Analysis of Landuse change performed using LANDSAT images of the environment shows that settlement area appreciated by 766km² (1984 to 2002) and 436km² (2002 to 2006) with great decrease in vegetative cover and floodplain across board. The implication is that the wetlands are destroyed due to human encroachment and urbanization. Vegetative area and floodplain have been transformed to built-up areas. The increased settlements simply means increase in impervious surfaces in Lagos metropolis; as such, the available channels were not able to contain excess water in case of heavy rain (for example, the 16-hour continuous rainfall experienced in June 2011). Cellular Automaton Evolutionary River and Slope Model (CAESAR) was used to simulate the flood events with discharge input point at Oyan Dam. From the CAESAR flood analysis, at least 25 settlements and infrastructure such as roads were seen to be at risk during low flow inundation. An average of 63 Settlements stand to be at risk with a spread of 2339.03 hectares of land underwater. Flood maps were produced for three flow regimes represented as high, medium and low flows. This study attributed the cause to encroachment of urban facilities on floodplain, drainage area and unprecedented land reclamation without strict adherence to landuse and natural waterway planning. Management suggestions are made for relocating people from drainage line and structural measures such as proper drainage system, channelization and real-time monitoring of water dynamics.

Keywords: *Flood, Landuse Change, Management, Mapping, Ogun River Catchment, CAESAR Model*

1.0 Introduction

Flood is one of the greatest disasters in the world. Flooding in Lagos has become a frequent hazard which is related to heavy precipitation, that can collapse the natural or man-made dams and the release of impounded waters (Glover, 1994). The

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flood problem is worsened with heavy rains and massive release from dam. Olaniran (1983) opined that the frequent flooding of the

Victoria and Ikoyi Islands in Lagos is predominantly caused by excessive rains which are very prevalent during the months of September and October. The aftermath of flood disaster in Lagos and environs is worrisome.

Population explosion in Lagos metropolis has also contributed to the flood problem being witnessed. Many are living in areas prone to flood and mud landslides as a result of inability to cope with the high cost of house rent where landlords have insisted on two-year tenancy, thereby increasing the population at risk each year. River valleys and flood plains have been the cradle of civilization since the ancient times and are still some of the most densely populated parts of the world. It is the immense density of population in close proximity to rivers that makes flooding one of the most common natural disasters which affect more people across the globe than all other natural or technological disasters. Flooding is also the most costly in terms of human hardship and economic loss (Huang, et al, 2008). Information from complex modelling/mapping is required for flood combat and effective management.

A flood hazard map is crucial for monitoring flood risk. There are several methods for flood mapping based primarily on hydrologid, meteorological and geomorphological approaches. In developing countries where hydro meteorological data are commonly insufficient, inaccurate and restricted to generate flood models, the geomorphological method, particularly, has demonstrated its effectiveness and appropriateness (Wolman, 1971; Lastra et al. 2008) because this method applies aerial photo interpretation and field investigation of flood evidences to the study of geomorphological characteristics in relationship with historical flood events. A geomorphological map can help in studying the extent of inundation area, direction of flood flows, and changes in river channel through remaining flood evidences, relief features and sediment deposits formed by repeated flood: hence understanding the nature of former flood and probable characteristics of flood occurring in the future (Oya, 2002).

Flood hazard mapping with LANDSAT and SRTM-derived Digital Elevation Model (DEM) is an economical and efficient method for mapping flood hazard and dealing with the problem of inadequate data source (Wang et al, 2002). The combination of supervised land cover classification from LANDSAT and SRTM – DEM classification could be employed for coastal flood risk analysis (Demirkesen, et al, 2006; Willige, 2007). Delineating flood extent areas and water body in general is always the most crucial concern to deal with flood mapping operation. LANDSAT images are usually the first choice because of their convenient obtainment. Efficient methods for mapping flood extent include: the use of LANDSAT TM by distinguishing water and non-water areas based on reflectance characteristics; using a pair of images before and after a flood event. And using TM7+TM4 formula [17] for extracting moist areas.

