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RESEARCH PROPOSAL ON LANDUSE EVALUATION AND OPTIMIZATION WITH REGARD TO FLOOD VULNERABILITY IN THE GEOGRAPHIC NIGER-DELTA REGION OF NIGERIA USING THE SWAT MODEL

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Introduction

Geographically, the Niger Delta region is situated in the southernmost part of Nigeria in West Africa. By definition, the geographic Niger Delta is a coastal region with distinctive geography demarcated by a natural delta of the River Niger system (Reijers et al., 1997). It is located in the Gulf of Guinea between longitude 5 degrees E to 8 degrees E and latitudes 4 degrees N to 6 degrees N, bordered by the Atlantic Ocean on the south; Cameroon on the east; Lagos State on the west and Onitsha on the north (Tuttle et al.; Abam,1999; Adekola and Mitchell, 2011). The extensive wetland delta is considered the largest in the African continent and the third largest in the world (Abam, 2001; Chiadikobi et al., 2011).

The geographic Niger Delta region covers an area of 86,087 km2, i.e. about 10% of the Nigerian land mass. Hence, its southern coastline frames the continental margin of the Gulf of Guinea, spanning 450 km (Reijers et al., 1997).

Globally, river deltas e.g. the Huanghe Delta, Liaohe Delta and Niger Delta, are among the most densely populated areas of the world perhaps due to the various benefits they provide for humans such as: flat topography, fertile soils for agriculture, access to harbours for export and trade, access to marine and water resources, extensive biodiversity in addition to subsurface oil and gas deposits (Liu et al., 2000). The Niger Delta region presently host over 30 million inhabitants making up about 20% of the Nigerian population that is attracted to the region (Kuenzer et al., 2014). Hence, the combination of its geography, topography and abundant natural resources, in addition to oil and gas resources, makes it an area of global and regional importance. Nevertheless, a gamut of studies has also demonstrated that the region is very vulnerable to the impact of natural and anthropogenic hazard due to several natural and socio-economic factors (Ologunorisa 2004).

The earth surface is being significantly altered by man and this has had a profound effect upon the natural environment thus resulting into an observable pattern in the land use over time. Man continues to explore and exploit the natural resources in his environment and this has brought immense contribution to observable changes

in land. "Land use involves both the manner in which the biophysical attributes of the land are manipulated and the intent underlying that manipulation – the purpose for which the land is used" (Turner et al. 1995).

Land is the fundamental basis of all human activities, from it we obtain our food we eat, our shelter, our water, the space to work, the room to relax and lots more. The magnitude of land use change varies with the time being examined as well as with the geographical area. The assessment of these changes depends on the area, the land use types being considered, the spatial groupings, and the data sets used.

The land use- land cover pattern of a region is the result of interplay of both natural and socioeconomic factors. Issues of Land use-land cover and its impacts on the environment has become of great concern all over the world. A Change in land use pattern has significant effects on local and global environmental conditions such as flooding.

Cities in the geographic Niger delta region of Nigeria are growing at an unprecedented rate and as such associated with land use changes which have resulted in severe flooding in the region. Increased flood risk resulting from heavy rainfall, land-use changes and floodplain dwelling is putting millions of inhabitants of geographic Niger-Delta mega-cities in danger.

In particular, coastal cities in geographic Niger-Delta region of Nigeria are increasingly at risk of flooding due to worsening natural and anthropogenic

influences. Natural forces, including intense precipitation, high tide, and low topography demand careful management. Moreover human influences due to urbanisations that result in rapid landuse changes and increased flood risk requires better management, (Owei et al., 2010).

Urbanization is broadly defined as the transition from rural to largely urban societies. There is now a wide consensus that Asia and Africa are more vulnerable to flooding effects due to increased urbanization, climate change, poor planning, weak regulations, poor socioeconomic conditions and poor adaptive capacity (UNFCCC, 2007).

Flooding is the most frequent and life-threatening environmental hazard affecting especially coastal areas in the Niger Delta (Abam, 2001). A recent example was the July 2012 flood disaster which affected 12 states around the River Niger. The event left 363 people dead; US$9.5 billion worth of damage; 5,851 injured. About four million people were displaced (GFDRR, 2013). After this event, a Post-Disaster Needs Assessment report (PDNA) showed the damages in Rivers State of the geographic Niger delta alone was worth US$3.4 billion (GFDRR, 2013).

This research focuses on the landuse changes as it affects flooding in the geographic Niger Delta region of Nigeria.

