Ecological Risk Zone Mapping for Flood and Oil Spill in Delta State, Nigeria

Ojiako J.C, Igbokwe, E.C

Department of Surveying & Geoinformatics, Nnamdi Azikiwe University Awka, Nigeria

***Abstract* —** *The development of risk assessments inherently requires a significant amount of spatial data concerning the status, extent, and distribution of natural and manmade features. GIS systems provide the tools for storage, retrieval, and analysis of geographic information, and are uniquely suited to integrate multiple layers of information in the complex process of ecological risk assessment. This research paper attempted to map and characterizes the ecological risk zones for flood and oil spill in Delta State Nigeria, using Landsat 8 OLI and Shuttle radar topographic mission. Results show that the flood risk zones in the study area had 30.42% high risk area, 44.79% moderate risk area and 24.78% low risk area with 528,299, 777,793 and 430,164 hectares in area respectively. Also the results show about 68 settlements at risk of oil spill in Delta State Nigeria. It was recommended that contingency plans be developed to mitigate damages caused by ecological events to the environment.*

Keywords— Flooding, Geographic Information System, Risk Mapping, Remote Sensing, Oil Spill.

I. INTRODUCTION

Ecological risk assessment, which is based on the integrated multidisciplinary knowledge (including environmental science, ecology, geography, biology), is a new field of study for evaluating the risks associated with a possible eco environmental hazard under uncertainty. It uses the means of risk analysis, like mathematics, and advanced space technologies like remote sensing, geographic information system analysis, to predict, analyze and evaluate the damage that the uncertain disasters or accidents may bring for the ecosystem (Minxia et al, 2008). Ecological risk assessment aims to provide regional risk management theoretical and technical support. Ecological risk assessment aims to provide regional risk management theoretical and technical support (Minxia et al, 2008).

Within this context environmental risk Analysis deals mainly with the evaluation of uncertainties in order to ensure reliability in environmental issues, such as the utilization of natural resources, ecological preservation and public health considerations. This papers looks into areas that will be affected by flooding and oil spill in the study area. Flooding and oil spillage has had a serious devastating effect on the environment in Delta State Nigeria. This phenomenon has had profound impact on the natural environment by affecting the climate, soil, hydrological and topographic system, meanwhile, lead to the change of ecosystem structure and function, such as decrease of biodiversity and dramatic change in landscape structure, with no precise data that will aid in management of the damages cause by these events. Several techniques have been used to map flood hazard and risks. The conventional technique is mostly through the use of information on historical floods, soil maps, aerial photographs, hydrological modeling of the major rivers, use of National Digital Terrain Model (DTM) and water levels (Ojigi and Shaba, 2012). GIS and Remote sensing has therefore been introduced as a medium of data collection and analysis, this platform will help map and characterize the ecological risk zones in Delta State so as to have an effective decision making tool in the management and development of early warning systems for areas liable to risks caused by these events.

II. STUDY AREA

Delta State is an oil and agricultural producing state of Nigeria, with latitudes 5°0'0''N and 6°30'0''N and Longitudes 5°0'0'' E and 7°0'0''E (fig1.0) situated in the region known as the South-South geo-political zone with a population of 4,098,291. The capital city is Asaba, located at the northern end of the state, with an estimated area of 762 square kilometres (294 sq mi), while Warri is the economic nerve center of the state and also the most populated located in the southern end of the state. The state has a total land area of 16,842 square kilometres (6,503 sq mi).

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Fig.1: Map of Delta State Nigeria

III. METHODOLOGY

For a proper and effective optimization, planning is very important. In this phase of the project, a user requirement analysis was done to focus on what information is presently being used, who is using it and how the source is being collected, stored and maintained, the result output, data requirement, hardware and software selections and method to be used.

3.1 Data Used

Data used in this research includes;

- i. Landsat-8 OLI imagery of 2017
- ii. SRTM
- iii. Oil Pipelines & Oil wells shape file Data
- iv. Road and Settlements shape file data

3.2 Methods and Techniques

The method incorporated in this study involves image subset, remote sensing image classification techniques, flood mapping and oil spill mapping. Image subset was done on the LandSat8 OLI image in order to cut out the study area, after which a land cover map of the study area was produced using the supervised maximum likelihood classification algorithm in ERDAS Imagine 9.1 used by (Onojeghuo and Onojeghuo, 2013). The Srtm was used to delineate flood risk zones in the study area using elevation as a preset and Euclidean distance was applied in order to delineate oil spill zones in the study area.

