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Evaluating Erosion using Remote Sensing and GIS Technique: A Case Study of Mada Town, Zamafara State

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ABSTRACT

Soil erosion is a gradual process that occurs when the impact of water or wind detaches and removes soil particles, causing the soil to deteriorate and lead to significant impacts such as significant decrease in the productive capacity of the land and sedimentation. Mada town in zamfara state has experienced loss of farm lands due to erosion in the mada stream area. This research studies the quantification of soil erosion by measuring the increment on the size of the stream for a twenty years period from year 2000 to 2020. Remote Sensing (RS) and Geographic Information Systems (GIS) techniques have been implemented for the assessment of the rate of erosion in the study area. Landsat satellite imageries for 2nd April, 2000, 7th April, 2010 and 25th May, 2020 were processed and digitized to map the stream boundary for each image to obtain the area enclosed by each. The results shows that from 2000 to 2010 and 2010 to 2020 there is an increase in size by 31849.8497 m² and 33767.7233 m² respectively. It also shows that area eroded from 2000 to 2020 is 65617.5730 m² which is the farm land area lost by erosion in the study area which if not addressed may lead to more farm lands in the future. The research ends by recommending policies such as providing vegetation cover which will reduce the impact of erosion in the study area.

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I. INTRODUCTION

Soil erosion is the detachment and transport of soil particles by erosive agents, most commonly water and/or wind. Soils generally take thousands of years to develop from their original parent material, and natural erosion is a part of this development process (Flanagan, 2013). The most important climate variable in soil erosion processes is rainfall erosivity, which is related to rainfall amount and rainfall intensity. Soil erosion is relatively related to rainfall, partially because of the shedding power of raindrops falls on the soil surface and partially because of the involvement of rainwater to surface runoff (Bochet, 2004).

With the presence of GIS competencies, the efforts have been directed to be based on spatially distributed models simulating erosion dynamics and surface runoff of more complex and larger catchments

Spatial data are required for the assessment of erosion. Satellite data can play an important role, both for the detection of erosion features and eroded surfaces, and for the assessment of erosion determining factors like topography and vegetation cover (Vrieling, 2004).

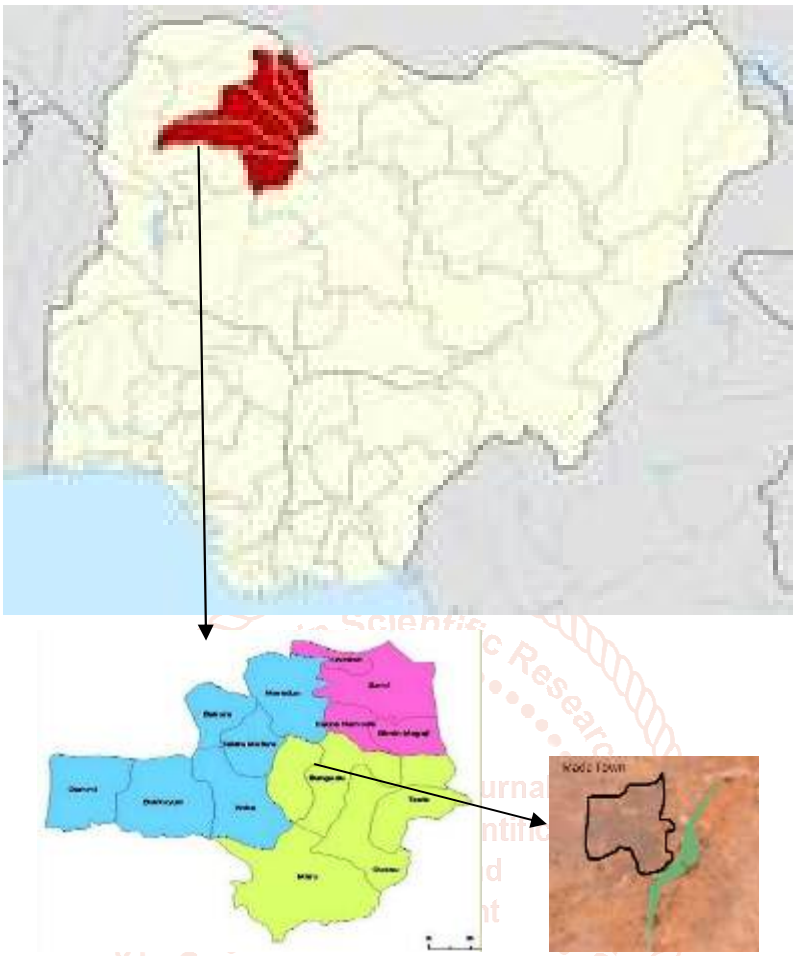
GIS is used to capture, display, and analyze data spatially. GIS combines layers of information about a place to give users a better understanding of that place. Unlike a flat paper map, a GIS-generated map can present many layers of different information that provide a unique way of thinking about a geographic space (Cova, 1999). By linking maps to databases, GIS enables users to visualize, manipulate, analyze, and display spatial data. GIS technology can create cost-effective and accurate solutions in an expanding range of applications. GIS displays geographic data as map layers and can be used to model erosion (Cova, 1999).

