DELINEATION OF FLOOD VULNERABLE ZONES AND DISASTER RISK MANAGEMENT ALONG ASA RIVER: A GIS APPROACH

BY

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INTRODUCTION

In recent years, floods have become increasingly significant as an environmental hazard. Nigeria has experienced a lot of flood incidences and the impact of flood has also increased due to population growth coupled with uncontrolled developmental practices which has resulted in pressure and congestion on urban land. This forces a considerable number of people to settle in unsafe areas with inherent risks. Low purchasing power also motivates people to acquire cheap land regardless of inherent risk involved. Climate change which culminates into rising sea level is another causative factor. Flooding poses a tremendous risk to the human and physical environment. Flooding is a potential harm to residences along the Asa river channel because of it severity, magnitude of its impact and frequency of occurrence. This calls for a systematic management of the disaster. Defining the level of vulnerability and delineating risk zones can help in understanding the best option in managing, mitigating and adapting to the impact of flood hazard (Bahaeldeen, 2006)

STATEMENT OF PROBLEM

Flooding along the Asa river in Ilorin is an annual occurrence. The unsafe condition of lives and properties along the river has over the years become an issue of serious concern to individuals, Local, State and the Federal Government. Properties amounting to billions of Naira are damaged yearly. The government disburses lots of resources to resettle flood victims and to provide relief materials. A viable tool for decision making in risk reduction is geo-spatial information.

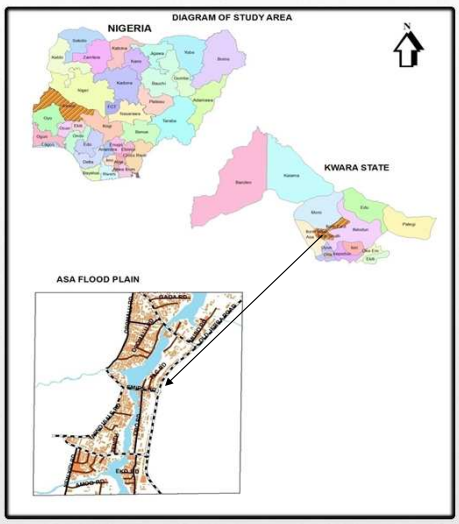
AIM OF THE STUDY

This research is aimed at delineating features that are susceptible to flood disaster along the Asa river in other to provide ameliorative and mitigating measures.

OBJECTIVES OF THE STUDY

1. Database design
2. Capturing the spatial data within the study area using Ikonos Imagery (One meter Resolution).
3. Create an attribute database for all elements at-risk.
4. Generate the Digital Elevation Model of the study area.
5. Production of risk map which will capture the at-risk elements and delineate risk zones.
6. Perform some spatial analysis such as buffering, overlay operation and 3D analyses.

THE STUDY AREA



DATABASE DESIGN

Database design is categorized into three stages, i.e. the conceptual design, logical design and the physical design phase.

Conceptual design, Logical design, Physical design

DATA SOURCES

The primary data acquired for this study include: Some points coordinated using Global Position System (GPS) to geo-reference the topographic maps, attribute data was collected through social survey and direct interview with residence of the area. The secondary data include: Ikonos Image of Ilorin (One meter resolution) covering the project area obtained from the Office of the Surveyor General of Kwara State, topographical map (1:50,000) covering the study area from the Office of the Surveyor-General of Kwara State, Rainfall data for a period of ten years (2000-2009) from Lower Niger River Basin Development Authority, Ilorin and population data from National Population Commission, Ilorin

DATABASE CREATION

The tables were created and populated in ARCGIS 9.3 and the attribute tables were linked with geometric data.

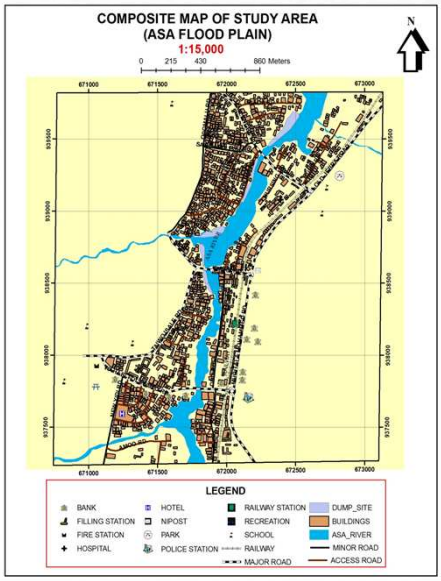
Sample of the table created

BUILDING_H

OBJECTID *	SHAPE *	VULN_LEVEL	LOCATION	B_USE	B_CONDITION	SHAPE_Length	SHAPE_Area
1	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	87.024101	324.98747
2	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	97.88275	534.533854
3	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	108.844256	582.215977
4	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	142.539256	1247.457146
5	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	113.169933	647.986943
6	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	103.487402	551.786091
7	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	62.458038	238.827257
8	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	106.729948	544.154875
9	Polygon	HIGH VULNERABLE ZONE	COCOA COLA R	RESIDENTIAL	WATER LOGGED/CRACKING/SINKING	159.859759	1545.570856

SPATIAL OPERATIONS

The spatial data acquired in this research were linked to the attribute data and used to demonstrate how GIS as an analytical tool is used to answer the basic generic questions of; "what is where", "where is what", and "what is the pattern?".