IV. RESULTS

In this section, results of image analysis as obtained from the hard classification procedure of supervised (MLC) classification, flood risk zone and oil risk mapping are presented. Most of the discussions are supported by maps, tables and illustrative graphs.

4.1 Land cover / Land use Distribution of 2017

In mapping landcover/land use, four different classes were identified to include water body, swamp, vegetation and built up land. The classified image of Delta State is shown in figure 4.1

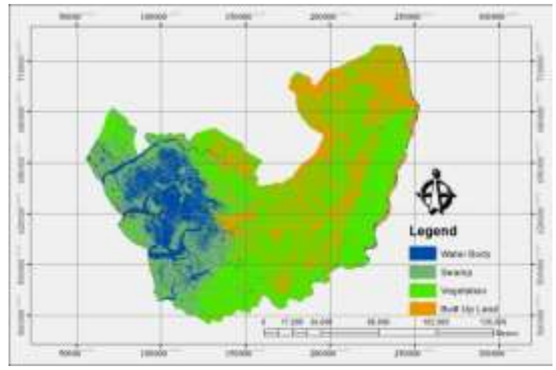

Fig.4.1: Landcover/Land use map of Delta State 2017

The land cover/land use distribution of Delta State as shown in table 4.1 indicate that Water Body, Swamp, Vegetation and Built Up Land accounted for about 12.01%, 18.22%, 44.06% and 25.35% respectively, with areas of about 215164, 313299, 770729 and 437064 hectares respectively.

Table.4.1: shows the Land cover/ Land use distribution for Delta State 2017

Class Type	Area (Hectares)	Percentage (%)
Water Body	215,164	12.01
Swamp	313,299	18.22
Vegetation	770,729	44.06
Built Up Land	437,064	25.35
Total	1,736,256	100.00

4.2 Flood risk zones

The Srtm was reclassified into risk zones according using 15m as benchmark at mean sea level of the study area. The result fig 5.2 shows that risk zones of the area reclassified as high risk, moderate risk and low risk.

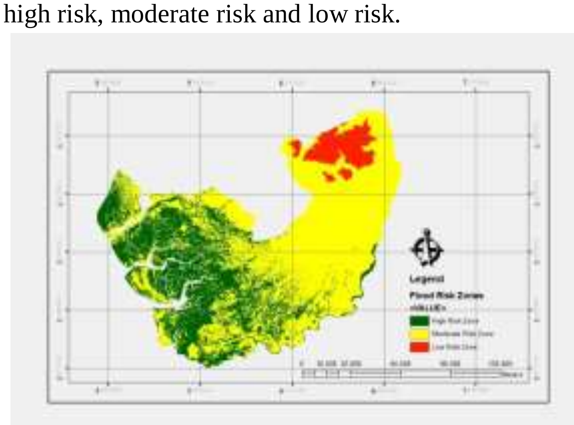

Fig.4.3: Classified flood risk zones

The high risk area accounted for 30.42% with 528,299 hectares as the area, while moderate risk accounted for

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44.79% with 777,793 hectares in area and low risk accounted for 24.78% with 430,164 hectares in area. The risk zone distribution is shown in table 4.2 while table 4.3 shows landcover/land use classes that will be affected by the risk zones.

Table.5.2: Risk zone distribution

Class Type	Area (Hectares)	Percentage (%)
High Risk Zone	528,299	30.42
Moderate Risk Zone	777,793	44.79
Low Risk Zone	430,164	24.78
Total	1,736,256	100.00

Table.4.3: Area of Landcover/Landuse classes that will be affected by risk zones

Water Body Affected (Hectares)	Swamp Affected (Hectares)	Vegetation Affected (Hectares)	Built up Land Affected (Hectares)
100433	221342	123432	83092
237439	197551	173822	169281
50987	60897	100967	217313
388,859	479,790	398,221	469,686

4.3 Oil Spills Risk Zones

1km buffer zones was applied around the oil pipelines and oil wells respectively, leading to a polygon feature datasets that describes the distances, this distance indicates features in close proximity to oil wells and oil pipeline will be affected in cases of oil spills from pipe vandalism and spills during drilling operations as shown in fig 5.3. Table 5.4 shows land cover/land use classes that will be affected by oil spill and table 5.5 shows settlements affected at risk of oil spill.