The study will explore the potential use of satellite imagery for assessing erosion within the stream in mada town of Zamfara state.

II. STUDY AREA

Mada is a town in Mada district of Gusau local government in Zamfara State of Nigeria. It is Located 31.3Km away from Gusau the capital of the state. It is located 12.121065 Lat and 6.940982 Long.

Map of Nigeria



Map of Zamfara State Map of Mada Town

Figure 1: Map of the study area.

III. METHODOLOGY

Materials Used

The materials used are software and hardware.

A. Software and hardware used

The hardware used are:

1. Hp Laptop computer.
2. Handheld GPS (Garmin 76).
3. ArcGIS v10.3 Desktop
4. Microsoft Office version 2016
5. Landsat satellite imageries of 30m spatial resolution for bands 1 to 7 and 15m resolution of band 8for 2nd April, 2000, 7th April, 2010 and 25th May, 2020.

Methods

The procedural steps used in the research are summarized in Figure 1

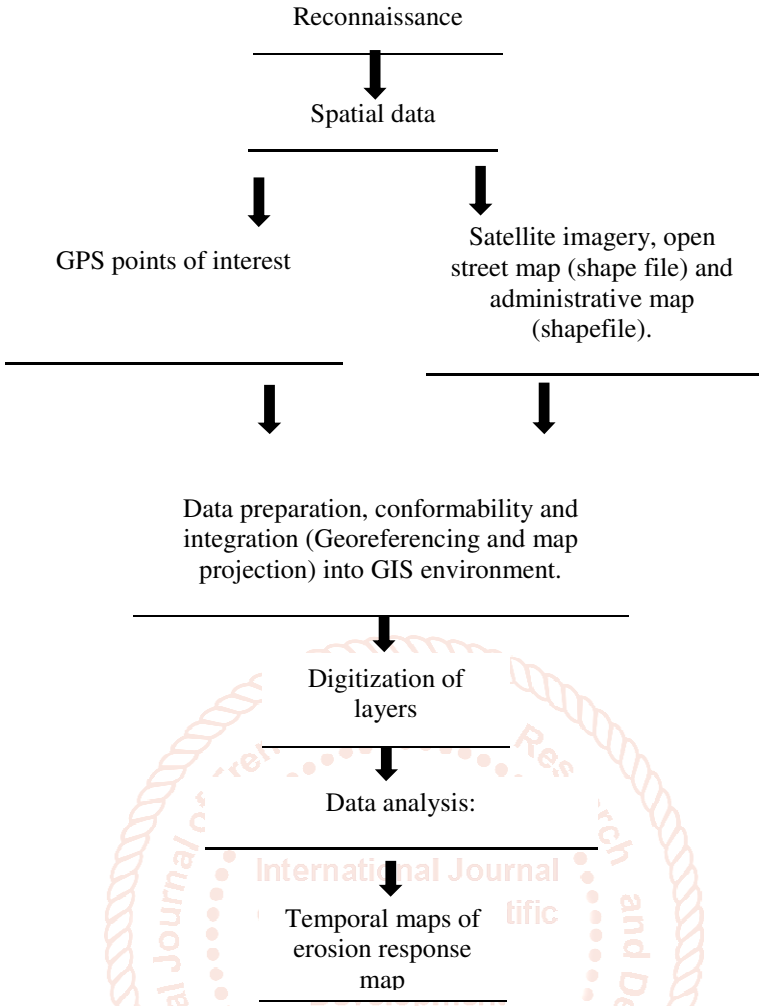


Figure 2: A flow diagram of the steps used in carrying out the research.