Description

In hydrology, much has been discussed on the effects on flooding such as: increase in peak flow, changes in total runoff, changes in water quality and effects on hydrologic amenities (Leopold, 1968; Verbeiren et al., 2013; Sanyal et al., 2014). Much has also been discussed on the effects on sediment load, effects on infiltration or the loss rate, changes in basin lag time (Harbor, 1994; Meade, 1996; Suriya and Mudgal, 2012; Nikolaidis et al., 2013). Regarding flood risk, much has also been researched on flood hazards, flood vulnerability, flood risk management (Plate, 2002; Smith, 2013; Viglione and Rogger, 2015). Others have researched on adaptation, flood mitigation, flood perception, emergency planning, etc. (Jha et al., 2012; UNFCCC, 2007; Bola et al.,2014).Presently, there is a growing interest in foresight and future studies relating to flood impacts (Ali et al.,2011; Du et al., 2012), flood risk and vulnerability assessment (Wheater and Evans, 2009). This will help our ability to make long-term plans and explore options for flood risk management. In a recent study by Samuels (2012:10) titled “Where next in flood risk management”, emphasis was laid on long term planning and options assessment. The study emphasised on “the urgent need to improve understanding and reduce uncertainty for estimates of decadal timescale changes to floods and their impacts”. Future studies are crucial for planning and formulating long-term adaptation and mitigation strategies for vulnerable areas. One major concern to

planners is the options that are likely to significantly impact on the future hydrologic functioning of basins (Leopold, 1968; Pauleit and Durham, 2000). Therefore, there is need to understand the impacts of land-use change scenarios on the flooding of the Niger-delta region of Nigeria.

General Analysis

In the Niger Delta region of Nigeria today, there are gaps in knowledge regarding potential impacts of land use changes on flooding. There is a need for future impact research relating to land use changes in the Niger-delta, since catchment response to changes in land use which varies from watershed to watershed (Leopold, 1968). However, there are recent studies on potential impacts of land-use change on flooding for several catchments in other developing countries (Chen et al., 2009; Ali et al., 2011; Du et al., 2012; Sanyal et al., 2014). For example, such studies have been carried out in Qinhuai River Basin, in China by Du et al. (2012); Thirusoolam Subwatershed n Chennai by Suriya and Mudgal (2012); Lai Nullah Basin, Pakistan by Ali et al. (2011); Tolka River Basin in Dublin, Ireland by Verbeiren et al. (2013); Gyeongancheon watershed in Korea by Im et al. (2009). These studies showed that future urbanisation could likely have a significant impact on flooding. In contrast, no such study have investigated the future impacts on flood in the Niger Delta. Such a study could be beneficial in providing further insight into the alternatives with the least impact on flooding in a tropical

watershed. The study will also provide an understanding of the future impact on this important tropical watershed. Moreover, the scope of this research will go beyond the impact on hydrology to the impact of the hydraulic condition. To date research on future flood hazard parameters such as flood depth, flood extent and fluid velocity are apparently non-existent for the Niger Delta region.

Current Information

This research is aimed at assessing the landuse pattern in relation to flooding in the geographic Niger-Delta region of Nigeria using the SWAT model.

To achieve the stated aim, the following objectives are set:

1. To determine major watersheds, flood plains, natural/artificial drains and water ways within the geographic Niger-Delta region of Nigeria.

2. To prepare land-use, soil and weather data for SWAT modeling

3. To evaluate the land-use pattern, land resource administration and future land use prediction over the study area.

4. To generate a digital elevation model for watersheds in the geographic Niger-Delta region of Nigeria.

5. To run the watershed simulation and discharge within the geographic Niger-Delta region of Nigeria.

6. To determine the magnitude of flood impacts within the plains of geographic Niger-Delta region of Nigeria.

7. To make recommendations on how to improve future planning using insights from this study.

Discussion

This section describes and justifies the general research design, workflow and methods applied. The goal is to provide a clear and complete description of the research process. The research approach provided details of the type and nature of the research and describes the general framework of the study consisting of the workflow.

Subsequently, we will also describe the data and justified the process and methods of its collection. It will provide information of when, where, and how the data was collected. Next are the Methods and Procedural aspect provided in a detailed description of steps taken for the data processing, model run, and calibration in addition to validation in this study? This includes methods and procedure used for studying LULC Change detection as well as the procedures and assumption made in the application of alternatives and construction of future prediction scenarios. This research work also presents the procedures used in the preparation of topographical and spatial input data as well as the runoff estimation using hydrologic modelling technique, while integrating the flood inundation analysis using the SWAT modelling and mapping techniques.

Conclusion

Landuse classification and flood vulnerability maps need therefore, to be created as they provide a basis for the development of flood risk management plans. What is more, these plans needed to be effectively communicated to various target groups (including decision makers, emergency response units and the public) as a measure to reduce flood risk by integrating different interests, potential and conflicts over space and land use in the geographic Niger delta region of Nigeria.

Reduction of the risk of flooding will depend largely on the amount of information on the flood that is available and the knowledge of the areas that are likely to be affected during a flood event. Therefore, it is necessary to use modern day technique in developing measures that will help relevant authorities and relief agencies in the identification of flood prone areas and in planning against flooding events in the future. Determining the flood prone area is important for effective flood mitigations. For this study, two flood simulation models were introduced which involves the use of Boolean operation which relies in the DEM of the study area which simulates and models the depth and extent of the flood prone areas within the state and multi-criteria method which was used for the simulation

considering seven factors that causes flooding including, rainfall, soil, elevation, slope, landuse land cover, drainage density and drainage distance were introduced into a GIS environment for its analysis.

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