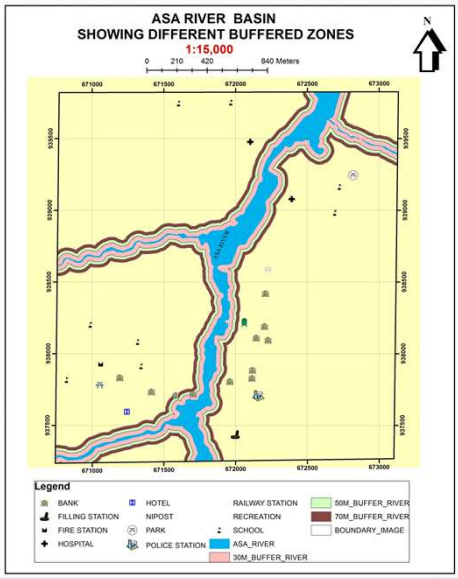
COMPOSITE MAP OF THE STUDY AREA

Buffering Operation *(Criterion One for Vulnerability Map)*

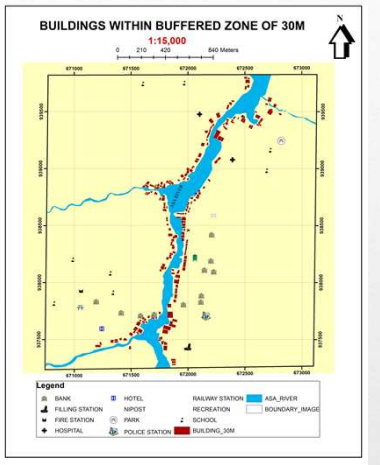
Buffering is the process by which zones of influence/interest around an entity or set of entities are created. It is often used to delineate areas not affected by a spatial activity or to show extent of coverage of an activity.

CRITERIA FOR THE BUFFER OPERATION

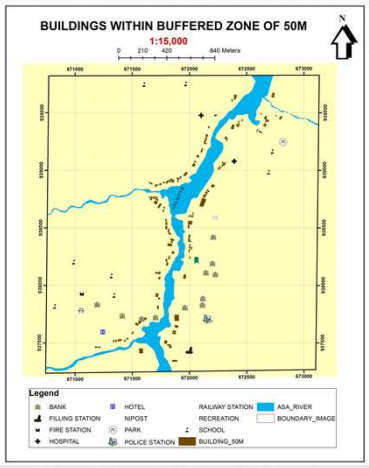
- Buildings must be at least 30meters away from the course of the river; Town and Regional Planning (Building Plan) Regulation, 1986.
- Fifty meters (50m) away from the river. This criterion was based on the previous flood extent experienced in the study area.
- Seventy meters (70m) away from the river. This criterion was included in this study to give room for eventualities "what if flood extends beyond the previous extents". Which areas will be affected under such circumstances



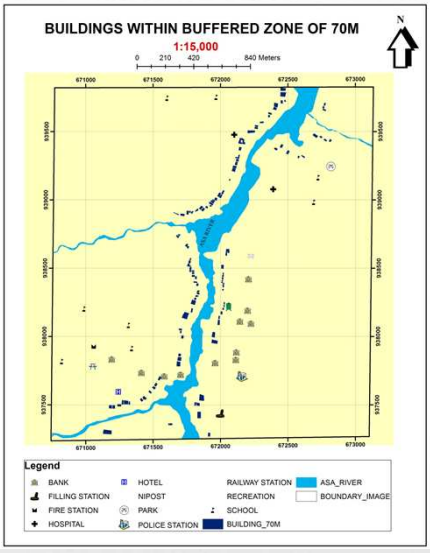
BUFFERED ZONES ALONG THE ASA FLOOD PLAIN