Reconnaissance:

A general inspection was carried out on the study area by the observation of the satellite imagery in order to ascertain the type, location, and spatial data to be acquired.

Data collection and collation:

Spatial data in terms of latitude and longitude was collected for all point of interest such as mada town and the erosion site. Such data was collected through physical survey of the area using Garmin hand-held GPS equipment. All point locations were collected in latitude and longitude format to maintain consistency.

Satellite imagery covering the study area of 2000, 2010, and 2020 were acquired. It came georeferenced to geographic coordinate system in latitude and longitude. Subsequently, these datasets were all projected to UTM WGS 84 zone 32N so as to serve the purpose of a map.

Data preparation and integration:

The various datasets collected in their raw format were processed for better interpretation and integration of the data for subsequent analyses. All datasets were converted to projected UTM WGS 84 zone 32N coordinate system and this was maintained all through so as enable synchronization of vector and raster data for compatibility.

Digitization of layers:

All the required datasets were digitized i.e. converting features into a digital format. This was done to make it possible to plot/map these data in ArcGIS environment. Shapefiles were eventually created from these tabulated data in ArcCatalog, for further analysis in the course of this study.

The satellite imagery covering the study area was used as a base map or image. Furthermore,

In this study, the on-screen method of digitizing was used to digitize the eroded areas.

IV. RESULTS AND DISCUSION.

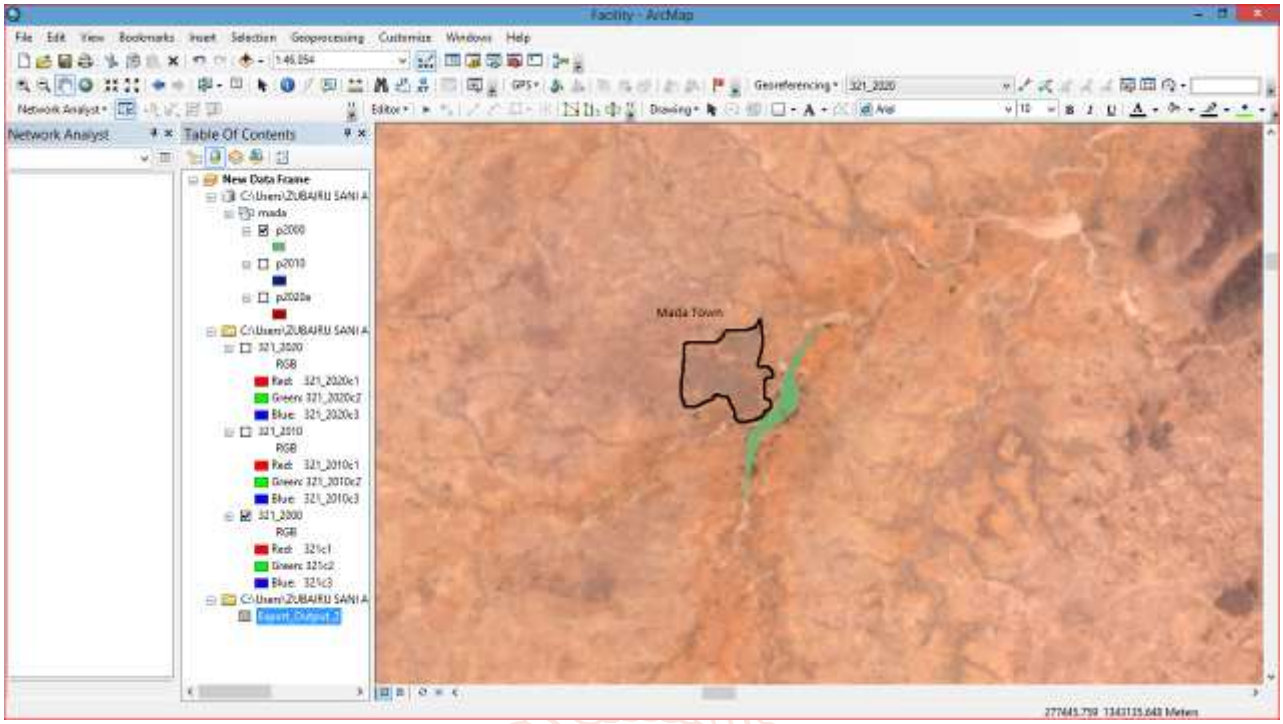


Figure 3: Shows ArcGIS widow of the stream and Mada Town.