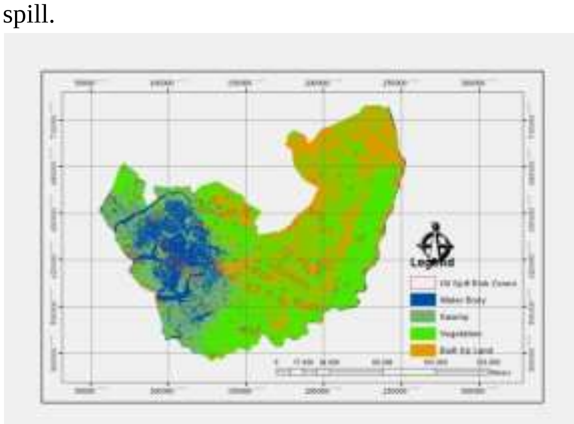

Fig.4.4: Oil spill risk zones

Table.4.4: Landcover/Landuse Class that will be affected by Oil Spill

Class Type at risk	Area (Hectares)	Percentage (%)
Water Body	20035	22.90
Swamp	20398	23.31
Vegetation	21392	24.44
Built Up Land	25693	29.36
Total	87518	100

Table.4.5: Settlements at risk of Oil Spill

Name	**Lga**
Odurubo	Bomadi
Toru-Angioma	Bomadi
Oboro	Bomadi
Gbaregolor	Bomadi
Kalatuo Island	Ugheli South
Olota	Ugheli South
Oghrughru	Ugheli South
Ogborogbene	Burutu
Ekoro	Burutu
Egbo – Uwheru	Ugheli North
Egbo	Isoko South
Ogulagha I	Burutu
Okuntu	Burutu
Yobebe	Burutu
Ukuowhe	Isoko South
Oteri	Isoko South
Igbide	Isoko South
Unenurhie	Ugheli North
Agbawa	Isoko South
Ovworigbala Jeremi	Burutu
Torogon Location	Ugheli South
Otu-Ghievwen	Okpe
Otujeremi	Okpe
Ole	Isoko South
Udo	Isoko South
Okpari	Ugheli South
Iwhreka (E.U.D.C.)	Okpe
Otor Udu	Okpe
Egini	Okpe
Igbide	Isoko South
Ekpe	Isoko North
Igbide	Isoko North
Aladja	Warri South
Ighwremaro	Ugheli South
Awnremaso	Unknown

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Eriem Fields	Ugheli North
Ekakpamre	Ugheli North
Agbarha-Otor	Ugheli North
Iwrogbovwa	Ugheli North
Ogunu	Warri South
Ajisimigi	Warri North
Omavovwe	Ugheli North
Iwremeragha	Ugheli North
Ovwiammuge	Ugheli South
Ogidigben	Warri North
Oghrerhe (E.U.D.C.)	Ugheli North
Emanweta	Isoko North
Ododegbo	Ugheli North
Ovrode	Isoko North
Oburu	Warri South
Ovwori	Ethiope East
Jeddo	Warri South
Madagho-Ajeda	Warri North
Okegbe	Warri North
Ughotor	Warri South
Obiegwa	Warri South
Ugbegungun	Warri North
Egwatie	Warri South
Okoh Idiovwa	Ugheli North
Ero-Ikeh	Ugheli North
Ubaoke	Warri
Ovara-Unukpo	Ugheli North
Eroh-Obaro	Ugheli North
Agborhoro	Ethiope East
Olagwe	Warri South
Opomu	Warri South
Agokutu	Warri
Degbrode	Sapele

V. CONCLUSION

GIS technology has evolved from several disciplines, including cartography, remote sensing, geography, and information management, and is in part the result of a mapping automation process that has evolved over the past 20 years. Advancements in microprocessors, computer graphics, imaging, and relational database management systems have made GIS technology a viable and predominant technology for investigating the complexities of ecological systems.

GIS and remote sensing has demonstrated its usefulness in mapping and characterizing ecological risk zones in Delta State, the results analyzed in the research will enable develop an early warning system for flooding events and aid in managing and preventing damages caused by oil spillage.

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