Buildings within 30m of buffered zone



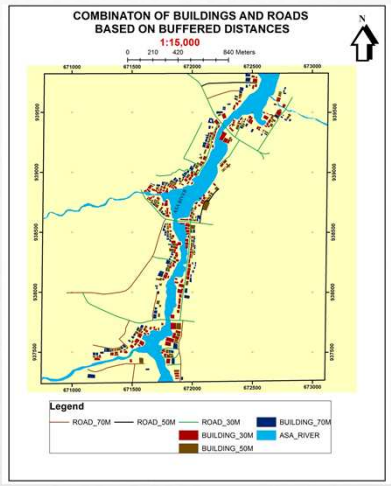
Buildings within 50m of buffered zone



Buildings within 70m of buffered zone

Overlay Operation

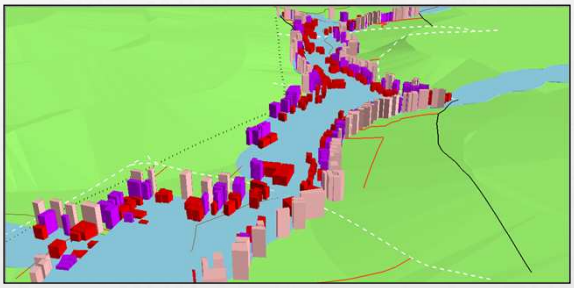
In this research, the buildings and roads were overlaid on the buffered zones



Combination of buildings and roads based on the buffered distances

3D Analysis

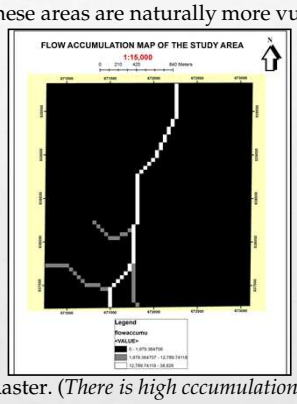
The shape of a surface determines the direction of water flow. The most common digital data of the shape of the Earth's surface is cell-based DEMs. The digital elevation model of the study area is given below



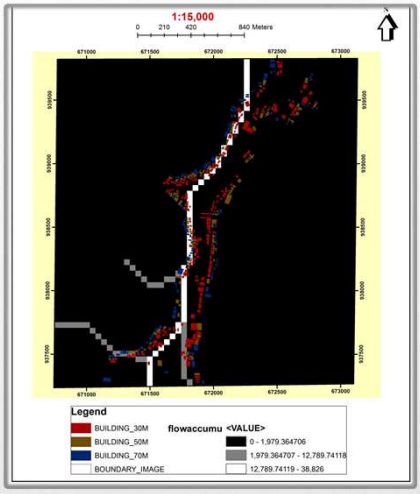
3D Scene of Buildings in ArcScene. The building area extruded based on the buffered distances of 30m (Red), 50m (Purple), and 70m (Brown).

Assessing the level of vulnerability using flow accumulation *(Criterion two for Vulnerability Map)*

In this research, the Flow Accumulation Function was used to generate the convergence point for the surface run-off. The buildings and other functions concentrated around these areas are naturally more vulnerable to flood



Flow Accumulation Raster. (*There is high cccumulation rate around the white areas*)



Overlay of buffered buildings (30m,70m,70m) on flow accumulation map to determine vulnerable zones

Categories of buildings at risk

ZONE	TOTAL
HIGH	51
MODERATE	22
LOW	30
TOTAL	103

Estimated population vulnerable to flooding

The study area is located in Ilorin West Location Government Area with a total population of 364666, land area of 98.4 Km^2 and population density of 3706 persons per square Kilometer (National Population Commission, 2006). Since personal geodatabase was used to create the themes, ArcGIS 9.3 automatically calculates the area of each of the buffered zones. The population density of the study area was used to multiply the areas of each zone to arrive at the population of the study area

Population Vulnerable to flood based on the buffered distance

ZONE	AREA (M^2)	AREA (KM^2)	POPN DENSITY	POPN AT RISK
30m buffer	726728.4	0. 7267284	3706	2693
50m buffer	973814.6	0.9738146	3706	3609
70m buffer	1219013.9	1.219013	3706	4518

Conclusion

Flood is an inevitable occurrence but it could be prevented and damage reduced through effective management and mitigation measures and giving sufficient information to residence and prospective developers. Geographic Information System is embedded with analytical capacity which can be used as a decision support system for prevention/mitigation, preparedness, response, recovery and also planning for operational activities; immediately before, during (taking initiative to evacuate people to save places) and after flood (reconstruction activities). This spatial analytical capacity was utilized for this study. To reduce the impact of flooding, adherence to appropriate building set back along Asa river corridor and dredging was recommended.

Recommendation

1. It is expected of the government to strictly enforce all relevant laws and edict that prohibit erection of structures along the flood plain. Development can be permitted in areas beyond 30meters but quality building materials that can withstand the impact of flooding must be used

1. Indiscriminate dumping of waste along the channel should be checked with penalty to violators of such policy