Figure 4: Shows an overlapping image of 2000, 2010 and 2020 maps of the stream. The green colour shows the stream boundary in 2000, the blue colour shows the stream increment in 2010 and the red colour shows the stream increament in 2020.

Table 1: Shows the Area of the stream in meters square per year

Year	area(m²)
2000	267146.6729
2010	298996.5226
2020	332764.2459

Table 2: Changes between 2000 to 2010

year	area(m²)	diff in area(m²)
2000	267146.6729	31849.8497
2010	298996.5226	

From Figure 4 and table 1 it shows that in 2010 there is an increase in the area covered by 31849.84967 m².

Table 2: Changes between 2010 to 2020

year	area(m²)	diff in area(m²)
2010	**298996.5226**	**33767.7233**
2020	**332764.2459**	

From Figure 4 and table 2 it shows that in 2020 there is an increase in the area covered by 33767.7233 m².

Table 3: Changes between 2000 to 2020

year	area(m²)	diff in area(m²)
2000	**267146.6729**	**65617.5730**
2020	**332764.2459**	

From Figure 4 and table 3 it shows that in 2020 there is an increase in the area covered by 65617.5730 m²

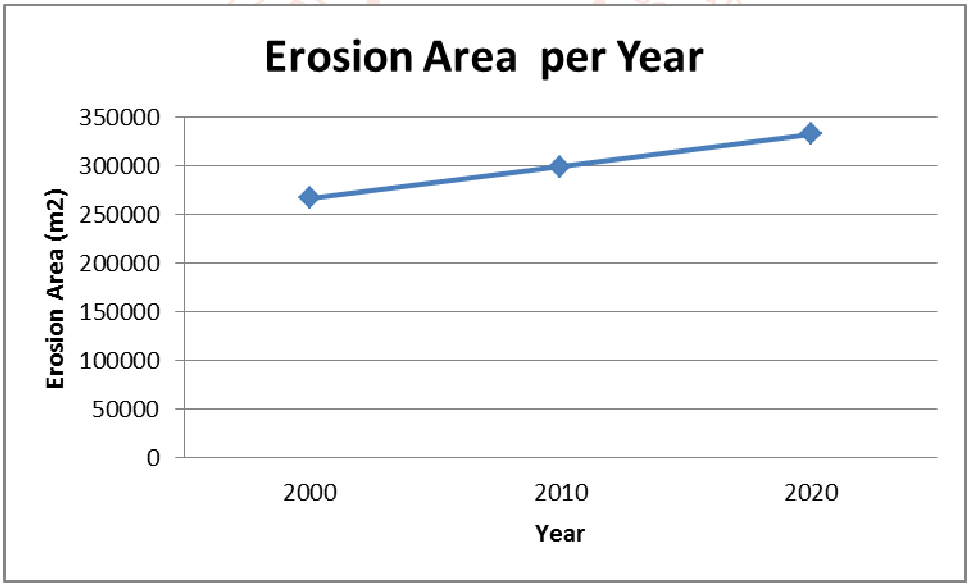


Figure 5: Graph showing area in m² by year

The graph shows how the stream gradually expands from the year 2000 to year 2020.It shows that it increases from the year 2000 to 2010 and also increases from year 2010 to 2020.

V. CONCLUSION

Remote Sensing and Geographical Information Sciences (GIS) has been applied in the analysis of erosion in Mada town of Z amfara State. A detailed assessment of erosion was achieved through the combined visual interpretation of landsat satellite imageries of 10 years interval i.e for 2000, 2010,and 2020. Therefore, findings were observed from the analysis. For 20 years i.e from 2000 to 2020 there is an increase in the area covered by the stream by 65617.5730 m².a

VI. RECOMMENDATION

A. Adequate measures should be taken by government to halt people from building houses near the erosion area.

B. Government should take necessary measures to control erosion in the study area.

C. Activities such as obtaining sand from the stream should stop to avoid more erosion.

D. Vegetation should be provided to reduce the rate of erosion in the study area.

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