The cellular framework approach and landuse change is used to determine the areas liable to flood, rate of spread at different flow regimes and population at risk. Real-time flood risk map can be produced in a Geographic Information System (GIS) software environment with the Digital Elevation Model/ Digital Terrain Model (DEM/DTM), LANDSAT data and flow data of the case study area.

1.1 Study Area

The study area is Ogun river catchment, South-western, Nigeria. The catchment is bordered by latitudes 6° 26' N and 9° 10'N and longitudes 2° 28'E and 4° 8'E. It captures parts of Lagos and Ogun State (Fig. 1). The land area is about 23,000km^2. Ogun River takes its source from the Igaran hills at an elevation of about 530m above mean sea level and flows directly southwards over a distance of about 480km before it discharges into the Lagos lagoon. The river is dammed. The major tributaries of the Ogun River are the Ofiki and Opeki rivers. About 9km upstream of Abeokuta town there is a sharp change in land gradient, changing the river morphology from fast flowing to slow moving and leading to the formation of alluvial deposits overlying the sedimentary formation of Ewekoro, Ilaro and Coastal plain sands in sequence towards the Lagos lagoon (Fig. 2).

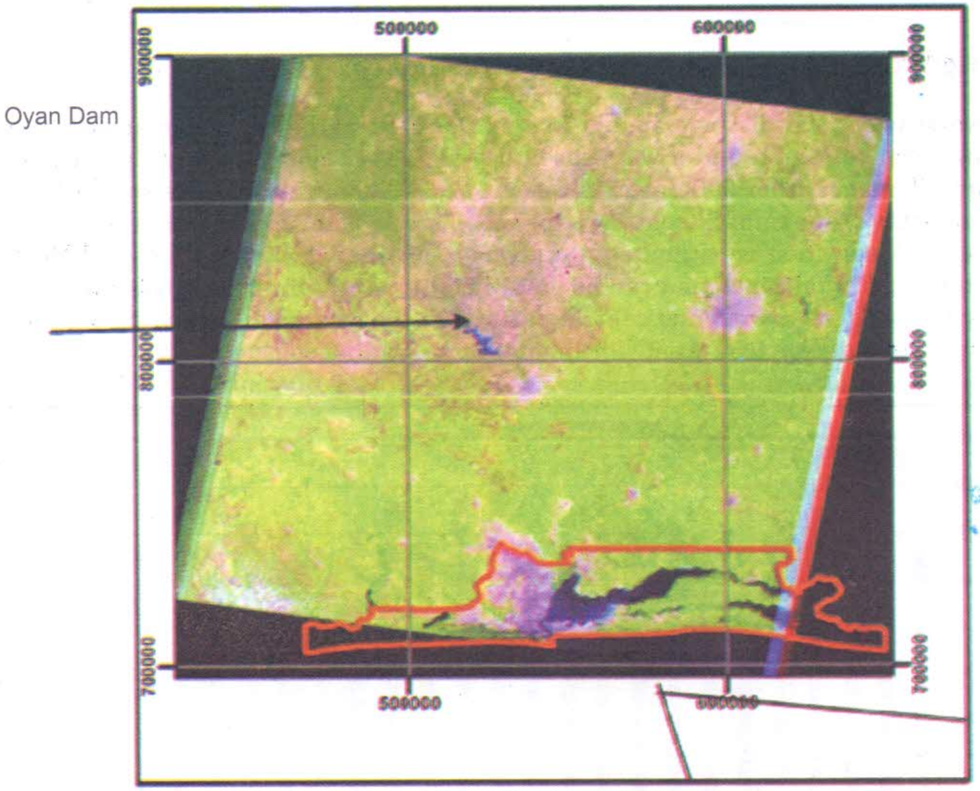

Fig.1: A Subset of LandSat ETM Showing the Boundary of Lagos State

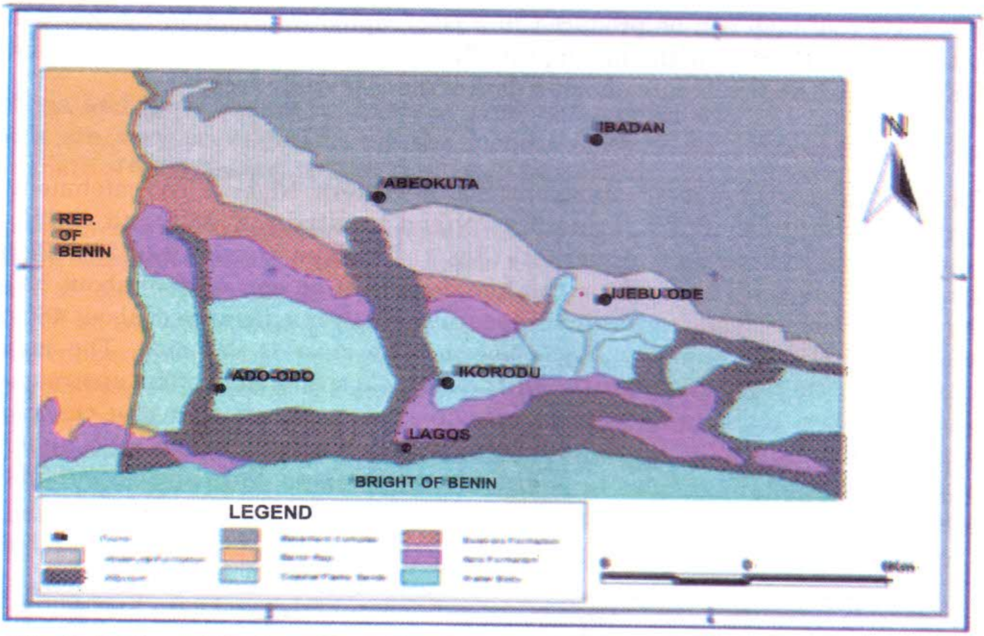

Fig. 2: Geology of the Ogun-Osun River Basin (Source: [1])

Two seasons are distinguishable in the Ogun River basin; a dry season from November to March and a wet season between April and October. Mean annual rainfall ranges from 900mm in the north to 2000mm towards the south. Fig. 3 represents the rainfall pattern for the area. The total annual potential evapotranspiration is estimated at between 1600 and 1900mm (Fig. 4). The two major vegetation zones that can be identified in the watershed are the high forest vegetation in the north and central parts, and the swamp/mangrove forests that cover the southern coastal and floodplains, next to the lagoon.

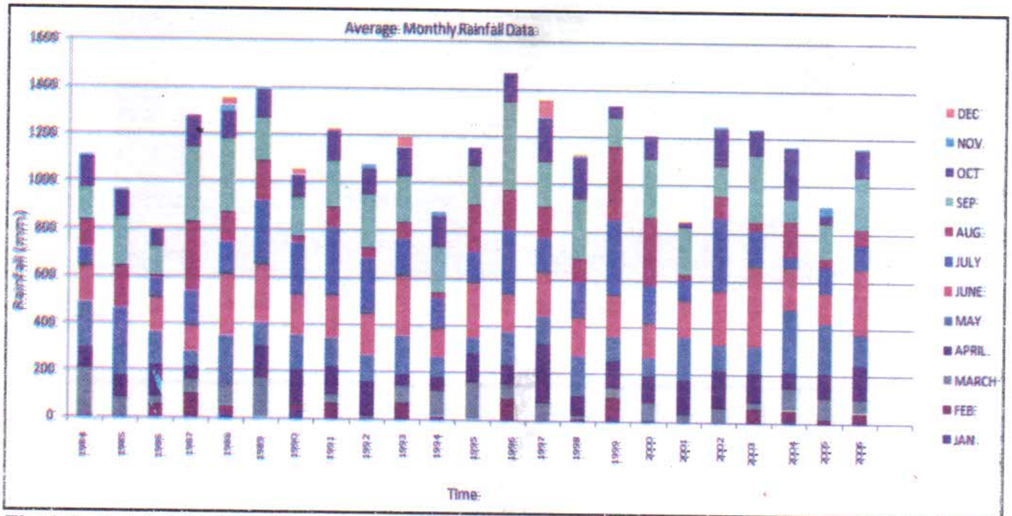

Fig.1.3: Rainfall Pattern.[9]